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Wetland Creation and Restoration: Description and Summary of the Literature

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Wetland Creation and Restoration: Description and Summary of the Literature

by

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Preface

The Wetland Creation/Restoration (WCR) data base was developed to compile information concerning the creation and restoration of wetlands and to provide a state-of-the-knowledge resource based on the published literature. This report provides a hard copy of the bibliographic material contained in the digital WRC data base for individuals that do not have access to or training in microcomputer use.

The estimated annual loss of wetlands between the mid-1950's and mid-1970's averaged 458,000 acres (Tiner 1984). Wetlands continue to be lost or degraded in spite of recent wetland protection regulations and policies. Recently, the President of the United States incorporated the goal of "no net loss of wetlands" into his Protecting the Environment agenda and recommended a redirection or expansion of Federal research and development programs directed towards effective wetland creation, restoration, and maintenance. This report and the companion data base (Schneller-McDonald et al. 1988) provide an essential starting point by compiling the published technical and semitechnical literature into highly indexed, coded, and annotated records to aid researchers, regulators, developers, policy makers, and the public in understanding the breadth and extent of current knowledge on this subject. We attempted to focus on literature dealing with restoration and creation of wetland functions, primarily through case studies, and on literature dealing with the evaluation of restoration or creation success. We intend to update and maintain this specialized data base as the science of wetland functional restoration and creation emerges.

The WCR data base comprises 1,100 records, each representing one article, report, or other publication. Sources were initially taken from the Society of Wetland Scientists' publication *Wetlands* (Wolf et al. 1986), which listed 304 items. In addition, we used conference and symposium proceedings, government reports, Current Contents, and several data bases, including BIOSIS, AGRICOLA, and ENVIROLINE (available on-line from Lockheed DIALOG). Bibliographies and references from these initial sources provided additional materials for inclusion in the data base.

The majority of these sources are from published literature; several were in press at the time of data entry, and a few were available only as preliminary unpublished reports. Common knowledge suggests that much information is contained in unpublished reports and documents; however, if original source information is not published or otherwise accessible, it is essentially unavailable for use as a guide to actual wetland creation and restoration efforts. We hope more of this information will be published in the future.

The WCR data base is available for use in a computer data base management system as described in Appendix A.

Questions about the WCR data base should be addressed to:

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ABSTRACT.—This report provides a hard copy of the bibliographic information contained in the digital Wetland Creation/Restoration Data Base. One thousand one hundred data base records are included; each of these represents one article, report, or other publication dealing with the creation or restoration of wetlands. Information contained in the data base records is (1) introduced in a description of all fields and keywords, (2) summarized in terms of findings in a set of graphs and tables, and (3) accessible via a cross-referenced index divided into four sections (Location Index, Plant Genus Index, Wetland Type Index, and Subject Index).

The Wetland Creation/Restoration (WCR) data base is intended to address the need for additional information pertaining to wetland creation and restoration, and the need for better aecess to existing information. The WCR data base provides information that can be used for (1) evaluating the success of wetland creation and restoration used as mitigation for wetland loss, (2) establishing consistent criteria for determining wetland creation and restoration success, (3) providing solutions to problems that contribute to creation or restoration failure, and (4) planning and implementing wetland creation and restoration projects to improve chances for project success. The following paragraphs provide a brief background for these information needs.

Although the rate of loss and remaining wetland acreage estimates vary, general trends are apparent: (1) the rate of wetland loss is estimated to be between 300,000 and 458,000 acres per year, and (2) of the original 215 million acres believed to exist in the conterminous United States, only about 95 million acres remained in 1987 (Feierabend and Zelazny 1987).

According to Tiner (1984), wetland gains have been made in inland ponds and unvegetated wetland flats, while significant losses are reported for palustrine forested wetlands, palustrine emergent wetlands, estuarine wetlands, and palustrine scrub–shrub wetlands (Fig. 1). These figures are from the mid-1950's to the mid-1970's and reflect a gain of 2.3 million acres of two wetland types, ponds and inland unvegetated wetland flats. Most of the 2.1 million acres of ponds (largely farm ponds) were created in uplands, although 530,500 acres of forested and emergent wetlands were changed to open water. The impressive 2.1-million-acre gain in created wetlands reported by Tiner should not be construed to be the result of any organized wetland conservation effort aimed at in-kind replacement of lost wetland acreage or function. No comparable figures for acreage of created or restored wetlands exist on a national or regional basis. Consequently, the contribution of wetland creation and restoration activities towards achieving the "no net loss of wetlands" policy goal cannot be accurately assessed.

While effective wetland protection involves the preservation of natural wetlands as a first choice, mitigation for wetland loss has beeome a significant means for achieving the goal of protection. As defined in the Federal Register (40 C.F.R. Section 1508.20), mitigation includes the following: avoiding impact, minimizing impact, rectifying impact, reducing or eliminating impact, and compensating for impact. Mitigation should occur in a sequence of avoidance of impacts

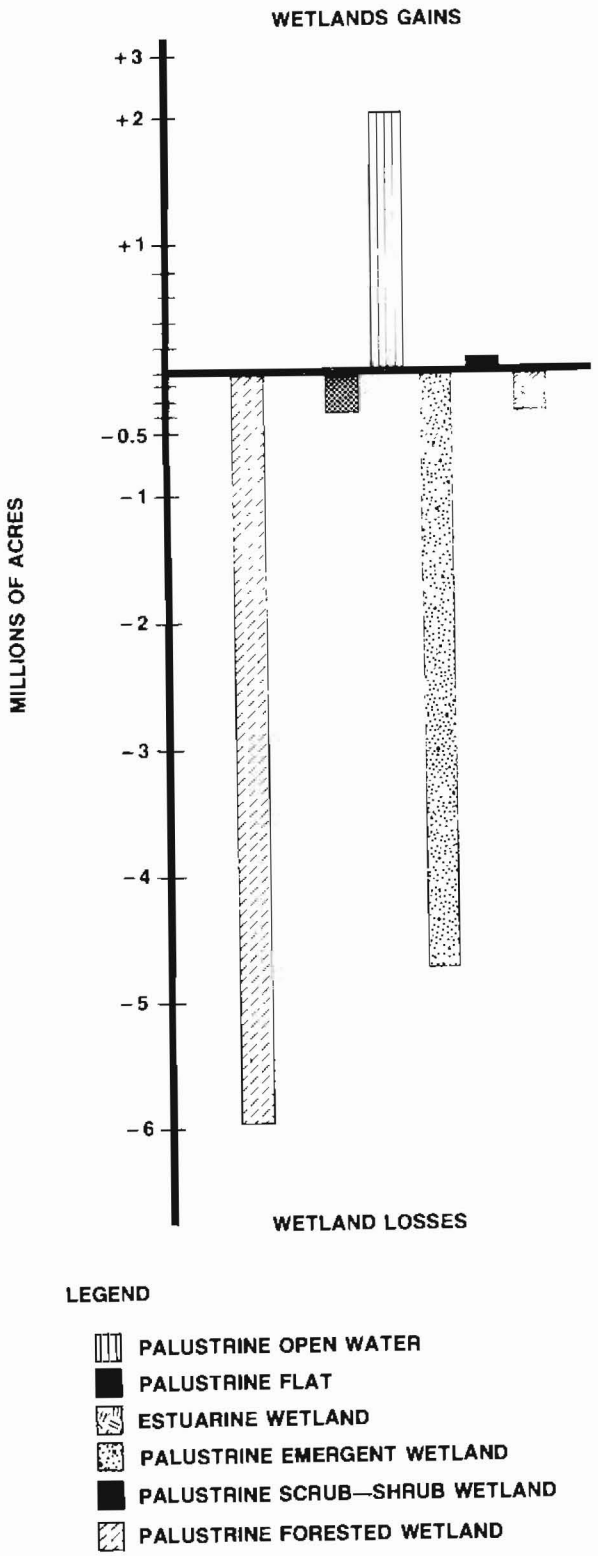


Fig. 1. Wetlands gained and lost in the conterminous United States between the mid-1950's and the mid-1970's (from Tiner 1984 and Frayer et al. 1983).

first, then minimization of impacts, and finally, compensation for unavoidable impacts. Wetland creation and restoration are often employed as mitigation for wetland loss, and while the success of such mitigation is often assumed, it is less often documented. If the success of such projects is not carefully evaluated in terms of wetland functions, wetland losses may continue to occur despite creation and restoration efforts. A successful policy of no net loss of wetlands depends on project monitoring and success evaluation.

It is often assumed that wetlands restored or created to replace those lost to construction, filling, draining, or contamination are successfully constructed systems that effectively duplicate the functional values and self-sustaining characteristics of the original (natural) wetland. However, information gleaned from extensive review of existing literature (Golet 1986; Ischinger and Schneller-McDonald 1988; Kusler 1988; Larsen 1988; Quammen 1986; Tiner 1984) pertaining to wetland creation and restoration fails to support this assumption.

The lack of consistent criteria for evaluating project success is also apparent from a review of the literature. Information needs pertaining to such evaluation include (1) defining success, (2) defining project objectives, (3) modifying success criteria so that they can be applied to different wetland types in different regions, and (4) comparing restoration and creation and determining whether each requires a separate set of criteria for success.

Wetland restoration and creation can be complex endeavors; wetland creation is especially difficult because of the complexities of creating the correct soil and hydrologic conditions. While a number of wetland restoration or creation projects have been successful, at least in some aspects, others have failed outright or are non-functional. It is unclear from the literature whether created wetlands can functionally duplicate natural systems and effectively replace wetland loss.

Wetland creation is usually more difficult to achieve than wetland restoration. This is due mainly to the difficulty of creating a suitable, self-sustaining hydrologic regime—the foundation on which any wetland is built. Some wetland types are more difficult to create or construct than others (e.g., bottomland hardwood wetlands vs. emergent freshwater marsh). Restoration success also varies among wetland types; some wetlands can be restored relatively quickly if existing hydrologic conditions are suitable (e.g., low salt marsh).

Reasons for failure of wetland restoration and creation projects include the following (Conservation Foundation 1988):

- lack of clearly stated project goals

- lack of adequate maintenance, monitoring, and management activities after the completion of the initial construction
- poor planning or design
- inexperienced or untrained workers
- invasion of undesirable vegetation
- poor understanding of the replaced wetland or general wetland system parameters
- lack of adequate funding
- the failure to establish proper hydrologic conditions
- lack of application of criteria for success.

If these problems are addressed, the probability of success may be increased.

All of the aforementioned issues indicate a need for more information and easier access to existing information. The WCR data base serves as a guide to wetland restoration and creation information, including identification of researchers, project locations, techniques that have been used, project costs, and project evaluation. The purpose of the data base is to enable users to benefit from the experiences and research of others and to facilitate the distribution of pertinent information, thereby increasing the chances for project success.

Report Contents

This report describes the information contained in the WCR data base in three main sections: (1) Description of Fields and Summary of Record Information, (2) Indexes, and (3) Data Base Records.

The description of fields defines and describes all fields and key words contained in the data base records. Each record represents a discrete literature reference or article possessing a unique item number. This section alerts the reader to subtleties that might not otherwise be apparant in the use and meaning of key words and fields. Understanding of all key words and fields as they are used in the WCR data base is essential for the most effective use of the other sections of this report. Record information is briefly summarized by field in graphs and tables. These summaries provide the reader with an idea of what information may be found in the data base on a particular subject.

The indexes consist of selected key words and subject combinations, and they list item numbers for those records containing the information specified. Thus, the indexes are used to locate individual data base records that contain specific types of information. There are four indexes: (1) Plant Genus (the 120 plant genera most frequently discussed in the data base records), (2) Location (the locations of wetland creation and restoration projects or studies), (3) Subject (selected key words or key word combinations representing a variety of creation and restoration subjects), and (4) Wetland Type. Examples of index use are provided.

The data base records are intended for cross-referencing with the indexes. The records are arranged in alphabetical order by author and in numerical order by item number. Each data base record here is based on seven selected fields from each entry in the computer data base: author, year, title, source, response, plant genera, and annotation. The data base records in Appendix C differ slightly from the computer entries. Some fields are concentrated and minor editorial changes have been made for this publication.

Description of Fields and Summary of Record Information

The following descriptions correspond to the information contained in each complete record of the WCR data base. The fields included in the data base records in this report are denoted by an asterisk (*).

Author*

The author's name is entered last name first, followed by initials.

Year*

This is the year of publication of the article. Articles are reported from 1940–88. Although the data base is not all-inclusive, it is clear that work in the field of wetland restoration and creation began to increase substantially in the mid-1970's (Fig. 2).

Title*

This is the complete title of the article or report.

Source*

Source is the bibliographic citation.

State

This field denotes the location by State(s) or foreign country of the wetland(s) discussed in the reference. State names are abbreviated according to U.S. postal code. For articles discussing wetlands located in 1–10 different States, the States are listed individually; more than 10 States are recorded as "many." The number of times a particular State appears in the data base as a location is shown in Table 1. Many records contain multiple location entries. For articles pertaining to wetlands outside the United States, this field contains the name of the country where the study was conducted.

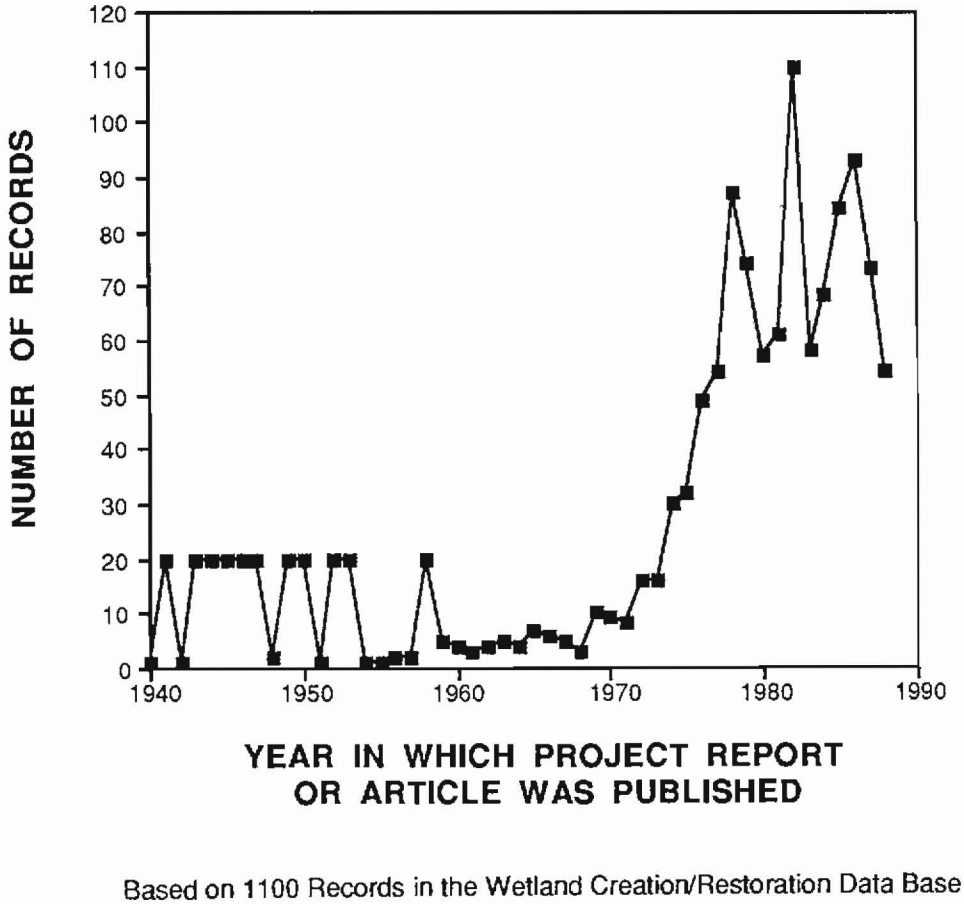


Fig. 2. Wetland Creation/Restoration articles in the data base.

About 8% of the records in the data base discuss projects in foreign countries. Of this 8%, one-third are located in Canada, and most of these are from Ontario. England and Sweden are the next most frequent foreign project locations, each with about one-tenth of the 8%.

USFWS Region

This field contains the U.S. Fish and Wildlife Service Region number that corresponds to the State(s) discussed in the article. There are seven regions (Fig. 3). "Many" is used in this field when the article is general and pertains to any or all regions or when regional location is not specified in the article.

The highest number of published reports were from Region 4 (the Southeast), followed by the Northeast and the Pacific States (Table 2).

Ecoregion

This field codes the geographic focus of the article by ecoregion (province/section level; Fig. 4). Ecoregions are coded as "many" if there are more than 10 or if the article is general in content. This field contains a blank space only if a foreign country is listed in the State field.

Table 1. *Location entries by State in the Wetland Creation/ Restoration data base.*

Number of occurrences in the data base	State
0	Kansas, Vermont
1–10	Alaska, Arkansas, Delaware, Hawaii, Idaho, Kentucky, Maine, Montana, Nebraska, New Hampshire, New Mexico, Nevada, Oklahoma, Rhode Island, South Dakota, West Virginia
11–20	Arizona, Connecticut, Iowa, Massachusetts, Michigan, Missouri, North Dakota, Ohio, South Carolina, Tennessee, Utah, Wyoming
21–30	Alabama, Colorado, Georgia, Indiana, Mississippi, New Jersey, Pennsylvania, Wisconsin
31–40	Louisiana, Maryland, Minnesota, New York, Washington
41–50	Oregon, Virginia
52	Illinois, Texas
67	North Carolina
124	California
202	Florida

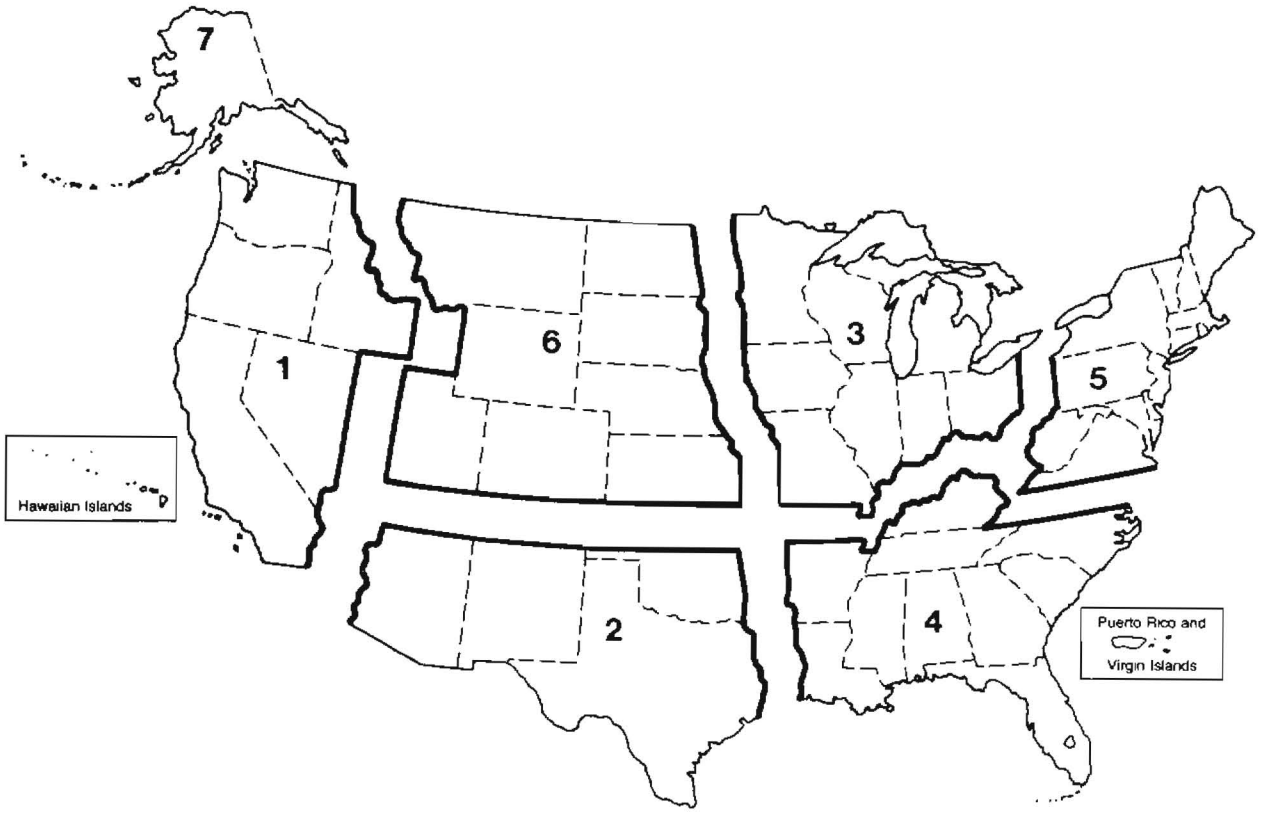


Fig. 3. U.S. Fish and Wildlife Service Regions.

Study Type

This key word field describes the nature of the study or article by any combination of the following key words.

Program. Program refers to articles that emphasize the legal, regulatory, institutional, or administrative aspects of wetland creation or restoration. It includes the development of project guidelines, management plans or programs, and Federal or State policies.

Overview. Overview denotes a general survey or summary that does not report specific results. Subjects for overview articles include general summaries of wetland restoration projects, reasons for the success or failure of restoration efforts, site surveys, environmental conditions, cost surveys, and functions of restored or created wetlands.

Table 2. *Frequency of appearance of U.S. Fish and Wildlife Service Regions in the data base.*

Region	Percent of total records
1	20
2	10
3	15
4	36
5	21
6	7
7	1

Technique. Articles coded with this key word emphasize methods or procedures used in restoring or creating wetlands. Some examples are seedling culture, seedling anchoring, planting methods, propagation, aerial photography, and techniques for improving water quality.

Case. A case study describes or evaluates a particular wetland creation or restoration project at a particular site.

Comparative. A comparative article includes information on multiple sites or actions. It may compare several case studies, evaluate similarities or differences in the results of several case studies or creation/restoration projects in general, or examine similarities and differences between natural and artificial wetlands.

The studies included in the WCR data base are fairly evenly distributed among case, comparative, and overview. The most frequently listed key word is technique. Of 470 records containing this key word, 45% deal with estuarine or marine systems, and 57% deal with freshwater systems (palustrine, lacustrine, river-

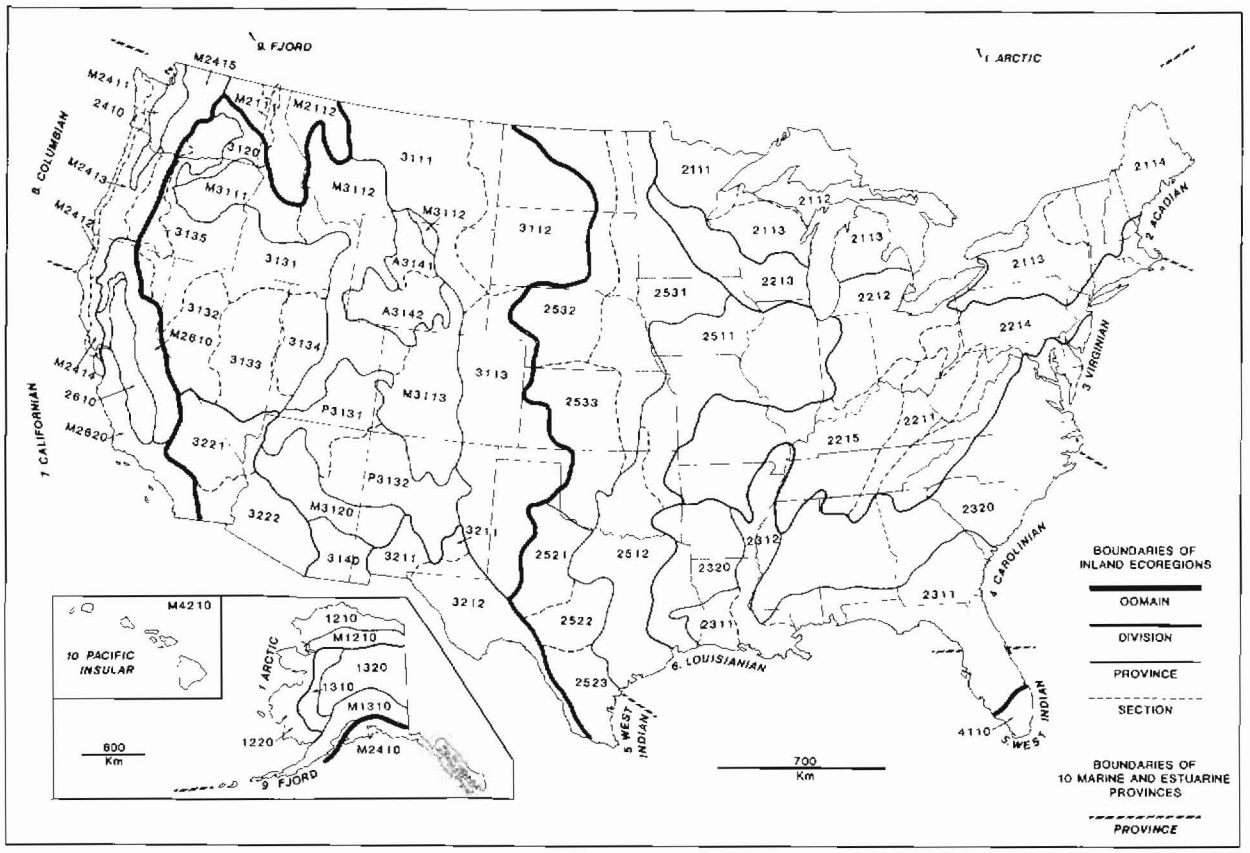


Fig. 4. Ecoregions of the United States from Bailey (1980) with the addition of 10 marine and estuarine provinces proposed in Cowardin et al. (1979).

ine. These figures do not equal 100% because some records contain multiple wetland type entries.) Techniques are most frequently associated with planting or seeding and landforming activities.

Objective

The objective is the reason, emphasized in the text of the publication, for the creation or restoration of a wetland, or for a related study. Usually, it is based on the functions performed by the wetland and resultant wetland values. There are eight key words in this field. Key word abbreviations as they appear in the data base are noted in parentheses.

Habitat. The wetland creation or restoration effort results in enhanced wetland habitat or food chain support for birds, mammals, fish, invertebrates, reptiles, or amphibians.

Harvest. The wetland creation or restoration effort is directed towards the production of food or fiber (e.g., timber, wild rice, oysters, crayfish).

Erosion. The wetland is created or restored to control erosion or stabilize shoreline and sediment.

Hydrology (Hydro). This key word refers to the hydrologic value derived from the wetland creation or restoration effort. The functions of a wetland, due to characteristics of its water regime, may include flood control, water supply, groundwater recharge, or stormwater retention.

Water Quality (Wquality). The created or restored wetland improves water quality through filtration of contaminants (such as heavy metals), sediment trapping, nutrient sink functions, wastewater treatment, reduction of pollutant load from urban or agricultural runoff, or uptake of dissolved pollutants by wetland plants. This also includes the cleanup of contaminated waters as part of the restoration process.

Experiment. A wetland is created or restored as part of an experiment or is used as the site for related experimentation (may be laboratory or field).

Incidental. A wetland is created without intention or calculation as a consequence of some other action or project, such as construction of a highway or reservoir.

General. General is used when specific objectives were not clearly identified. Some examples include aesthetics, research, recreation, and mitigation (replacement or compensation for wetlands that have been damaged or destroyed). Excluding the "general" category, experiment and habitat were cited most frequently as project or study objectives (Fig. 5).

Action

Action describes the procedures, activities, and methods employed in the creation or restoration of a wetland. Actions are undertaken to achieve the objectives defined in the previously described field. This field includes 15 key words.

Landform (Lform). This is the modification of topography by landforming or earthmoving. Some examples are dike or levee construction or breaching, changing the elevation of the site, channel construction or blocking, construction of wildlife habitat features (ponds, nesting sites), backfilling, grading, and contouring.

Spoil. This is a special case of landforming involving the use of dredged materials (spoil) for wetland creation (e.g., salt marsh creation on dredged material, diking, filling with dredged material).

Seed. This is the dissemination of seed by artificial means. It includes the use of mulch as a seed source.

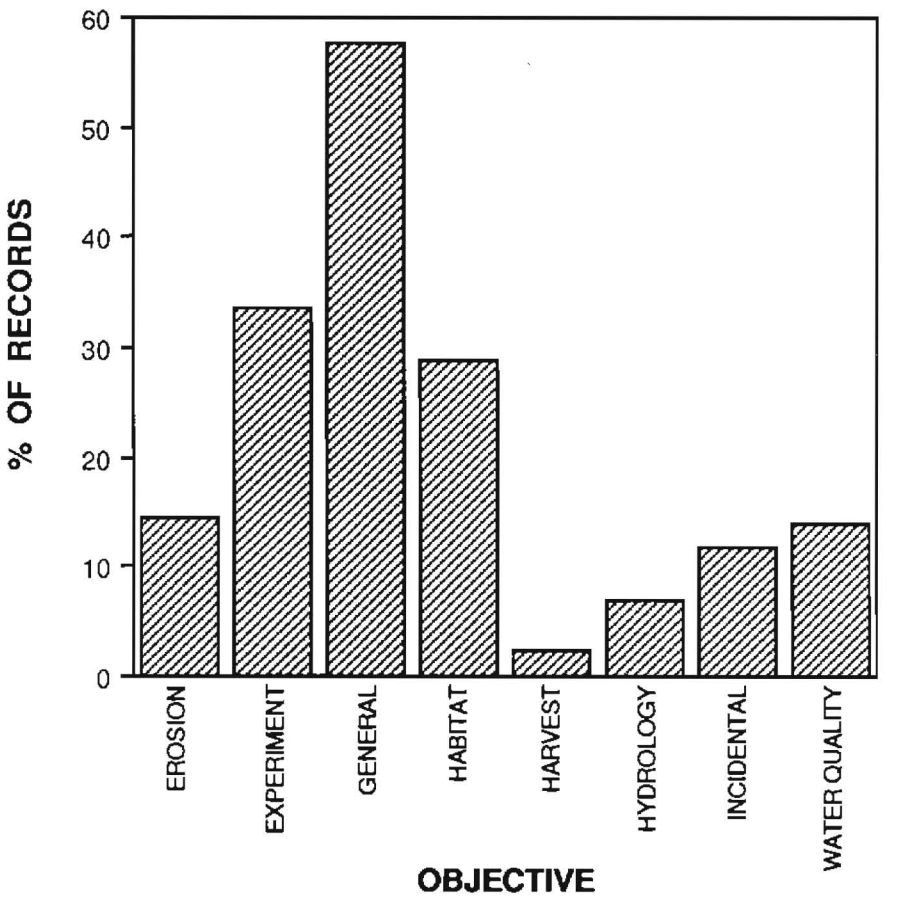
Plant. This is the introduction of plants as part of the wetland restoration or creation process, including planted seedlings, transplants, or cuttings.

Soil. This is the addition of soil (including peat or topsoil) to the wetland site, including surface preparation, such as disking or the removal of debris and litter. Peat inoculation may also be coded as Seed if its role as a seed source is discussed.

Stocking (Stock). Stocking is the artificial introduction of animals to the wetland project site.

Hydrology (Hydro). This action refers to the active manipulation of the hydrologic regime (e.g., stop-log spillway operation, drainage, pumping). It does not include those actions described under Landform.

Biocide. This is the application of biocides as a management action to eliminate or reduce undesirable species. For example, herbicides may be applied to remove unwanted plant species before planting preferred species.



Based on 1100 Records in the Wetland Creation/Restoration Data Base

Fig. 5. Objectives of wetland creation restoration projects.

Cut. The removal of vegetation by cutting, thinning, or mowing is a management action to maintain or encourage growth of desirable plant species.

Fertilization (Fert). Fertilization includes the application of chemical fertilizers, hormones, rooting agents, or commercial growth regulators. For the purposes of this data base, it does not include topsoil, peat, or organic matter; these are entered under Soil.

Fire. Prescribed burning may be used as a management tool in wetland creation, restoration, or maintenance.

Stabilization (Stabil). Stabilization denotes the use of riprap, wave breaks, or mesh to stabilize streambanks, shorelines, or substrate, or to reduee wave energy or stress. It includes containment structures or materials (e.g., hay bales for containing spoil), concrete revetments, bulkheads, gabions, sod, and burlap for the stabilization of planted areas.

Contaminants (Contam). In some cases, the removal of existing contaminants (or contaminant sources) is part of a wetland creation or restoration project. Water quality improvements and site recovery following a major pollution event (e.g., an oil spill) are included. This key word also denotes the presence at the wetland site of specific contaminants that may affect creation or restoration activities or responses, such as excessive acidity caused by acid precipitation.

Model. This key word describes the use of explicit spatial or temporal models (e.g., simulation, optimization, vegetation mapping) for planning, designing, or evaluating wetland creation or restoration projects. It ineludes the use of aerial imagery for the analysis of community types.

Lab. Lab refers to laboratory or small plot experiments under controlled conditions. It includes the evaluation of the effects of salinity, temperature, water depth, turbidity, and similar conditions on plant growth; demonstration of vegetative culture techniques; analysis of vegetative tolerance or adaptation to low oxygen supply or ammonia; and determination of the viability, germination, and storage requirements of seeds.

According to the wetland creation and restoration projects in the WCR data base, the most frequently employed actions are landforming and planting (Fig. 6). About one-fifth of the data base records deal with dredged materials or gravel-mined sites. Contaminated sites were treated in 263 (24%) of the data base records. Of these, 43% were concerned with the use of wetlands for treatment of wastewater, acid mine waste, urban runoff, coal mine wastewater, and stormwater runoff; several records discussed the use of lime as a treatment for acid conditions and the effects of liming on biotic systems; 8% contained information about heavy metals in wetland systems (including uptake by plants) and subsequent effects; 9% discussed cleanup of oil pollution and its effects on vegetation and coastal systems; and 1.5% discussed pesticides in wetland systems. Of the 263 records, just over one-third (37%) addressed general pollution problems such as phosphorus removal, nutrients, eutrophic conditions, salinity, and effluent in wetland systems.

Wetland Type

This field describes the subject wetland using National Wetland Inventory codes (Cowardin et al. 1979) in a system–subsystem – Class–subclass format (Table 3). All records contain an entry for wetland type. For general or overview articles or reports, all five systems are listed. The term riparian ("ripar" in the data base) has been added to this field even though it is not part of the system (Cowardin et al. 1979).

Of the 1,100 records in the data base, 68% listed freshwater wetland types and 46% listed saltwater types; many contained multiple wetland type listings.

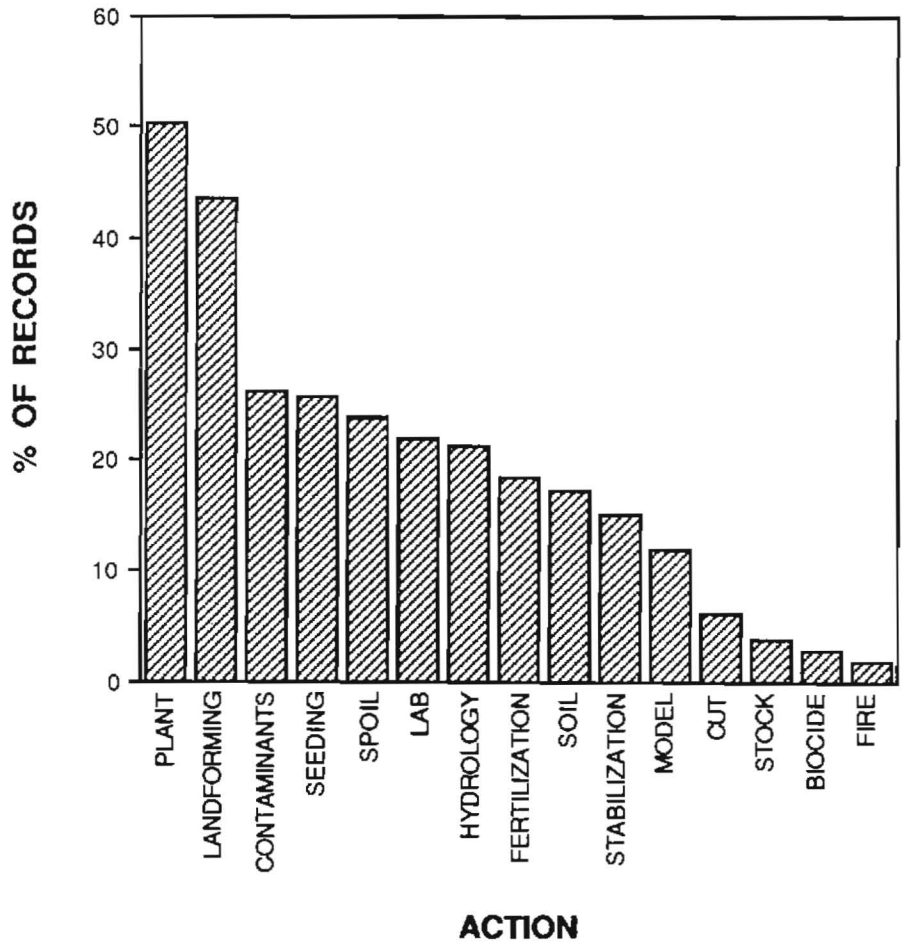
Time

Time is the maximum period reported for a particular study, rounded off to the nearest year. For example, 13 months would be entered as 1 year; 2 years, 7 months would be entered as 3 years. All periods less than 1 year are recorded as 1 year. A "0" entry indicates that no period was specified in the report or article, that the project was in the preliminary or planning stages of development, or that period was not applicable.

Of the 1,100 records in the data base, 42% have a zero in the time field, 38% deal with studies of 1–2 years' duration (Group 1), and only 7% contain information from studies that lasted 10 or more years (Group 2; Fig. 7). Groups 1 and 2 had the same proportion of freshwater and saltwater wetlands. Group 2 had a significantly higher percentage of the key words Erosion, Habitat, and Incidental. Group 2 had twice the percentage of waterfowl-related studies, a slightly higher percentage of hydrology studies, and a much higher percentage (eight times greater) of studies that attempted to evaluate project success than Group 1. Group 1 had a slightly higher percentage of chemical studies, twice as high a percentage of water quality studies, and small percentages for four fields that did not appear at all under Group 2: amphibians, reptiles, human use, and shellfish. The remaining percentages for key words used in both groups were very close.

Quantification

A "Y" indicates that quantitative results are reported for one or more response variables. An "N" indicates



Based on 1100 Records in the Wetland Creation/Restoration Data Base

Fig. 6. Wetland Creation/Restoration data base: action field.

that no quantitative results are reported. The nature of the information varies, as does its usefulness and quality.

Response

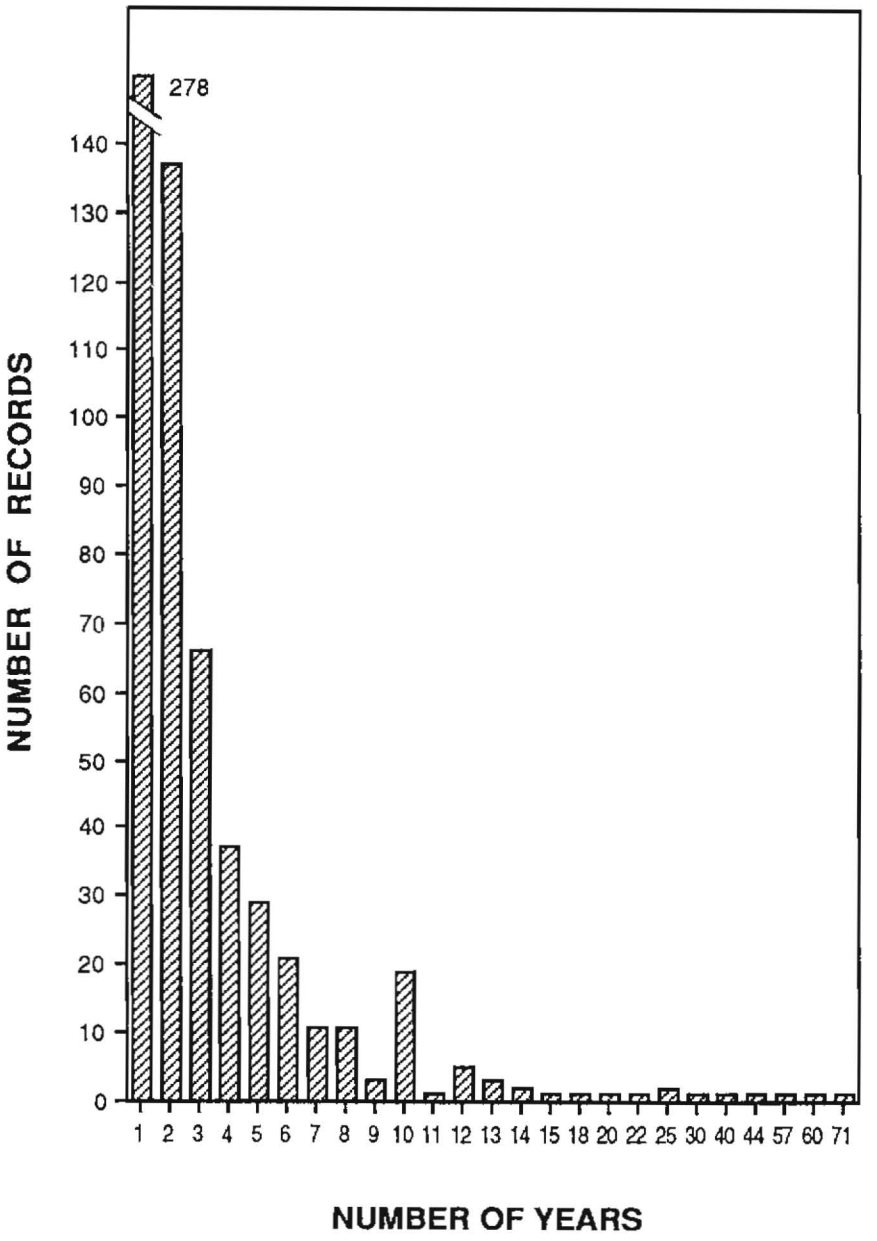
This field describes reactions to, or results of, the creation or restoration effort in terms of variables that can be measured, monitored, or evaluated. The observed results of the project, data collection, and monitoring are included in this field. Responses of fish or wildlife species to wetland creation or restoration activities might be measured in terms of biomass, food availability, habitat, distribution, recreational or commercial use, population density, species richness, or species diversity. Key word abbreviations as they appear in the data base are indicated in parentheses.

Nongame Birds (NGBirds). All nongame birds except shorebirds and nongame waterfowl.

Waterfowl (Wfowl). Waterfowl and all game birds.

Table 3. *Creation/restoration of various wetland types.*

System	Number of records
Marine	88
Lacustrine	238
Riverine	311
Estuarine	499
Palustrine	598
Selected system-class	
Riverine-riparian	89
Estuarine (intertidal)-emergent	320
—unconsolidated shore	125
—aquatic bed	107
Palustrine-emergent	380
—forested	170
—scrub–shrub	148
—aquatic bed	132
Lacustrine (littoral)-aquatic bed	27
—unconsolidated shore	22
—emergent (nonpersistent)	25
Marine (intertidal)-aquatic bed	29
—unconsolidated shore	16



Based on 1100 Records in the Wetland Creation/Restoration Data Base

Fig. 7. Duration of Wetland Creation/Restoration projects.

Shorebirds (Shoreb). All wading birds, sea birds, and other shorebirds.

Mammals. All mammals.

Amphibians (Amphib). All amphibians.

Reptiles (Rept). All reptiles.

Invertebrates (Inverts). All invertebrates except commercially valuable shellfish. Also includes mosquito control.

Shellfish (Shellf). Shellfish with commercial value.

Fish. All fish.

Vegetation (Veg). Responses may be recorded for natural revegetation or artificially established vegetation. Examples of responses include survival rate, growth rate, biomass, species richness, colonization success, and tolerance to flooding.

Human Use (Huse). This key word refers to human use of the created or restored wetland for recreation, education, research, or aesthetics.

Hydrology (Hydro). Hydrology denotes the measurement of hydrologic variables: flood control, hydroperiod, water supply, flow stabilization, groundwater recharge or discharge, and stormwater retention.

Soil. Soil describes the physical characteristics of soil and sediment, such as temperature, elevation, erosion control, and shoreline or sediment stabilization.

Water Quality (Wqual). Water quality measurements include turbidity, temperature, trophic state, sediment-trapping, and monitoring of pH, ammonia, biochemical oxygen demand (BOD), dissolved oxygen, and nutrients.

Economics (Econ). This key word indicates that an article contains specifie reference to the costs of the creation or restoration project. Examples include economic analysis; cost comparisons; dollar benefits; labor requirements; costs of monitoring, planting, or equipment; criteria for estimating project costs; economic effects of restoration efforts; and project feasibility studies.

Chemical (Chem). Chemical concentrations are measured or monitored for other variables in the response field, such as vegetation, water quality, or soil. Thus, Chem is always coded with another key word (e.g., Veg, Wqual, Soil).

Success. Success denotes specific information regarding the evaluation of the success of a wetland restoration or creation project. Success is interpreted to mean more than, "If it's green after one growing season, it's a success." It may include monitoring a site over a longer-than-usual period, guidelines for determining criteria for success, guidelines for determining mitigation success, or evaluation of project results in terms of wetland functions and values.

The most frequently measured responses were vegetation (65%), soil (29%), chemistry (28%), and water quality (25%; Fig. 8). Regarding projects undertaken to improve or restore habitat, birds were cited in 18% of

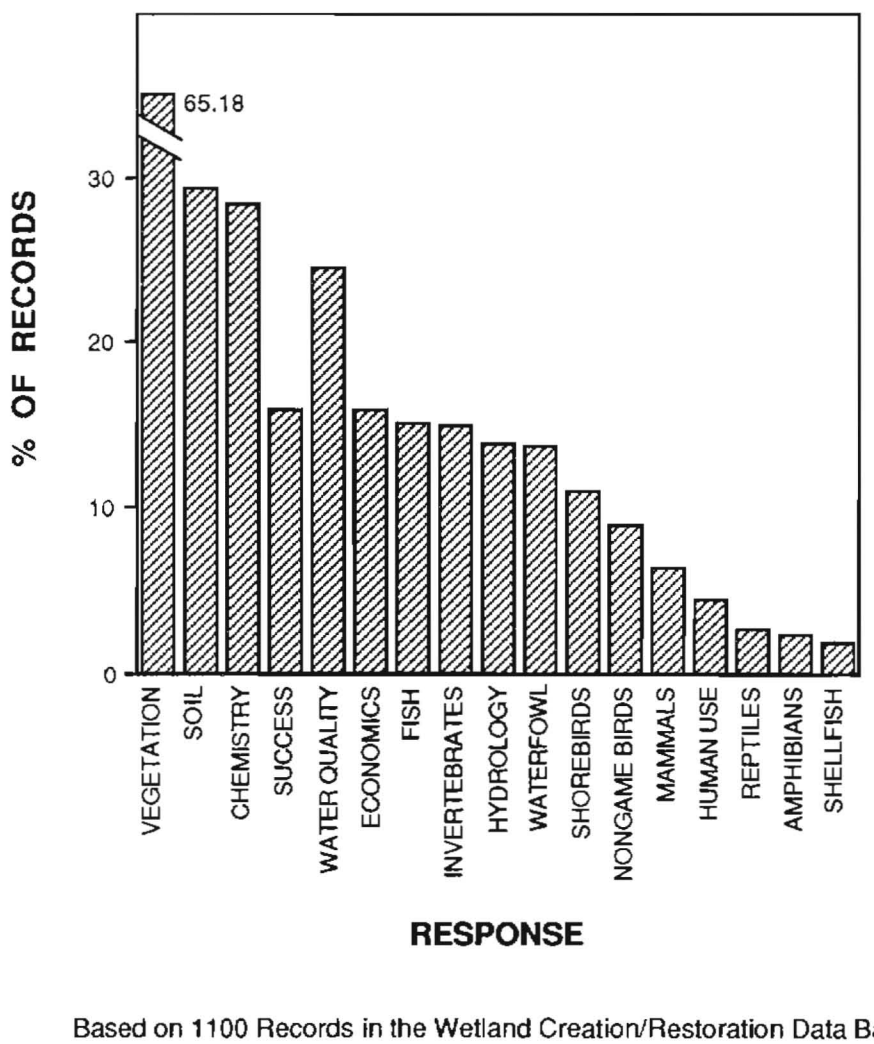


Fig. 8. Responses measured for Wetland Creation/Restoration projects.

the records (waterfowl, 14%; shorebirds, 11%; and nongame birds, 9%); fish and invertebrates, 15% each; mammals, 6%; reptiles, 3%; and amphibians and shellfish, 2% each.

The Soil response key word is more frequently associated with the physical properties of the substrate, in terms of bank stabilization, erosion, and elevation, than with soil profile information. Nearly 30% of the records in the data base contain this key word; this 30% also contains about two-thirds of the reeords keyed for Erosion in the objeetives field.

The Chemical response key word is used with other key words for clear definition of what is being measured (e.g., water, soil, plants). Beeause this field may contain multiple key words for any one record, it may not be immediately apparent which key word is specifically assoeiated with Chemieal. Within the response field, Chemical is most often associated with vegetation (73%), water quality (70%), soil (57%), invertebrates (25%), and fish (19%). Review of other fields (or the original article) is reeommended for a more specific account of chemical responses.

More than half the records that are coded Success also include cost considerations. The 175 records that contain the Success key word are further characterized in Table 4.

Plant Genus (PGenus)*

This field describes the plants that are significant in a particular study; only the genus is recorded. "Many" may be used alone or at the end of a list when a large number of plants are included in the text or tables of a publication.

There arc 565 genera listed in the data base; those most frequently cited are listed in Table 5. Frequency of occurrence of a particular genus does not guarantee consistent quality of information about that genus in the original reports or articles. However, a brief survey of the most frequently listed genera does provide some insight into which types of wetlands are the focus of the most creation or restoration attention (or which plants are most readily available or easiest to grow).

Table 4. *Characteristics of the set of 175 records containing the success keyword.*

Objectives		Actions	
Habitat	31%	Plant	50%
General	74%	Landform	38%
Experiment	19%	Seed	26%
Erosion	11%	Spoil	22%
(All other objectives are ≤8%)		Contamination	18%
		Hydrology	17%

These plants reflect a desired result or an observation of revegetation at the site, and sometimes they are the subjects of experimentation.

Annotation*

The annotation is a brief summary of the article prepared by us; it is usually 9–14 lines long. The annotation includes site descriptions and significant details not described by the key words or other fields of the data base. Study results and recommendations are briefly summarized.

Acknowledgments

We thank K. Manci for data base editing, J. Muhlenbruck for data base support, K. Hoover for typing and related support services, P. Gillis for typing, and M. Kentula, L. Lee, T. Muir, and W. Wilen, for technical review. The cover art was drawn by R. Davis from a photograph by C. Singletary.

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Table 5. *Plant genera most frequently listed in the data base.*

Genus	Percent records[1]
Spartina	26
Scirpus	19
Typha	18
Juncus	14
Carex	10
Distichlis	9
Panicum	9
Salix	9
Phragmites	8
Polygonum	8
Potamogeton	8
Eleocharis	7
Sagittaria	7
Populus	6
Quercus	6
Acer	5
Avicennia	5
Cyperus	5
Halodule	5
Thalassia	5
Zostera	5
Fraxinus	4
Pinus	4
Pontederia	4
Rhizophora	4
Taxodium	4

[1] Based on 1,100 records in the WCR data base.

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Appendix A. Wetland Creation/Restoration Data Base Ordering Information

WE102: An Annotated Wetland Creation/Restoration Bibliography

The bibliographic information on which this report is based is also available as a complete data base in the form of a self-tutorial course. This course is for IBM PC/XT/AT-compatible machines running the equivalent of MS-DOS 2.0 or higher. A 5 1/4-inch floppy disk drive is required to copy the data base, with a minimum space requirement of 4 megabytes initially and 2 megabytes after loading is completed.

The data base that contains information from published literature on the creation and restoration of wetlands. The scope is international, although most articles describe projects conducted in the United States. Each article is coded by bibliographic citation, description of restoration or creation project (objectives, actions taken, responses measured, duration), wetland type and location, and listing of significant plants. A brief annotation summarizes the article. Materials include a user's handbook and the creation/restoration data in standard file format that can be used to load the records into the user's own data base management system. This data base was developed using QUICKTEXT for managing wetland data bases. QUICKTEXT is an easily used and highly recommended data base management system well-suited to textual information. It is also available as a self-tutorial course. Costs are $150 for WE102 and $50 for QUICKTEXT. Updates for WE102 may be available for a minimal fee.

Additional information on ordering QUICKTEXT may be obtained from:

National Ecology Research Center Courses
Office of Conference Services – Rockwell Hall
Colorado State University
Fort Collins, Colorado 80523
(303) 491-7767

Appendix B. Indexes

Examples of Index Use

1. Objective: To obtain a list of citations from the Data Base Records for articles containing information on elevation as a factor in the establishment of *Spartina* in North Carolina.

Refer to North Carolina in the Location Index and compare the item numbers listed to those that appear under Elevation in the Subject Index. Compare the item numbers that are common to both listings to the item numbers listed under *Spartina* – USFWS Region 4 in the Plant Genus Index. Look up the resultant set of item numbers in the Data Base Records to obtain the desired citations.

2. Objective: To compile a list of the plant genera most commonly associated with the restoration and creation of freshwater marshes in New York.

Compile a set of item numbers common to both New York in the Location Index and Palustrine–Emergent USFWS Region 5 in the Wetland Type Index. Look up the resultant set of item numbers in the Data Base Records, and note the plant genera listed there.

Plant Genus Index

Acer (Aceraceae): 1, 51, 70, 96, 101, 104, 106, 127, 137, 163, 168, 170, 193, 196, 201, 222, 226, 268, 286, 288, 289, 290, 293, 358, 369, 370, 371, 375, 382, 395, 398, 401, 421, 433, 434, 459, 473, 474, 475, 476, 567, 589, 616, 623, 666, 696, 711, 737, 776, 796, 821, 823, 835, 836, 841, 991, 1014, 1057, 1058, 1073

Agropyron (Gramineae): 163, 391, 399, 407, 421, 437, 440, 457, 458, 459, 500, 531, 596, 774, 924, 931, 954, 1021

Alisma (Alismataceae): 33, 62, 63, 108, 111, 137, 189, 208, 229, 281, 285, 321, 517, 522, 703, 769, 831, 911, 938, 954

Alnus (Betulaceae): 2, 127, 301, 383, 398, 455, 459, 497, 509, 511, 623, 624, 640, 700, 711, 774, 806, 807, 985, 1017, 1044, 1055, 1056, 1073

Altemanthera (Amaranthaceae): 88, 222, 368, 370, 372, 536, 797, 900, 948, 994, 1007

Ambrosia (Compositae): 34, 179, 368, 578, 585, 704, 1007, 1070, 1081

Ammophila (Gramineae): 69, 126, 189, 196, 210, 224, 300, 343, 344, 350, 351, 407, 492, 494, 538, 540, 556, 557, 569, 703, 859, 865, 869, 870, 871, 907, 954, 992, 993, 1079, 1081, 1082

Andropogon (Gramineae): 12, 34, 162, 179, 222, 231, 276, 278, 368, 407, 450, 459, 531, 596, 616, 737, 739, 776, 874, 893, 939, 1007, 1098

Aster (Compositae): 3, 85, 121, 162, 174, 195, 200, 212, 246, 259, 279, 300, 333, 368, 395, 456, 466, 556, 674, 699, 794, 881, 924, 1007

Atriplex (Chenopodiaceae): 21, 22, 23, 24, 25, 85, 231, 426, 672, 707, 723, 725, 744, 794, 907, 908

Avicennia (Verbenaceae): 45, 61, 66, 73, 158, 161, 164, 165, 166, 213, 218, 230, 244, 250, 295, 303, 348, 366, 373, 461, 462, 508, 540, 544, 545, 571, 598, 600, 601, 604, 605, 607, 630, 633, 652, 739, 783, 791, 845, 847, 848, 888, 930, 949, 950, 951, 1020, 1035, 1036, 1039, 1053, 1078, 1092

Baccharis (Compositae): 34, 61, 85, 155, 164, 179, 192, 210, 222, 259, 276, 278, 288, 302, 368, 382, 426, 431, 527, 605, 640, 734, 735, 736, 738, 739, 766, 803, 828, 835, 836, 872, 881, 907, 918, 919, 920

Bacopa (Scrophulariaceae): 35, 49, 162, 174, 368, 371, 372, 670, 739, 795, 828, 874, 1007

Batis (Batidaceae): 61, 66, 73, 161, 164, 174, 278, 373, 504, 739, 770, 771, 803, 845, 920, 1036, 1043, 1092

Betula (Betulaceae): 1, 104, 111, 204, 222, 264, 398, 509, 531, 589, 596, 673, 695, 696, 697, 711, 774, 807, 914, 985, 1058, 1098

Bidens (Compositae): 34, 63, 74, 82, 96, 108, 136, 202, 331, 517, 560, 570, 585, 621, 623, 624, 703, 816, 840, 996, 1008, 1009, 1050, 1098

Borrichia (Compositae): 3, 66, 98, 121, 164, 179, 195, 227, 281, 300, 338, 417, 418, 481, 629, 703, 737, 771, 803, 805, 893, 918, 920, 921

Bromus (Gramineae): 391, 407, 437, 457, 498, 684, 704, 774, 1056

Calamagrostis (Gramineae): 78, 139, 204, 233, 358, 450, 540, 656, 985, 1078

Carex (Cyperaceae): 11, 13, 68, 71, 76, 77, 78, 96, 97, 100, 108, 109, 127, 136, 137, 169, 189, 196, 198, 203, 204, 205, 222, 233, 251, 252, 256, 264, 281, 285, 321, 324, 338, 348, 358, 359, 378, 383, 422, 440, 450, 455, 466, 481, 509, 522, 529, 544, 545, 546, 567, 569, 570, 572, 578, 589, 597, 615, 629, 654, 655, 672, 700, 703, 733, 744, 747, 769, 774, 775, 776, 793, 796, 804, 806, 811, 812, 831, 846, 869, 874, 887, 893, 900, 911, 914, 926, 935, 938, 953, 954, 960, 985, 993, 998, 1002, 1009, 1017, 1019, 1044, 1048, 1058, 1070, 1075, 1078, 1098

Carya (Junglandaceae): 16, 106, 168, 193, 222, 395, 421, 434, 470, 475, 476, 666, 711, 737, 874, 1014

Celtis (Ulmaceae): 1, 106, 193, 395, 473, 474, 475, 476, 623, 666, 737, 835, 1014, 1021, 1057

Cephalanthus (Rubiaceae): 16, 35, 104, 168, 222, 276, 348, 370, 401, 407, 421, 455, 473, 673, 676, 734, 735, 736, 796, 806, 835, 874, 887, 939, 1002, 1007, 1044, 1057, 1071

Ceratophyllum (Ceratophyllaceae): 71, 102, 104, 127, 137, 138, 139, 173, 175, 205, 251, 260, 333, 358, 450, 513, 547, 559, 609, 635, 683, 692, 747, 796, 827, 842, 914, 948, 1009, 1019, 1050

Chara (Chanaceae) : 76, 78, 80, 138, 208, 229, 254, 260, 358, 507, 559, 582, 583, 683, 699, 718, 719, 747, 814, 831, 887, 1050

Chenopodium (Chenopodiaceae): 34, 222, 422, 457, 458, 500, 507, 623, 744, 840

Cladium (Cyperaceae): 42, 51, 276, 371, 372, 382, 776, 795, 1071

Cornus (Cornaceae): 1, 13, 35, 104, 139, 163, 193, 198, 201, 268, 301, 358, 407, 455, 459, 511, 654, 674, 711, 774, 796, 807, 823, 938, 991, 1002, 1014, 1055, 1098

Cotula (Compositae): 254, 298, 383, 505, 707, 746, 766, 1017, 1093

Cynodon (Gramineae): 1, 12, 34, 61, 215, 231, 368, 421, 565, 567, 569, 704, 874, 893, 1040

Cyperus (Cyperaceae): 34, 50, 71, 96, 98, 108, 121, 136, 162, 172, 174, 175, 196, 201, 202, 222, 254, 259, 281, 288, 289, 290, 301, 331, 355, 368, 370, 372, 531, 588, 596, 616, 623, 676, 678, 686, 692, 703, 704, 733, 739, 747, 828, 840, 846, 874, 929, 939, 965, 1007, 1008, 1009, 1025, 1050

Deschampsia (Gramineae): 13, 189, 198, 281, 348, 440, 481, 522, 544, 545, 546, 569, 570, 572, 629, 655, 672, 703, 774, 846, 893, 953, 954, 1075, 1078

Digitaria (Gramineae): 34, 231, 288, 331, 368, 565, 623, 704, 737, 874, 939

Distichlis (Gramineae): 3, 17, 42, 47, 50, 64, 66, 85, 98, 99, 117, 120, 170, 174, 182, 186, 196, 215, 227, 230, 231, 250, 273, 275, 276, 278, 281, 298, 300, 302, 319, 337, 338, 343, 344, 347, 348, 350, 351, 367, 394, 413, 417, 418, 426, 430, 481, 494, 544, 545, 546, 549, 556, 557, 569, 574, 586, 587, 588, 591, 672, 699, 703, 704, 715, 737, 739, 770, 771, 775, 786, 794, 799, 803, 804, 805, 806, 846, 881, 883, 893, 895, 899, 905, 907, 908, 918, 920, 927, 1035, 1036, 1038, 1039, 1043, 1075, 1078, 1083, 1092

Echinochloa (Gramineae): 34, 42, 80, 96, 97, 104, 127, 172, 174, 193, 201, 222, 241, 242, 258, 285, 289, 290, 325, 331, 368, 560, 565, 578, 621, 623, 656, 676, 688, 695, 697, 704, 718, 719, 874, 965, 1025

Eichhornia (Pontederiaceae): 88, 138, 162, 192, 222, 258, 259, 370, 375, 527, 586, 676, 777, 797, 798, 900, 948, 990, 994, 1007, 1076, 1077

Eleocharis (Cyperaceae): 13, 33, 35, 42, 88, 100, 104, 108, 109, 110, 137, 162, 172, 173, 174, 175, 179, 189, 198, 200, 201, 202, 205, 208, 234, 254, 258, 276, 278, 285, 321, 324, 338, 368, 371, 399, 465, 507, 516, 546, 563, 570, 597, 623, 656, 672, 673, 678, 703, 718, 719, 747, 776, 806, 812, 821, 828, 831, 840, 874, 887, 895, 936, 939, 953, 954, 985, 996, 998, 1007, 1036, 1044, 1056, 1058

Elodea (Hydrocharitaceae): 48, 111, 135, 137, 138, 139, 333, 358, 513, 547, 609, 635, 671, 683, 703, 747, 816, 827, 838, 900, 1050

Equisetum (Equisetaceae): 77, 108, 109, 110, 137, 196, 222, 374, 569, 900, 985, 996

Eupatorium (Compositae): 34, 124, 222, 259, 368, 517, 565, 578, 605, 623, 624, 739, 828, 874, 1007

Festuca (Gramineae): 40, 163, 212, 348, 440, 459, 497, 498, 623, 624, 693, 711, 763, 846, 893, 924, 954

Fimbristylis (Cyperaceae): 3, 35, 69, 281, 300, 370, 371, 394, 623, 737, 874, 908

Fraxinus (Oleaceae): 1, 35, 70, 106, 127, 139, 155, 168, 170, 192, 196, 222, 247, 268, 286, 289, 290, 293, 301, 369, 370, 391, 395, 398, 401, 421, 459, 470, 473, 474, 475, 476, 511, 666, 696, 737, 821, 823, 835, 876, 914, 1014, 1057, 1071

Gordonia (Theaceae): 35, 70, 222, 286, 288, 289, 290, 293, 395, 401, 433, 666, 737, 821, 835, 841

Halodule (Potamogetonaceae): 45, 158, 159, 185, 230, 243, 244, 263, 273, 275, 278, 308, 309, 310, 311, 312, 313, 316, 317, 318, 329, 348, 461, 467, 469, 608, 612, 632, 633, 651, 653, 754, 755, 756, 757, 758, 759, 760, 762, 846, 893, 958, 967, 968, 970, 972, 973, 974, 975, 976, 977, 979, 1011

Hydrilla (Hydrocharitaceae): 48, 88, 138, 192, 251, 513, 676, 777, 884

Hydrocotyle (Umbelliferae): 88, 162, 172, 215, 222, 231, 276, 286, 288, 289, 290, 292, 370, 372, 536, 704, 737, 821, 828, 874, 919, 939, 1007, 1077

Ilex (Aquifoliaceae): 16, 35, 70, 201, 215, 222, 231, 278, 286, 289, 290, 293, 358, 382, 395, 401, 431, 666, 776, 835, 856, 869, 1002

Impatiens (Balsaminaceae): 96, 97, 511, 585, 623, 624, 816, 1050, 1055

Ipomoea (Convolvulaceae): 34, 162, 164, 215, 224, 231, 273, 276, 454, 739

Iris (Iridaceae): 189, 281, 301, 382, 395, 459, 522, 563, 570, 669, 703, 769, 911, 913, 954

Iva (Compositae): 69, 85, 98, 121, 170, 179, 210, 215, 227, 231, 276, 278, 281, 300, 302, 367, 417, 418, 431, 458, 481, 605, 629, 803, 805, 806, 869, 872, 881, 893, 907, 918, 919, 920, 921, 1078

Juncus (all) (Juncaceae): 3, 13, 35, 40, 41, 42, 47, 66, 69, 82, 85, 97, 98, 100, 108, 109, 110, 113, 115, 117, 120, 127, 169, 173, 175, 189, 195, 196, 198, 201, 205, 209, 212, 213, 222, 227, 229, 230, 244, 250, 252, 254, 258, 259, 264, 269, 273, 275, 276, 277, 278, 281, 285, 293, 300, 301, 321, 324, 337, 338, 347, 359, 361, 366, 367, 368, 369, 370, 371, 375, 378, 382, 394, 395, 407, 417, 418, 430, 461, 465, 481, 494, 522, 540, 544, 545, 546, 549, 556, 557, 591, 597, 599, 605, 616, 623, 629, 630, 669, 671, 672, 703, 704, 712, 737, 739, 747, 763, 766, 769, 771, 794, 802, 803, 804, 805, 806, 812, 828, 831, 840, 874, 887, 893, 901, 911, 920, 924, 936, 939, 953, 954, 985, 987, 1007, 1017, 1023, 1024, 1035, 1036, 1037, 1038, 1039, 1044, 1056, 1058, 1077, 1078, 1083, 1093

Juncus, USFWS Region 1 (Juncaceae): 13, 98, 189, 195, 196, 198, 227, 254, 281, 300, 337, 366, 481, 522, 544, 545, 546, 549, 630, 672, 703, 712, 766, 893, 953, 954, 1017, 1056, 1078, 1093

Juncus, USFWS Region 2 (Juncaceae): 13, 42, 98, 195, 196, 227, 250, 281, 300, 337, 366, 481, 544, 545, 549, 630, 703, 771, 893, 1035, 1036, 1038, 1039, 1078

Juncus, USFWS Region 3 (Juncaceae): 259, 285, 407, 747, 812, 831, 893, 1078

Juncus, USFWS Region 4 (Juncaccae): 3, 35, 42, 47, 66, 69, 82, 98, 108, 109, 110, 115, 117, 120, 173, 175, 195, 196, 201, 209, 222, 227, 230, 244, 258, 259, 269, 273, 275, 276, 277, 278, 281, 293, 300, 301, 324, 337, 338, 361, 366, 367, 368, 369, 370, 371, 375, 382, 394, 395, 417, 418, 461, 465, 481, 544, 545, 549, 556, 557, 599, 605, 630, 669, 703, 704, 737, 739, 802, 803, 805, 828, 874, 887, 893, 901, 920, 936, 939, 987, 1007, 1023, 1024, 1036, 1037, 1044, 1077, 1078, 1083

Juncus, USFWS Region 5 (Juncaceae): 42, 85, 97, 98, 100, 113, 127, 195, 196, 227, 229, 259, 281, 300, 321, 337, 338, 366, 407, 430, 481, 544, 545, 549, 591, 616, 623, 630, 703, 763, 769, 794, 802, 804, 893, 911, 1058, 1078, 1083

Juncus, USFWS Region 6 (Juncaceae): 13, 205, 252, 285, 985

Juncus, USFWS Region 7 (Juncaceae): 227, 300

Juniperus (Pinaceae): 35, 155, 222, 369, 382, 407, 605, 737, 869, 919

Laguncularia (Combretaceae): 45, 61, 66, 161, 165, 166, 213, 218, 230, 244, 296, 303, 348, 366, 461, 462, 544, 545, 598, 600, 601, 605, 630, 633, 783, 847, 848, 888, 949, 950, 951, 1020, 1053, 1078

Leersia (Gramineae): 33, 63, 71, 82, 88, 96, 108, 127, 135, 202, 208, 229, 285, 348, 623, 670, 676, 695, 697, 874, 936, 965, 996, 1007, 1044, 1050

Lemna (Lemnaceae): 71, 82, 127, 137, 138, 192, 202, 222, 229, 241, 285, 288, 358, 370, 371, 422, 450, 477, 536, 559, 567, 609, 676, 796, 797, 821, 831, 914, 938, 948, 998, 1008, 1009, 1019, 1033, 1050, 1076, 1077

Limonium (Plumbaginaeeae): 3, 85, 154, 174, 212, 300, 302, 549, 591, 712, 737, 794, 803, 918, 920, 921, 1092

Liquidambar (Hamamelidaceae): 35, 70, 106, 124, 168, 193, 222, 288, 289, 290, 293, 369, 370, 395, 401, 434, 470, 473, 474, 476, 666, 696, 737, 821, 823, 835, 841, 876, 1002, 1057

Lolium (Gramineae): 1, 323, 325, 437, 459, 497, 498, 623, 893

Ludwigia (Onagraceae): 34, 35, 162, 222, 258, 259, 276, 324, 368, 370, 372, 527, 623, 676, 797, 828, 835, 840, 874, 936, 939, 948

Magnolia (Magnoliaceae): 35, 201, 222, 382, 395, 401, 433, 666, 737, 821, 823, 835, 841

Myrcia (Myrtaceae): 12, 85, 192, 195, 210, 215, 222, 231, 278, 301, 371, 375, 382, 394, 395, 401, 431, 433, 527, 536, 605, 616, 737, 738, 776, 821, 835, 836, 841, 869, 893, 907, 919, 1007, 1040

Myriophyllum (Halorrhagidaceae): 48, 49, 75, 76, 78, 80, 111, 127, 138, 178, 251, 260, 358, 450, 513, 559, 586, 635, 683, 747, 796, 816, 831, 838, 884, 887, 948, 994, 1019

Najas (Najadaceae): 35, 42, 80, 88, 127, 173, 192, 208, 251, 289, 290, 292, 293, 358, 370, 372, 508, 513, 559, 560, 582, 583, 635, 718, 719, 733, 747, 887, 1008, 1009, 1050

Nuphar (Nymphaeaceae): 77, 111, 135, 137, 358, 372, 382, 395, 450, 513, 529, 585, 661, 669, 769, 776, 795, 827, 911

Nymphaea (Nymphaeaceae): 42, 82, 233, 260, 293, 358, 371, 372, 382, 395, 450, 513, 669, 733, 776, 827, 914, 1008, 1044

Nyssa (Cornaceae): 35, 51, 58, 70, 124, 168, 170, 192, 193, 201, 222, 247, 286, 288, 289, 290, 293, 301, 369, 370, 395, 401, 433, 470, 616, 666, 737, 811, 835, 856, 876, 914, 1002, 1044, 1055, 1057

Panicum (Gramineae): 12, 13, 34, 35, 69, 88, 101, 124, 162, 167, 172, 175, 193, 196, 201, 210, 215, 222, 224, 227, 230, 231, 273, 275, 276, 278, 281, 285, 286, 289, 290, 292, 293, 300, 331, 343, 348, 351, 367, 368, 369, 370, 372, 395, 418, 450, 457, 459, 465, 481, 494, 531, 538, 540, 556, 557, 578, 596, 616, 623, 624, 669, 676, 703, 704, 739, 776, 777, 821, 828, 841, 842, 846, 859, 865, 869, 871, 874, 893, 907, 919, 939, 965, 993, 1007, 1040, 1044, 1055, 1060, 1071, 1078, 1079, 1081, 1082, 1086

Paspalum (Gramineae): 1, 34, 35, 61, 66, 88, 164, 174, 179, 196, 200, 210, 211, 215, 222, 244, 276, 368, 370, 431, 531, 544, 545, 567, 596, 605, 623, 633, 669, 704, 739, 821, 828, 874, 888, 939, 996

Peltandra (Araceae): 101, 127, 281, 301, 345, 347, 348, 349, 427, 459, 481, 585, 621, 623, 624, 781, 816, 892, 893, 1077

Persea (Lauraceae): 35, 70, 168, 222, 431, 433, 737, 776, 835

Phalaris (Gramineae): 11, 71, 82, 96, 97, 136, 169, 321, 407, 457, 458, 459, 477, 540, 578, 589, 615, 661, 674, 693, 711, 796, 954, 965, 993, 996, 998, 1033

Phragmites (Gramineae): 69, 74, 76, 77, 78, 85, 86, 98, 102, 121, 127, 130, 138, 160, 167, 169, 170, 181, 187, 196, 207, 208, 233, 236, 250, 251, 273, 275, 278, 281, 300, 302, 337, 338, 351, 359, 360, 364, 365, 378, 407, 422, 458, 459, 494, 507, 508, 531, 544, 545, 548, 550, 556, 586, 596, 661, 686, 687, 688, 695, 697, 704, 710, 721, 733, 744, 794, 798, 804, 806, 816, 827, 833, 872, 881, 893, 907, 908, 914, 926, 929, 948, 1003, 1008, 1026, 1035, 1036, 1039, 1048, 1070, 1077, 1078, 1083

Pinus (Pinaceae): 1, 16, 35, 51, 127, 140, 155, 168, 203, 222, 276, 278, 286, 289, 290, 293, 301, 369, 370, 382, 398, 401, 407, 470, 589, 616, 674, 693, 696, 737, 776, 811, 823, 841, 853, 856, 869, 888, 893, 1073

Platanus (Platanaceae): 55, 70, 155, 168, 222, 247, 286, 288, 289, 290, 293, 369, 370, 383, 421, 434, 473, 474, 475, 476, 577, 623, 684, 695, 696, 697, 711, 796, 876, 1014, 1055, 1057

Pluchea (Compositae): 34, 85, 155, 162, 174, 195, 222, 227, 302, 368, 418, 481, 556, 828, 874, 881, 939

Poa (Gramineae): 96, 101, 457, 458, 459, 498, 500, 578, 774, 793

Polygonum (Polygonaceae): 13, 35, 42, 51, 62, 88, 96, 108, 124, 127, 137, 162, 198, 200, 201, 222, 254, 258, 259, 280, 281, 285, 286, 289, 290, 292, 301, 331, 348, 358, 368, 370, 378, 407, 418, 422, 424, 457, 458, 459, 517, 560, 567, 570, 582, 583, 585, 609, 615, 623, 624, 656, 692, 695, 697, 699, 703, 704, 715, 733, 769, 796, 816, 828, 835, 840, 874, 911, 939, 965, 991, 996, 998, 1002, 1007, 1008, 1009, 1025, 1044, 1050, 1055, 1070

Pontederia (Pontederiaceae): 35, 51, 127, 139, 162, 222, 258, 286, 289, 290, 292, 293, 301, 347, 348, 349, 368, 369, 370, 371, 375, 382, 395, 459, 569, 621, 623, 624, 669, 670, 692, 776, 795, 804, 821, 828, 841, 874, 892, 893, 939, 984, 990, 994, 1007, 1044, 1071, 1077

Populus (Salicaceae): 1, 16, 20, 21, 22, 23, 24, 25, 51, 106, 107, 136, 155, 176, 196, 226, 264, 268, 339, 369, 370, 378, 383, 391, 398, 407, 421, 434, 457, 459, 473, 474, 475, 476, 508, 509, 516, 567, 577, 578, 586, 589, 623, 640, 674, 684, 695, 697, 723, 750, 793, 796, 809, 853, 914, 940, 941, 985, 991, 998, 1014, 1056, 1073, 1098

Potamogeton (Potamogctonaceae): 16, 42, 48, 49, 51, 71, 75, 76, 78, 80, 100, 102, 104, 108, 127, 131, 135, 137, 138, 173, 178, 186, 202, 208, 229, 233, 251, 254, 260, 333, 339, 348, 358, 359, 410, 422, 450, 507, 508, 509, 547, 559, 560, 582, 583, 609, 615, 617, 635, 654, 671, 676, 683, 686, 699, 718, 719, 728, 733, 744, 747, 806, 816, 818, 819, 831, 838, 884, 887, 899, 914, 915, 936, 938, 948, 994, 998, 1008, 1009, 1019, 1034, 1044, 1050

Prunus (Rosaceae): 1, 140, 215, 268, 382, 391, 398, 407, 704, 774, 776, 869

Puccinellia (Gramineae): 40, 116, 154, 212, 213, 456, 806, 924, 1005

Quercus (Fagaceae): 1, 12, 16, 35, 51, 101, 104, 106, 140, 155, 168, 192, 193, 196, 215, 222, 231, 247, 286, 289, 290, 293, 301, 369, 370, 382, 383, 395, 398, 401, 421, 433, 434, 459, 470, 473, 474, 475, 476, 531, 567, 577, 589, 596, 654, 666, 693, 695, 696, 697, 700, 711, 737, 776, 821, 823, 835, 836, 876, 888, 893, 991, 1002, 1014, 1040, 1056, 1057

Ranunculus (Ranunculaceae): 80, 111, 285, 358, 623, 671, 744, 769, 840, 911

Rhizophora (Rhizophoraceae): 45, 61, 66, 161, 165, 166, 213, 218, 230, 244, 295, 303, 347, 348, 361, 366, 380, 381, 461, 544, 545, 598, 600, 601, 602, 604, 605, 630, 633, 739, 783, 791, 792, 806, 845, 847, 848, 888, 902, 904, 930, 949, 950, 951, 952, 1020, 1053, 1078

Rhus (Anacardiaceae): 1, 12, 35, 196, 226, 383, 511, 684, 893, 919, 1021, 1040

Rosa (Rosaceae): 1, 13, 163, 167, 198, 407, 869, 985, 1036

Rubus (Rosaceae): 169, 276, 339, 368, 378, 382, 383, 578, 684, 835, 919, 1056, 1058, 1073, 1098

Rumex (Polygonaceae): 200, 276, 285, 394, 422, 457, 458, 623, 692, 699, 715, 744, 769, 840, 874, 895, 911, 1009, 1055, 1056, 1093

Ruppia (Potamogetonaceae): 45, 158, 159, 161, 167, 172, 173, 175, 178, 230, 244, 316, 348, 367, 373, 419, 431, 495, 507, 560, 617, 635, 712, 739, 757, 766, 806, 831, 893, 899, 933, 972, 975, 1034, 1090

Sabal (Palmae): 168, 215, 222, 382, 395, 605, 739, 776, 835

Sagittaria (Alismataceae): 13, 33, 35, 48, 51, 62, 63, 71, 74, 101, 104, 108, 111, 127, 137, 162, 172, 189, 195, 198, 201, 205, 208, 222, 229, 233, 278, 280, 281, 285, 301, 348, 368, 369, 370, 371, 372, 382, 395, 459, 508, 517, 560, 563, 567, 585, 621, 623, 624, 629, 654, 656, 669, 670, 692, 703, 704, 718, 733, 776, 795, 812, 816, 828, 831, 842, 874, 892, 893, 936, 954, 996, 998, 1002, 1007, 1009, 1036, 1044, 1050, 1070, 1071, 1077

Salicornia (Chenopodiaceae): 3, 40, 41, 61, 66, 73, 85, 99, 116, 148, 154, 161, 164, 174, 178, 179, 195, 196, 206, 212, 221, 227, 244, 246, 276, 278, 281, 298, 299, 300, 302, 337, 338, 347, 366, 373, 383, 400, 413, 426, 430, 456, 481, 501, 503, 504, 505, 507, 508, 539, 546, 549, 569, 572, 629, 636, 654, 658, 659, 672, 678, 679, 699, 703, 707, 712, 713, 725, 737, 739, 746, 766, 770, 771, 775, 786, 794, 803, 806, 845, 881, 893, 895, 918, 920, 921, 924, 1005, 1017, 1036, 1043, 1059, 1068, 1075, 1078, 1083, 1092, 1093, 1094, 1095, 1096

Salix (Salicaceae): 1, 2, 11, 13, 21, 22, 23, 24, 25, 31, 34, 35, 71, 96, 101, 127, 136, 137, 154, 155, 163, 168, 169, 176, 189, 191, 192, 193, 196, 198, 203, 204, 222, 226, 229, 252, 256, 264, 268, 276, 339, 368, 370, 378, 382, 391, 398, 407, 420, 421, 422, 452, 455, 457, 459, 473, 474, 475, 476, 497, 498, 508, 509, 516, 527, 531, 536, 567, 577, 578, 586, 596, 616, 623, 640, 644, 654, 671, 674, 676, 692, 695, 697, 699, 700, 703, 711, 723, 734, 735, 736, 739, 750, 774, 780, 793, 796, 806, 809, 821, 835, 836, 853, 914, 938, 940, 941, 985, 991, 993, 996, 998, 1014, 1021, 1044, 1055, 1056, 1057, 1071, 1073, 1098

Scirpus (all) (Cyperaceae): 3, 13, 16, 33, 34, 35, 42, 50, 62, 71, 74, 77, 80, 82, 98, 101, 102, 104, 108, 109, 110, 113, 121, 127, 136, 137, 148, 164, 168, 170, 172, 173, 174, 175, 178, 186, 189, 195, 196, 198, 200, 205, 207, 208, 217, 222, 229, 233, 234, 236, 241, 242, 250, 251, 252, 254, 264, 276, 278, 280, 281, 285, 300, 301, 319, 345, 347, 348, 351, 362, 363, 364, 365, 370, 374, 378, 383, 394, 395, 407, 410, 418, 422, 423, 426, 431, 455, 458, 459, 477, 481, 494, 501, 503, 507, 508, 516, 517, 522, 527, 530, 540, 546, 560, 563, 565, 567, 571, 574, 578, 582, 583, 586, 588, 597, 611, 615, 616, 617, 623, 624, 629, 656, 669, 672, 676, 678, 686, 692, 695, 699, 703, 704, 715, 720, 721, 733, 744, 747, 766, 769, 775, 776, 781, 794, 795, 797, 803, 806, 812, 816, 819, 821, 829, 831, 837, 840, 846, 872, 887, 893, 895, 899, 900, 905, 907, 908, 911, 913, 920, 924, 926, 936, 938, 948, 953, 954, 965, 984, 986, 990, 993, 994, 998, 1005, 1008, 1009, 1017, 1019, 1025, 1026, 1035, 1036, 1039, 1044, 1048, 1050, 1058, 1060, 1068, 1069, 1070, 1078, 1083, 1090, 1092, 1093, 1095, 1098

Scirpus, USFWS Region 1 (Cyperaceae): 13, 98, 102, 148, 172, 178, 189, 195, 196, 198, 200, 241, 242, 254, 281, 300, 362, 363, 364, 365, 383, 410, 426, 481, 501, 503, 522, 546, 586, 672, 703, 720, 766, 846, 893, 953, 954, 1017, 1068, 1078, 1090, 1092, 1093, 1095

Scirpus, USFWS Region 2 (Cyperaceae): 13, 16, 42, 98, 172, 174, 195, 196, 250, 281, 300, 481, 574, 703, 846, 893, 1035, 1036, 1039, 1078

Scirpus, USFWS Region 3 (Cyperaceae): 62, 71, 74, 104, 208, 233, 285, 374, 407, 422, 423, 563, 567, 578, 586, 615, 656, 686, 692, 695, 747, 812, 831, 893, 913, 938, 965, 1009, 1019, 1025, 1050, 1060, 1069, 1070, 1078, 1098

Scirpus, USFWS Region 4 (Cyperaceae): 3, 16, 34, 35, 42, 82, 98, 108, 109, 110, 121, 164, 168, 172, 173, 174, 175, 195, 196, 222, 276, 278, 281, 300, 301, 370, 374, 394, 395, 418, 431, 477, 481, 527, 565, 567, 574, 586, 669, 676, 703, 704, 776, 795, 803, 821, 829, 846, 887, 893, 905, 907, 908, 920, 926, 986, 990, 1036, 1044, 1078, 1083,

Scirpus, USFWS Region 5 (Cyperaceae): 33, 42, 98, 101, 104, 113, 127, 136, 137, 170, 172, 195, 196, 229, 280, 281, 300, 345, 351, 374, 407, 455, 481, 530, 574, 582, 583, 586, 616, 617, 623, 624, 703, 715, 769, 781, 794, 816, 846, 872, 893, 900, 911, 1005, 1058, 1078, 1083

Scirpus, USFWS Region 6 (Cyperaceae): 13, 80, 186, 205, 217, 252, 285, 319, 458, 459, 507, 516, 699, 819, 837, 895, 899, 998

Scirpus, USFWS Region 7 (Cyperaceae): 300

Sesuvium (Aizoaceae): 61, 66, 164, 172, 174, 215, 565, 739, 920

Setaria (Gramineae): 34, 101, 170, 276, 278, 718, 719, 842, 998, 1070

Solidago (Compositae): 85, 226, 276, 300, 466, 578, 684, 703, 737, 739, 794, 874, 881, 939

Sparganium (Sparganiaceae): 71, 100, 109, 111, 139, 202, 229, 233, 234, 280, 285, 410, 455, 459, 563, 582, 583, 654, 656, 733, 769, 812, 831, 911, 1002, 1003, 1008, 1009, 1070

Spartina (all) (Gramineae): 3, 10, 12, 14, 15, 35, 40, 41, 42, 45, 47, 50, 58, 61, 64, 66, 69, 85, 86, 98, 99, 104, 115, 116, 117, 118, 119, 120, 121, 122, 123, 127, 148, 150, 151, 152, 153, 154, 158, 162, 164, 167, 170, 173, 174, 175, 179, 182, 183, 187, 195, 196, 205, 210, 211, 212, 213, 214, 215, 222, 224, 227, 230, 231, 233, 240, 244, 246, 250, 261, 265, 269, 273, 275, 276, 277, 278, 281, 298, 299, 300, 302, 303, 321, 322, 335, 336, 337, 338, 343, 344, 345, 347, 348, 350, 351, 352, 356, 360, 361, 366, 367, 371, 372, 377, 382, 394, 395, 400, 404, 407, 413, 414, 415, 416, 417, 418, 426, 430, 431, 450, 456, 459, 461, 462, 466, 479, 481, 494, 495, 501, 503, 504, 508, 517, 528, 531, 539, 540, 541, 542, 543, 544, 545, 546, 548, 549, 550, 552, 553, 555, 556, 557, 558, 565, 569, 571, 572, 574, 586, 587, 588, 591, 596, 601, 603, 605, 606, 607, 613, 623, 625, 629, 630, 633, 636, 638, 657, 658, 669, 677, 679, 686, 692, 701, 702, 703, 704, 707, 708, 712, 715, 721, 737, 739, 745, 746, 753, 763, 764, 770, 771, 776, 781, 786, 793, 794, 799, 802, 803, 804, 805, 806, 808, 839, 846, 859, 860, 861, 862, 863, 864, 866, 869, 870, 871, 872, 874, 881, 883, 888, 892, 893, 901, 902, 904, 905, 907, 908, 918, 919, 920, 921, 927, 944, 945, 955, 965, 968, 987, 993, 1003, 1005, 1006, 1023, 1024, 1025, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1053, 1059, 1067, 1075, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086, 1090, 1091, 1092, 1093, 1094, 1095, 1096

Spartina, USFWS Region 1 (Gramineae): 98, 99, 116, 148, 154, 195, 196, 227, 281, 298, 299, 300, 335, 336, 337, 352, 366, 426, 481, 501, 503, 504, 528, 539, 541, 542, 543, 544, 545, 546, 549, 555, 569, 572, 586, 630, 636, 679, 701, 702, 703, 707, 708, 712, 746, 764, 786, 846, 869, 883, 893, 1053, 1059, 1067, 1075, 1078, 1081, 1090, 1091, 1092, 1093, 1094, 1095, 1096

Spartina, USFWS Region 2 (Gramineae): 12, 42, 98, 116, 158, 174, 179, 195, 196, 215, 224, 227, 250, 281, 300, 335, 336, 337, 352, 366, 481, 531, 541, 542, 543, 544, 545, 549, 569, 572, 574, 587, 596, 613, 630, 703, 770, 771, 846, 860, 869, 883, 893, 944, 945, 1035, 1036, 1038, 1039, 1040, 1041, 1042, 1043, 1053, 1078, 1081

Spartina, USFWS Region 3 (Gramineae): 104, 233, 407, 450, 466, 548, 569, 586, 686, 692, 869, 893, 965, 1003, 1025, 1078

Spartina, USFWS Region 4 (Gramineae): 3, 14, 15, 35, 42, 45, 47, 58, 61, 64, 66, 69, 98, 115, 116, 117, 118, 119, 120, 121, 122, 123, 150, 151, 152, 153, 162, 164, 167, 173, 174, 175, 195, 196, 210, 211, 214, 215, 222, 227, 230, 231, 240, 244, 261, 269, 273, 275, 276, 277, 278, 281, 300, 303, 335, 336, 337, 338, 352, 361, 366, 367, 371, 372, 382, 394, 395, 404, 417, 418, 431, 461, 462, 481, 495, 541, 542, 543, 544, 545, 548, 549, 556, 557, 558, 565, 569, 572, 574, 586, 587, 601, 603, 605, 606, 607, 625, 630, 633, 657, 669, 677, 703, 704, 737, 776, 802, 803, 805, 839, 846, 859, 860, 861, 862, 863, 864, 866, 869, 870, 874, 883, 888, 893, 901, 902, 904, 905, 907, 908, 918, 919, 920, 921, 987, 1023, 1024, 1036, 1037, 1042, 1053, 1075, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086

Spartina, USFWS Region 5 (Gramineae): 10, 42, 85, 86, 98, 104, 116, 127, 170, 182, 195, 196, 227, 265, 281, 300, 302, 321, 322, 335, 336, 337, 338, 343, 344, 345, 350, 351, 352, 356, 366, 377, 404, 407, 413, 415, 416, 430, 481, 541, 542, 543, 544, 545, 548, 549, 550, 552, 553, 569, 574, 586, 587, 591, 623, 630, 638, 658, 702, 703, 715, 753, 763, 781, 794, 799, 802, 804, 846, 860, 869, 870, 871, 872, 881, 883, 893, 927, 955, 1005, 1006, 1053, 1078, 1081, 1083

Spergularia (Caryophyllaceae): 40, 212, 298, 300, 456, 505, 672, 707, 746, 924

Sphagnum (Sphagnaceae): 110, 112, 125, 160, 374, 485, 530, 616, 673, 748, 856, 914, 1058, 1060

Spirodela (Lemnaceae): 138, 192, 251, 285, 513, 1009, 1050, 1076, 1077

Sporobolus (Gramineae): 64, 164, 179, 215, 231, 337, 338, 605, 803, 931, 1021, 1043

Suaeda (Chenopodiaceae): 21, 23, 24, 121, 174, 187, 212, 231, 246, 300, 413, 456, 504, 678, 712, 771, 794, 920, 924, 1092, 1093

Syringodium (Potamogetonaceae): 158, 159, 230, 244, 308, 309, 313, 316, 318, 329, 461, 467, 608, 612, 632, 653, 756, 757, 759, 873, 893, 933, 968, 970, 972, 975, 976, 977, 1011

Tamarix (Tamaricaceae): 12, 21, 22, 23, 24, 25, 167, 179, 250, 710, 723, 893, 1035, 1036, 1038, 1039, 1061

Taxodium (Pinaceae): 51, 55, 58, 70, 101, 104, 124, 168, 170, 192, 193, 196, 201, 222, 286, 289, 290, 293, 301, 369, 370, 382, 395, 401, 421, 470, 567, 623, 693, 695, 696, 697, 704, 737, 776, 811, 821, 823, 835, 841, 856, 876, 991, 1044, 1055

Thalassia (Hydroeharitaceae): 38, 158, 159, 230, 243, 244, 262, 263, 273, 274, 275, 278, 308, 311, 313, 316, 318, 329, 334, 348, 367, 461, 467, 520, 574, 608, 612, 632, 651, 653, 729, 754, 755, 756, 757, 758, 759, 760, 761, 806, 893, 928, 933, 947, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 1011

Trifolium (Leguminosae): 163, 198, 378, 440, 498, 623, 624, 678, 693, 893, 954

Triglochin (Juncaginaceae): 40, 50, 98, 212, 522, 544, 545, 546, 591, 672, 846, 924, 1017, 1078, 1092, 1093, 1098

Typha (all) (Typhaceae): 13, 16, 28, 29, 33, 34, 35, 42, 62, 63, 66, 69, 71, 74, 77, 80, 82, 88, 96, 97, 100, 102, 104, 108, 109, 110, 112, 113, 125, 127, 131, 138, 139, 148, 160, 169, 170, 178, 179, 186, 192, 196, 198, 202, 205, 207, 208, 217, 222, 226, 229, 233, 234, 241, 242, 254, 260, 264, 276, 281, 285, 286, 289, 290, 292, 293, 300, 301, 321, 324, 326, 339, 343, 347, 348, 351, 358, 363, 364, 365, 368, 370, 372, 374, 378, 397, 410, 422, 448, 455, 458, 459, 460, 466, 468, 477, 494, 501, 507, 508, 509, 517, 527, 529, 530, 536, 540, 563, 565, 571, 582, 585, 586, 615, 616, 617, 621, 623, 624, 646, 654, 656, 661, 671, 673, 676, 686, 687, 688, 692, 695, 699, 703, 704, 710, 712, 715, 718, 721, 728, 733, 739, 744, 747, 748, 766, 776, 777, 779, 794, 796, 797, 804, 806, 812, 816, 821, 827, 828, 831, 835, 837, 841, 842, 874, 887, 895, 899, 900, 926, 936, 938, 939, 948, 984, 986, 998, 1003, 1008, 1009, 1019, 1026, 1033, 1044, 1047, 1048, 1050, 1054, 1056, 1060, 1069, 1070, 1077, 1092, 1093, 1095, 1098

Typha, USFWS Region 1 (Typhaceae): 13, 102, 148, 178, 196, 198, 241, 242, 254, 281, 300, 339, 363, 364, 365, 410, 501, 586, 703, 710, 712, 766, 779, 1056, 1092, 1093, 1095

Typha, USFWS Region 2 (Typhaceae): 13, 16, 42, 179, 196, 281, 300, 703

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Wildlife—amphibians: 34, 35, 51, 88, 99, 196, 208, 233, 242, 324, 330, 331, 368, 370, 382, 450, 451, 527, 535, 616, 684, 752, 834, 896, 939, 986

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Wildlife—invertebrates: 12, 25, 26, 27, 34, 35, 45, 55, 60, 66, 77, 78, 84, 88, 92, 99, 113, 128, 134, 145, 151, 152, 153, 157, 161, 164, 189, 219, 220, 227, 237, 240, 241, 242, 244, 245, 248, 251, 256, 279, 286, 289, 290, 296, 302, 310, 324, 328, 330, 332, 333, 344, 350, 359, 368, 369, 370, 372, 388, 389, 390, 391, 392, 393, 404, 413, 417, 429, 444, 445, 446, 469, 472, 480, 481, 486, 493, 503, 514, 521, 522, 524, 529, 536, 549, 550, 553, 559, 561, 563, 570, 579, 609, 622, 623, 624, 648, 651, 658, 670, 702, 703, 707, 718, 724, 729, 741, 747, 751, 752, 753, 766, 772, 777, 778, 780, 781, 785, 802, 803, 821, 822, 823, 831, 834, 839, 867, 868, 872, 887, 896, 912, 916, 917, 922, 923, 927, 930, 934, 935, 936, 943, 962, 963, 964, 982, 983, 994, 1013, 1018, 1019, 1023, 1024, 1032, 1034, 1040, 1052, 1055, 1063, 1064, 1065, 1072, 1073, 1074, 1087

Wildlife—mammals: 12, 21, 22, 24, 25, 31, 34, 35, 51, 74, 86, 88, 99, 100, 104, 134, 164, 168, 172, 173, 189, 196, 208, 242, 253, 331, 343, 357, 368, 370, 399, 417, 450, 451, 460, 481, 503, 509, 527, 535, 565, 566, 567, 570, 615, 616, 637, 646, 654, 656, 699, 703, 752, 766, 781, 834, 841, 893, 896, 931, 932, 938, 939, 986, 991, 1015, 1040, 1049, 1050, 1068, 1096

Wildlife—nongame birds: 21, 22, 23, 24, 25, 31, 34, 35, 51, 54, 71, 77, 86, 88, 95, 99, 104, 148, 164, 168, 169, 189, 196, 208, 217, 241, 242, 251, 253, 264, 289, 290, 297, 302, 330, 331, 368, 370, 372, 378, 450, 451, 503, 509, 527, 535, 536, 564, 565, 566, 567, 570, 584, 590, 616, 623, 624, 637, 641, 646, 654, 659, 671, 699, 703, 707, 712, 720, 724, 737, 738, 747, 752, 766, 831, 834, 846, 849, 881, 893, 896, 906, 907, 931, 932, 938, 939, 960, 966, 986, 988, 991, 998, 1015, 1018, 1040, 1049, 1050, 1096

Wildlife—reptiles: 24, 34, 35, 51, 88, 99, 168, 172, 173, 196, 208, 233, 242, 297, 330, 331, 368, 370, 450, 451, 527, 535, 536, 684, 752, 834, 896, 939, 986, 1046

Wildlife—shellfish: 12, 35, 92, 172, 230, 418, 490, 501, 524, 565, 624, 651, 670, 701, 703, 893, 930, 987, 990, 1034, 1096

Wildlife—shorebirds: 12, 24, 34, 35, 45, 47, 51, 54, 71, 78, 86, 88, 95, 99, 104, 130, 148, 164, 168, 169, 172, 179, 189, 196, 208, 217, 241, 242, 244, 251, 253, 254, 264, 265, 267, 289, 290, 297, 299, 302, 330, 331, 361, 368, 370, 371, 372, 378, 410, 450, 451, 462, 527, 535, 536, 564, 565, 566, 567, 569, 570, 572, 598, 605, 607, 616, 620, 623, 637, 641, 646, 660, 671, 699, 703, 704, 707,

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Wildlife – waterfowl: 22, 24, 31, 34, 36, 42, 51, 54, 63, 71, 74, 75, 77, 80, 86, 88, 95, 99, 100, 101, 104, 127, 148, 169, 171, 172, 173, 187, 189, 196, 200, 208, 217, 233, 241, 242, 244, 251, 253, 254, 264, 267, 280, 289, 290, 297, 302, 305, 330, 331, 343, 357, 368, 370, 372, 378, 399, 410, 432, 450, 451, 460, 493, 495, 500, 503, 522, 527, 535, 547, 551, 557, 564, 565, 566, 567, 570, 584, 615, 616, 623, 624, 626, 627, 637, 646, 654, 656, 662, 664, 671, 675, 676, 688, 689, 690, 699, 703, 707, 712, 718, 719, 720, 724, 727, 733, 737, 747, 752, 765, 779, 781, 806, 820, 827, 831, 832, 834, 837, 841, 842, 844, 849, 852, 858, 881, 887, 896, 899, 906, 931, 935, 938, 960, 965, 986, 988, 990, 991, 998, 1002, 1015, 1018, 1025, 1049, 1050, 1059, 1061, 1096

Wetland Type Index

For those who are not familiar with the wetland classification system used in this data base (Cowardin et al. 1979), the following brief descriptions are provided:

Estuarine Tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean; ocean water is at least occasionally diluted by freshwater runoff. Salinities range from hyperhaline (40 ppt) to oligohaline (0.5–5 ppt). These systems are generally low energy. Examples: estuaries, lagoons, embayments.

Lacustrine Permanently flooded lakes, reserviors, and intermit- tent lakes (e.g., playa lakes) that are characterized by total surface area greater than 8 ha and depths greater than 2 m in the deepest part of the basin at low water, or with active wave-formed or bedrock shorelines. "Limnetic" refers to all deepwater habitats; "littoral" refers to the area from the shoreward boundary to a depth of 2 m below low water.

Marine The open ocean which overlies the continental shelf, and its associated high-energy coastline. In subtidal systems, the substrate is continuously submerged, while in intertidal areas the substrate is periodically exposed and flooded by tides (intertidal includes the associated splash zone).

Palustrine Nontidal wetlands that are dominated by trees, shrubs, emergents, or emergent mosses or lichens. They are characterized by surface areas less than 8 ha and water depth less than 2 m in the deepest part of the basin at low water, lack of active wave-formed or bedrock shoreline features, and salinity of less than 0.5 ppt. Examples: marshes, swamps, bogs, fens, prairie potholes, wet meadows, pocosins, and ponds.

Riverine All wetlands contained within a channel, except those with salinity greater than 0.5 ppt or where trees, shrubs, persistent emergents, or emergent mosses or lichens are dominant. Tidal: low gradient; tidal influence; streambed mainly mud with some sand. Lower perennial: low gradient; slow water velocity; no tidal influence; substrate primarily sand and mud. Upper perennial: high gradient; fast water velocity; no tidal influence; substrate is rock, cobble, or gravel with occasional sand. Intermittent: channel contains nontidal flowing water for only part of the year.

Estuarine (general): 8, 37, 81, 94, 143, 172, 190, 194, 199, 238, 254, 271, 282, 340, 385, 386, 409, 412, 425, 439, 441, 502, 512, 515, 562, 568, 576, 580, 581, 634, 647, 649, 715, 721, 767, 784, 785, 790, 806, 857, 891, 892, 909, 968, 1012, 1049, 1059, 1089

Estuarine, intertidal (general): 6, 32, 43, 44, 52, 133, 195, 216, 237, 253, 266, 283, 298, 304, 353, 356, 394, 402, 506, 508, 541, 543, 575, 579, 612, 622, 660, 698, 702, 738, 742, 846, 877, 889, 906, 907, 910, 957, 960, 989, 993, 1040, 1046, 1051, 1066, 1097

Estuarine, intertidal – aquatic bed: 38, 46, 89, 92, 98, 99, 148, 158, 172, 184, 188, 206, 212, 230, 243, 244, 251, 262, 263, 273, 275, 278, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 329, 334, 348, 373, 379, 413, 419, 431, 456, 461, 467, 469, 471, 495, 504, 513, 519, 520, 522, 523, 524, 547, 571, 574, 597, 612, 617, 625, 632, 635, 653, 729, 730, 754, 755, 756, 757, 758, 759, 760, 761, 762, 766, 789, 799, 804, 813, 825, 846, 873, 893, 928, 933, 947, 958, 967, 970, 971, 972, 973, 974, 975, 976, 977, 980, 987, 1011, 1017, 1024, 1034, 1051, 1096

Estuarine, intertidal – emergent (all): 3, 12, 14, 15, 17, 40, 41, 42, 45, 46, 47, 50, 58, 59, 61, 64, 65, 66, 69, 73, 85, 86, 98, 99, 115, 116, 117, 118, 119, 120, 121, 122, 123, 126, 127, 130, 148, 149, 150, 151, 152, 153, 154, 158, 159, 161, 164, 167, 170, 172, 173, 174, 175, 177, 178, 179, 182, 183, 187, 189, 195, 196, 206, 210, 211, 212, 213, 214, 215, 221, 224, 227, 230, 240, 244, 246, 250, 251, 257, 261, 265, 269, 272, 273, 275, 276, 277, 278, 281, 298, 299, 300, 302, 303, 322, 335, 336, 337, 338, 341, 343, 344, 345, 346, 347, 348, 350, 351, 352, 356, 360, 361, 366, 373, 377, 383, 394, 400, 402, 404, 408, 409, 413, 414, 415, 416, 417, 418, 426, 430, 431, 440, 455, 456, 461, 462, 469, 479, 481, 482, 492, 494, 495, 499, 501, 503, 504, 505, 522, 528, 538, 539, 541, 542, 543, 544, 545, 546, 548, 549, 550, 552, 553, 555, 556, 557, 558, 564, 565, 569, 570, 571, 572, 574, 586, 587, 588, 590, 591, 597, 599, 603, 606, 607, 613, 614, 619, 625, 629, 630, 633, 636, 638, 641, 655, 657, 659, 660, 672, 677, 678, 679, 701, 702, 703, 704, 707, 708, 712, 713, 715, 725, 737, 739, 745, 746, 753, 757, 763, 764, 766, 770, 771, 775, 781, 786, 787, 794, 799, 802, 803, 804, 805, 808, 829, 833, 839, 840, 845, 846, 852, 859, 860, 861, 862, 863, 864, 865, 866, 869, 870, 871, 872, 881, 883, 888, 890, 892, 893, 894, 901, 902, 903, 904, 905, 907, 908, 918, 920, 921, 924, 927, 933, 944, 945, 953, 954, 955, 958, 987, 992, 999, 1005, 1006, 1013, 1017, 1022, 1024, 1031, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1053, 1059, 1067, 1068, 1075, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086, 1090, 1091, 1092, 1093, 1094, 1095, 1096, 1097

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1068, 1075, 1078, 1081, 1090, 1091, 1092, 1093, 1094, 1095, 1096, 1097

Estuarine, intertidal—emergent (USFWS Region 2): 12, 42, 98, 116, 158, 159, 172, 174, 179, 195, 196, 215, 224, 227, 250, 281, 300, 335, 336, 337, 352, 366, 481, 482, 541, 542, 543, 544, 545, 549, 564, 569, 572, 574, 587, 613, 614, 630, 703, 770, 771, 846, 860, 869, 883, 893, 894, 944, 945, 958, 1035, 1036, 1038, 1039, 1040, 1041, 1042, 1043, 1053, 1078, 1081

Estuarine, intertidal—emergent (USFWS Region 4): 3, 14, 15, 17, 42, 45, 46, 47, 58, 59, 61, 64, 65, 66, 69, 73, 98, 115, 116, 117, 118, 119, 120, 121, 122, 123, 150, 151, 152, 153, 161, 164, 167, 172, 173, 174, 175, 195, 196, 210, 211, 214, 215, 227, 230, 240, 244, 261, 269, 272, 273, 275, 276, 277, 278, 281, 300, 303, 335, 336, 337, 338, 352, 361, 366, 373, 394, 404, 417, 418, 431, 461, 462, 469, 481, 495, 541, 542, 543, 544, 545, 548, 549, 556, 557, 558, 564, 565, 569, 572, 574, 586, 587, 590, 599, 603, 606, 607, 625, 630, 633, 657, 677, 703, 704, 737, 739, 757, 802, 803, 805, 829, 839, 845, 846, 852, 859, 860, 861, 862, 863, 864, 865, 866, 869, 870, 883, 888, 893, 894, 901, 902, 903, 904, 905, 907, 908, 918, 920, 921, 933, 958, 987, 992, 1013, 1024, 1036, 1037, 1042, 1053, 1075, 1078, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086

Estuarine, intertidal—emergent (USFWS Region 5): 42, 85, 86, 98, 116, 127, 130, 170, 172, 182, 195, 196, 227, 265, 281, 300, 302, 322, 335, 336, 337, 338, 341, 343, 344, 345, 350, 351, 352, 356, 366, 377, 402, 404, 413, 415, 416, 430, 455, 481, 482, 492, 541, 542, 543, 544, 545, 548, 549, 550, 552, 553, 564, 569, 574, 586, 587, 591, 630, 638, 641, 702, 703, 715, 753, 757, 763, 781, 794, 799, 802, 804, 833, 846, 860, 869, 870, 871, 872, 881, 883, 893, 894, 927, 955, 992, 1005, 1006, 1053, 1078, 1081, 1083

Estuarine, intertidal—forested: 9, 45, 46, 58, 61, 66, 73, 86, 158, 161, 164, 165, 166, 196, 213, 215, 218, 230, 244, 250, 295, 296, 303, 348, 361, 366, 373, 380, 381, 461, 462, 470, 544, 545, 598, 600, 601, 602, 604, 605, 607, 630, 633, 652, 737, 738, 739, 783, 791, 792, 845, 847, 848, 869, 888, 902, 903, 904, 930, 949, 950, 951, 952, 987, 1020, 1036, 1039, 1053, 1078, 1083

Estuarine, intertidal—scrub-shrub: 61, 69, 86, 98, 130, 158, 164, 166, 179, 210, 215, 244, 281, 347, 361, 373, 418, 431, 461, 481, 605, 629, 630, 633, 737, 738, 739, 805, 869, 881, 903, 907, 918, 920, 921, 958, 1020, 1035, 1040, 1053, 1078

Estuarine, intertidal—unconsolidated shore: 14, 15, 61, 64, 86, 98, 99, 118, 127, 130, 148, 150, 151, 152, 153, 164, 179, 184, 187, 189, 206, 210, 213, 215, 224, 230, 231, 244, 251, 261, 276, 300, 306, 307, 310, 312, 313, 322, 343, 344, 351, 356, 373, 379, 400, 409, 413, 416, 430, 431, 440, 454, 456, 462, 482, 492, 495, 501, 504, 519, 522, 538, 539, 546, 550, 557, 565, 569, 570, 586, 605, 607, 613, 620, 625, 641, 655, 660, 681, 685, 712, 739, 746, 789, 794, 803, 839, 840, 848, 861, 862, 864, 865, 866, 869, 870, 871, 873, 881, 888, 890, 893, 902, 907, 908, 945, 952, 953, 971, 992, 993, 1011, 1022, 1030, 1035, 1037, 1041, 1051, 1059, 1079, 1081, 1082, 1084, 1086, 1096

Estuarine, subtidal (general): 195, 353, 501, 508, 543, 612, 906, 961, 1066

Estuarine, subtidal—aquatic bed: 38, 65, 159, 185, 243, 244, 262, 263, 274, 278, 306, 310, 329, 379, 653, 730, 755, 756, 758, 759, 760, 761, 762, 928, 967, 969, 970, 971, 972, 974, 976, 977, 978, 979, 980, 1011, 1090

Estuarine, subtidal—unconsolidated bottom: 66, 151, 177, 185, 274, 306, 310, 373, 379, 620, 681, 928, 970, 971, 976, 978, 979, 1011

Lacustrine (general): 2, 7, 8, 11, 16, 27, 37, 53, 55, 57, 60, 76, 77, 78, 79, 81, 83, 87, 91, 94, 105, 113, 114, 132, 136, 141, 143, 144, 156, 172, 190, 197, 199, 213, 223, 235, 239, 248, 260, 268, 271, 279, 320, 328, 333, 339, 359, 376, 385, 387, 396, 398, 410, 429, 439, 441, 443, 450, 451, 452, 455, 463, 464, 486, 488, 489, 490, 496, 498, 502, 510, 512, 514, 515, 517, 526, 531, 532, 533, 534, 535, 537, 551, 554, 562, 568, 580, 581, 584, 589, 616, 618, 622, 631, 633, 637, 639, 647, 648, 649, 665, 680, 686, 689, 692, 693, 706, 716, 721, 724, 740, 749, 751, 767, 778, 784, 785, 796, 804, 806, 814, 815, 827, 830, 831, 837, 842, 843, 849, 850, 851, 857, 867, 878, 891, 896, 897, 898, 906, 909, 910, 914, 916, 925, 931, 935, 942, 959, 968, 984, 991, 994, 1004, 1012, 1016, 1044, 1045, 1049, 1062, 1099, 1100

Lacustrine, limnetic (general): 75, 76, 139, 255, 323, 325, 332, 493, 628, 733, 868, 914, 990

Lacustrine, limnetic—aquatic bed: 513, 812

Lacustrine, limnetic—unconsolidated bottom: 268, 443, 537, 724, 959

Lacustrine, littoral (general): 75, 76, 139, 226, 255, 327, 331, 332, 342, 355, 358, 395, 403, 421, 458, 465, 493, 540, 628, 643, 673, 699, 733, 735, 736, 772, 868, 981, 989, 990, 993, 1057

Lacustrine, littoral—aquatic bed: 49, 75, 76, 100, 138, 172, 208, 260, 333, 358, 359, 457, 493, 513, 514, 733, 747, 776, 777, 796, 812, 827, 887, 914, 994, 1009, 1044

Lacustrine, littoral—emergent: 13, 100, 139, 208, 260, 358, 395, 407, 432, 457, 493, 569, 692, 734, 747, 776, 777, 796, 812, 831, 887, 914, 1009, 1044, 1070

Lacustrine, littoral—unconsolidated bottom: 49, 403, 443, 569, 724, 895, 959

Lacustrine, littoral—unconsolidated shore: 11, 13, 57, 136, 198, 319, 323, 325, 395, 407, 457, 459, 531, 540, 586, 596, 734, 840, 869, 895, 993, 1070

Marine (general): 8, 81, 94, 143, 190, 238, 271, 385, 439, 441, 504, 512, 515, 562, 568, 580, 647, 649, 721, 767, 784, 785, 790, 806, 892, 909, 910, 968, 1012, 1049

Marine, intertidal (general): 353, 522, 549, 612, 702, 906, 1066, 1096

Marine, intertidal – aquatic bed: 38, 262, 263, 278, 307, 311, 313, 315, 316, 318, 329, 367, 413, 608, 612, 653, 730, 755, 756, 758, 759, 760, 761, 873, 912, 928, 933, 972, 977

Marine, intertidal – rocky shore: 213, 912

Marine, intertidal – unconsolidated shore: 213, 215, 230, 231, 367, 454, 492, 538, 586, 869, 919, 952, 992, 993, 1030, 1081

Marine, subtidal (general): 213, 353, 413, 612, 906, 1066

Marine, subtidal – aquatic bed: 38, 262, 263, 274, 278, 295, 329, 608, 651, 653, 730, 755, 756, 758, 759, 760, 761, 928, 969, 972, 977, 978, 979, 1090

Marine, subtidal – unconsolidated bottom: 26, 274, 413, 756, 928, 979

Palustrine (general): 6, 8, 30, 37, 57, 79, 81, 83, 94, 101, 103, 105, 112, 114, 132, 133, 141, 142, 143, 144, 156, 157, 190, 197, 199, 213, 217, 223, 226, 228, 232, 235, 242, 253, 254, 259, 260, 268, 271, 282, 283, 285, 287, 297, 304, 305, 326, 332, 339, 340, 353, 376, 385, 387, 394, 396, 411, 425, 427, 438, 439, 441, 443, 449, 450, 451, 460, 463, 464, 485, 487, 488, 489, 493, 496, 498, 502, 508, 510, 512, 515, 522, 525, 530, 532, 533, 534, 535, 537, 551, 562, 566, 568, 580, 581, 584, 592, 593, 609, 622, 627, 628, 631, 634, 637, 643, 647, 649, 650, 660, 668, 673, 675, 680, 689, 690, 691, 692, 693, 694, 696, 700, 706, 709, 716, 717, 721, 722, 724, 732, 740, 749, 751, 752, 765, 767, 782, 784, 785, 798, 806, 810, 815, 820, 824, 826, 831, 832, 837, 843, 853, 854, 857, 877, 882, 891, 896, 898, 909, 910, 917, 925, 931, 957, 966, 968, 981, 991, 997, 1012, 1015, 1016, 1023, 1045, 1049, 1057, 1061, 1062, 1078, 1099

Palustrine – aquatic bed: 16, 33, 48, 49, 51, 71, 80, 82, 88, 93, 100, 102, 104, 108, 109, 127, 131, 135, 137, 139, 171, 172, 173, 175, 178, 186, 192, 202, 205, 208, 229, 233, 241, 251, 280, 285, 289, 290, 292, 293, 294, 324, 348, 370, 371, 372, 382, 399, 410, 422, 466, 477, 478, 495, 507, 509, 513, 514, 516, 527, 536, 559, 560, 567, 571, 582, 583, 585, 586, 609, 615, 616, 617, 637, 654, 661, 663, 669, 671, 676, 682, 683, 686, 694, 697, 699, 718, 719, 727, 728, 739, 744, 769, 788, 795, 796, 797, 811, 816, 818, 819, 820, 832, 838, 840, 842, 858, 874, 884, 887, 899, 900, 911, 935, 936, 939, 948, 986, 998, 1002, 1007, 1008, 1015, 1019, 1025, 1031, 1033, 1048, 1050, 1071, 1076, 1077

Palustrine – emergent (all): 1, 2, 11, 13, 16, 18, 28, 29, 33, 34, 35, 36, 42, 48, 50, 51, 54, 59, 62, 63, 65, 67, 68, 71, 74, 76, 77, 80, 82, 88, 93, 95, 96, 97, 98, 100, 101, 102, 104, 108, 109, 110, 111, 112, 113, 117, 124, 125, 127, 129, 131, 135, 136, 137, 138, 139, 140, 148, 149, 160, 162, 168, 169, 170, 171, 172, 173, 175, 176, 178, 181, 186, 191, 192, 193, 196, 198, 200, 201, 202, 203, 204, 205, 207, 208, 209, 217, 222, 225, 226, 229, 233, 234, 236, 241, 242, 250, 251, 252, 253, 255, 256, 258, 259, 260, 264, 267, 280, 281, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 297, 301, 320, 321, 323, 324, 326, 327, 330, 331, 342, 346, 347, 348, 349, 351, 354, 355, 357, 358, 359, 362, 363, 364, 365, 368, 369, 370, 371, 372, 374, 375, 378, 382, 384, 391, 394, 397, 407, 410, 421, 422, 423, 424, 426, 427, 431, 432, 437, 448, 452, 455, 457, 458, 459, 460, 465, 466, 468, 477, 478, 481, 493, 494, 495, 496, 497, 499, 500, 507, 508, 509, 511, 514, 516, 517, 518, 527, 529, 530, 531, 536, 540, 545, 548, 560, 563, 564, 567, 569, 570, 571, 578, 582, 583, 585, 586, 587, 588, 589, 596, 609, 611, 615, 616, 617, 621, 623, 624, 626, 627, 629, 637, 646, 650, 654, 656, 661, 663, 664, 668, 669, 670, 671, 673, 674, 676, 678, 682, 684, 686, 687, 688, 692, 693, 694, 695, 697, 699, 703, 710, 711, 718, 719, 720, 727, 728, 733, 734, 739, 744, 747, 748, 750, 752, 768, 769, 772, 776, 777, 779, 788, 795, 796, 797, 802, 804, 805, 807, 811, 812, 816, 820, 821, 827, 828, 829, 831, 832, 834, 835, 837, 840, 841, 842, 844, 858, 869, 874, 882, 887, 894, 895, 899, 900, 905, 911, 913, 926, 929, 932, 934, 935, 936, 937, 938, 939, 948, 958, 960, 965, 984, 985, 986, 989, 990, 991, 992, 993, 994, 996, 998, 1000, 1001, 1002, 1003, 1007, 1008, 1009, 1015, 1017, 1018, 1019, 1021, 1022, 1023, 1025, 1026, 1027, 1031, 1033, 1036, 1044, 1047, 1048, 1050, 1054, 1055, 1056, 1058, 1060, 1061, 1068, 1069, 1070, 1071, 1077, 1078, 1095, 1098

Palustrine – emergent (USFWS Region 1): 2, 11, 13, 18, 48, 68, 98, 102, 148, 149, 171, 172, 176, 178, 191, 196, 198, 200, 241, 242, 267, 281, 357, 362, 363, 364, 365, 410, 421, 426, 481, 545, 564, 569, 570, 586, 637, 668, 674, 703, 710. 720, 734, 779, 869, 894, 960, 996, 1000, 1017, 1021, 1022, 1031, 1056, 1068, 1078, 1095

Palustrine – emergent (USFWS Region 2): 13, 16, 18, 42, 98, 171, 172, 196, 250, 281, 481, 531, 545, 564, 569, 587, 596, 637, 674, 693, 703, 869, 894, 958, 1000, 1027, 1036, 1061, 1078

Palustrine – emergent (USFWS Region 3): 28, 29, 54, 62, 63, 71, 74, 104, 125, 160, 181, 208, 225, 233, 259, 285, 327, 330, 342, 374, 397, 407, 422, 423, 424, 452, 460, 466, 468, 478, 493, 496, 509, 511, 514, 529, 548, 563, 567, 569, 578, 586, 589, 615, 626, 627, 656, 673, 684, 686, 687, 688, 692, 693, 694, 695, 697, 718, 719, 728, 747, 772, 788, 796, 807, 811, 812, 831, 842, 869, 913, 938, 965, 991, 1003, 1009, 1015, 1019, 1025, 1047, 1050, 1060, 1069, 1070, 1078, 1098

Palustrine – emergent (USFWS Region 4): 1, 16, 34, 35, 36, 42, 51, 59, 65, 82, 88, 98, 108, 109, 110, 117, 124, 140, 160, 162, 168, 172, 173, 175, 192, 193, 196, 201, 209, 222, 253, 255, 258, 259, 281, 284, 286, 287, 288, 289, 290, 291, 292, 293, 294, 297, 301, 320, 323, 324, 326, 354, 368, 369, 370, 371, 372, 374, 375, 382, 384, 394, 431, 432, 465, 477, 481, 495, 518, 527, 536, 545, 548, 564, 567, 569, 586, 587, 589, 669, 670, 673, 676, 693, 703, 711, 739, 776, 777, 795, 802, 805, 811, 821, 828, 829, 834, 835, 841, 869, 874, 882, 887, 894, 905, 926, 936, 939, 958, 984, 986, 990, 991, 992, 1001, 1007, 1023, 1036, 1044, 1054, 1055, 1071, 1077, 1078

Palustrine – emergent (USFWS Region 5): 33, 36, 42, 93, 96, 97, 98, 100, 101, 104, 112, 113, 127, 129, 131, 135, 136, 137, 139, 170, 172, 196, 202, 229, 259, 280, 281, 321, 327, 342, 349, 351, 358, 374, 407, 427, 455, 481, 493, 496, 530, 545, 548, 564, 569, 582, 583, 585, 586, 587, 589, 616, 617, 621, 623, 624, 646, 693, 703, 752, 768, 769, 772, 802, 804, 816, 869, 894, 900, 911, 937, 992, 1002, 1018, 1033, 1058, 1078

Palustrine – emergent (USFWS Region 6): 13, 18, 80, 171, 186, 203, 204, 205, 217, 252, 256, 285, 391, 437, 457, 458, 459, 460, 478, 496, 500, 507, 516, 674, 693, 699, 728, 750, 772, 820, 832, 837, 844, 858, 895, 899, 932, 985, 998, 1000

Palustrine – emergent (USFWS Region 7): 497, 650

Palustrine – forested: 1, 2, 4, 5, 9, 11, 16, 18, 20, 21, 22, 23, 24, 25, 31, 34, 35, 36, 51, 55, 59, 67, 70, 96, 101, 104, 106, 107, 124, 125, 127, 136, 139, 140, 155, 160, 168, 170, 176, 180, 192, 193, 196, 201, 222, 245, 247, 249, 264, 281, 284, 286, 287, 288, 289, 290, 291, 293, 294, 297, 301, 320, 330, 358, 368, 369, 370, 378, 382, 383, 391, 393, 398, 401, 406, 421, 431, 432, 433, 434, 452, 455, 458, 459, 466, 470, 473, 474, 475, 476, 496, 508, 509, 511, 518, 531, 548, 564, 567, 571, 577, 578, 586, 589, 596, 621, 623, 624, 640, 644, 654, 666, 668, 674, 676, 684, 693, 695, 696, 697, 699, 710, 711, 723, 727, 737, 750, 752, 772, 773, 774, 776, 802, 809, 810, 811, 821, 822, 823, 834, 835, 836, 841, 853, 856, 869, 876, 923, 938, 941, 956, 958, 965, 991, 996, 998, 1000, 1001, 1002, 1010, 1014, 1018, 1028, 1055, 1056, 1057, 1060, 1061, 1073, 1098

Palustrine – moss–lichen: 68, 125, 374, 485, 530, 673, 748, 772, 856, 885, 1058

Palustrine – scrub–shrub: 1, 2, 11, 13, 16, 18, 21, 22, 23, 24, 25, 31, 34, 35, 36, 67, 68, 96, 101, 104, 127, 136, 137, 139, 140, 155, 163, 168, 169, 170, 176, 180, 191, 192, 193, 196, 198, 201, 203, 204, 222, 226, 229, 249, 252, 256, 264, 284, 286, 288, 289, 290, 358, 368, 378, 382, 383, 391, 393, 407, 420, 421, 422, 432, 437, 452, 455, 457, 458, 459, 466, 474, 481, 497, 508, 509, 511, 518, 527, 531, 536, 564, 567, 571, 577, 578, 586, 589, 596, 629, 640, 641, 644, 654, 664, 666, 668, 671, 674, 682, 684, 697, 699, 711, 723, 734, 735, 736, 739, 744, 750, 774, 780, 796, 804, 807, 809, 823, 834, 835, 853, 880, 885, 886, 923, 937, 938, 941, 956, 965, 985, 991, 993, 996, 998, 1000, 1002, 1007, 1010, 1014, 1021, 1044, 1055, 1056, 1057, 1058, 1060, 1098

Palustrine – unconsolidated bottom: 28, 54, 56, 57, 63, 104, 125, 127, 148, 169, 258, 268, 362, 363, 378, 443, 455, 472, 496, 511, 517, 536, 537, 662, 667, 682, 724, 744, 835, 840, 885, 895, 913, 934, 988, 1077, 1098

Palustrine – unconsolidated shore: 56, 57, 169, 378, 422, 472, 507, 570, 662, 667, 750, 858, 895, 960, 981, 988

Riverine (general): 8, 9, 16, 18, 19, 21, 25, 31, 37, 67, 81, 94, 112, 114, 115, 128, 132, 140, 141, 142, 143, 144, 145, 146, 147, 155, 176, 180, 190, 194, 196, 197, 199, 203, 213, 220, 223, 232, 235, 249, 256, 270, 271, 283, 291, 304, 327, 328, 333, 385, 389, 391, 393, 394, 396, 401, 406, 420, 428, 429, 434, 435, 439, 441, 442, 444, 445, 446, 447, 450, 451, 453, 463, 464, 466, 474, 476, 480, 488, 490, 491, 496, 502, 510, 512, 515, 518, 530, 532, 548, 561, 562, 566, 568, 573, 577, 580, 581, 589, 594, 610, 631, 634, 644, 645, 647, 649, 658, 673, 674, 675, 680, 690, 693, 706, 711, 716, 721, 740, 743, 749, 767, 773, 774, 780, 784, 785, 800, 801, 806, 809, 817, 830, 841, 855, 857, 879, 880, 892, 896, 898, 906, 909, 910, 915, 922, 923, 941, 942, 943, 956, 966, 983, 989, 993, 995, 1000, 1010, 1012, 1016, 1023, 1027, 1032, 1045, 1049, 1055, 1062, 1065, 1073, 1099, 1100

Riverine, riparian: 1, 9, 16, 18, 20, 21, 22, 23, 24, 25, 31, 106, 134, 140, 146, 155, 163, 176, 180, 191, 193, 203, 204, 232, 234, 249, 256, 290, 297, 330, 383, 391, 401, 406, 420, 434, 437, 450, 451, 452, 455, 466, 474, 476, 488, 491, 518, 567, 577, 589, 637, 640, 644, 668, 674, 696, 700, 705, 711, 723, 773, 774, 780, 800, 801, 809, 821, 822, 823, 826, 841, 853, 880, 886, 896, 923, 940, 941, 942, 956, 962, 985, 996, 1000, 1010, 1014, 1021, 1028, 1056

Riverine, intermittent (general): 112, 115, 193, 256, 403, 437, 438, 534, 648, 821, 837, 915, 962, 963, 1063

Riverine, intermittent – streambed: 128, 155, 220, 256, 480, 518, 640, 658, 726, 741, 743, 780, 793, 879, 886, 983, 995, 1032, 1063, 1073

Riverine, lower perennial (general): 20, 23, 24, 84, 106, 128, 163, 191, 193, 219, 234, 266, 290, 297, 330, 357, 375, 383, 388, 390, 392, 401, 405, 449, 452, 455, 466, 480, 483, 518, 522, 534, 548, 624, 642, 643, 648, 650, 670, 700, 705, 714, 723, 726, 741, 809, 822, 834, 837, 875, 894, 915, 940, 946, 962, 963, 964, 982, 990, 1014, 1052, 1064, 1087, 1088

Riverine, lower perennial – aquatic bed: 111, 513, 673, 741, 822, 915, 996, 1073

Riverine, lower perennial – emergent: 4, 5, 111, 234, 245, 281, 650, 703, 822, 823, 996, 1056

Riverine, lower perennial – unconsolidated bottom: 1, 90, 111, 134, 220, 393, 405, 406, 567, 595, 741, 793, 886, 996, 1064, 1065, 1072, 1073, 1074, 1087

Riverine, lower perennial – unconsolidated shore: 4, 5, 10, 22, 198, 245, 281, 482, 586, 621, 623, 640, 774, 840, 1018, 1021

Riverine, tidal (general): 59, 153, 163, 187, 195, 237, 266, 383, 402, 417, 427, 455, 522, 546, 553, 638, 672, 705, 715, 731, 763, 775, 805, 875, 960, 1027, 1036, 1052, 1093, 1094

Riverine, tidal – aquatic bed: 513, 547, 585, 893

Riverine, tidal – emergent: 4, 5, 245, 251, 281, 301, 349, 564, 585, 587, 621, 623, 624, 703, 1018, 1027, 1083

Riverine, tidal – unconsolidated bottom: 4, 5, 245, 349, 621, 623, 1018

Riverine, tidal – unconsolidated shore: 4, 5, 10, 45, 189, 245, 281, 440, 482, 570, 621, 623, 624, 655, 840, 871, 893, 902, 908, 953, 1018

Riverine, upper perennial (general): 24, 72, 84, 128, 163, 191, 219, 388, 436, 438, 483, 484, 522, 700, 826, 853, 940, 946, 962, 964, 982, 985, 1028, 1029, 1088

Riverine, upper perennial – rock bottom: 72

Riverine, upper perennial – unconsolidated bottom: 39, 72, 90, 134, 220, 391, 392, 393, 403, 406, 436, 484, 491, 521, 879, 985, 1028, 1072, 1073, 1074

Riverine, upper perennial – unconsolidated shore: 774

Appendix C. Wetland Creation/Restoration Data Base Report[1]

1. Abbey, D. G. A. 1988. Tangipahoa crossing: restoring and preserving one of Louisiana's designated scenic rivers. Pages 107–124 *in* Erosion Control: stay in tune. Proceedings of the XIX International Conference, Erosion Control Association, New Orleans, La.

   Response: None

   Genus: *Acer, Berberis, Betula, Carpinus, Celtis, Cornus, Crataegus, Cynodon, Fraxinus, Ligustrum, Lolium, Lonicera, Paspalum, Pinus, Populus, Prunus, Quercus, Rhus, Rosa, Salix, Sambucus, Ulmus*, many

   Describes the planning and design for restoration of a portion of a natural scenic river, the Tangipahoa, Tangipahoa Parish, Louisiana, crossed by a gas transmission pipeline. Topics include a cultural profile of Tangipahoa Parish, the natural profile of the general vicinity of the project site, and a design profile of the project. The design includes planting trees, shrubs, and bank cover; shaping and grading the river bank; installing an artificial irrigation system to insure survival of seedbeds during early stages of succession; biotechnical erosion control features; and creation of tree islands. Construction of the project had not yet begun.

2. Abernathy, M. C., D. J. Morris, and R. Van Wormer. 1985. Wetland reclamation planning at the John Henry mine in western Washington. Pages 153–159 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

   Response: None

   Genus: *Alnus, Salix, Spiraea*

   Describes a restoration plan for the marshy remnant of a man-made lake on coal-mined land in King County, northwestern Washington. The marsh was created in 1971 by the breach of a dam. The restoration plan to enhance the 5.7-ha (14-acre) wetland includes a detailed review of mine plans and reclamation schedules, site reconnaissance, and summaries of geologic, geotechnical, and hydrologic features. The final plan calls for partially backfilling an open mine pit, while blending the original lake into the 5.2- to 5.6-ha wetland at the shallow end. A water control structure will be installed to permit water level fluctuations and banks will be graded to a 3:1 slope to allow development of shrubs and wildlife habitat.

3. Adams, D. A. 1963. Factors influencing vascular plant zonation in North Carolina salt marshes. Ecology 44(3):445–456.

   Response: VEG, SOIL, CHEM, WQUAL

   Genus: *Aster, Borrichia, Distichlis, Fimbristylis, Juncus, Limonium, Salicornia, Scirpus, Spartina*

   Describes salt-marsh vegetation and its relation to sea level in seven sites along the lower coast of North Carolina. Statistical analyses were performed on vegetation and soil samples; comparisons of 10 marsh plant species are presented. Species in the low marsh consisted of smooth cordgrass (*Spartina alterniflora*), *Salicornia perennis*, *Limonuim carolinianum*, and needle rush (*Juncus roemerianus*). The high marsh species association was *Aster tenuifolius*, seashore saltgrass (*Distichlis spicata*), marshhay cordgrass (*Spartina patens*), chestnut fimbristylis (*Fimbristylis castanea*), and bushy sea-oxeye (*Borrichia frutescens*). Salinity, soil pH, water table depth, and water nutrient concentrations were measured to determine the relation between these environmental conditions and salt marsh succession.

4. Adams, D. D., D. A. Darby, and R. J. Young. 1978. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix F: Environmental impacts of marsh development with dredged material-sediment and water quality. Vol. II. Substrate and chemical flux characteristics of a dredged material marsh. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-23. 495 pp.

   Response: SOIL, CHEM, WQUAL, SUCCESS

   Genus: None

   This report is the second of a two-volume study of sediment characteristics of a dredged material marsh at Windmill Point, James River, Virginia. Substrate sediment studies and physical–chemical transport characteristics of the marsh development site and a natural marsh are compared. The natural marsh substrate was more acidic and slightly more oxidized, with finer, more organic sediments that had a higher cation exchange capacity. Water quality studies included measurements of temperature, dissolved oxygen, turbidity, pH, alkalinity, and dissolved nutrients.

5. Adams, D. D., D. A. Darby, and R. J. Young. 1978. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia; Appendix F: Environmental impacts of marsh development with dredged material: sediment and water quality. Vol. I. Characteristics of channel sediments before dredging and effluent quality during and shortly after marsh habitat development. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-23. 79 pp.

   Response: SOIL, CHEM

   Genus: None

   Describes sediment and water quality at the Windmill Point marsh development site, James River, Virginia. River bottom sediments were fine-textured and poorly sorted. Sediments were described in terms of temperature, pH, oxidation-reduction potential, water, volatile solids, particle size, minerals, and cation exchange capacity. Channel sediment characteristics and chemical quality of effluent leaving the marsh development site were studied during dredged material disposal (for marsh substrate), during dewatering, and 3.5 months after dredging (before planting). Baseline data are examined in

[1] Please note that the following records are out of sequence in terms of the alphabetical listing of author's names: #83. B. Dobie, #535. R. W. Koopman, and #809. W. H. Rickard.

detail to evaluate potential detrimental effects on successful marsh development and to assess the presence of pollutants.

6. Adams, S. R. 1983. Investigation of environmental enhancement needs and alternatives for the Loxahatchee slough/canal 18 basin, Florida. Pages 1–16 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

   Response: HYDRO, WQUAL, CHEM

   Genus: None

   Describes three alternative water management plans for the environmental enhancement of Loxahatchee slough and the northwest fork of the Loxahatchee River, Martin and Palm Beach Counties, Florida. These areas have been severely altered by drainage activities and subsequent saltwater intrusion. A computerized simulation model, developed to test the applicability of the management plans, was based on analysis of the hydrological characteristics of the study areas. Flood control, water supply, water quality, and environmental preservation and enhancement are focal points of the plans.

7. Adamski, J. M., and M. F. P. Michalski. 1975. Reclamation of acidified lakes—Middle and Lohi, Sudbury, Ontario. Verh. Internatl. Verein. Limnol. 19:1971–1983.

   Response: VEG, CHEM, WQUAL

   Genus: *Cryptomonas, Dinobryon, Mougeotia, Oocystis, Peridinium, Rhodomonas, Selenastrum*

   Discusses the addition of chemical neutralizing agents to supplement the natural buffering capacity of two acidified lakes: Middle and Lohi, Sudbury, Ontario, Canada. Calcium hydroxide was the primary treatment chemical; calcium carbonate was applied after initial treatment with calcium hydroxide was complete. Substantial reductions in heavy metal content were recorded following chemical neutralization. Lime demand also decreased and pH increased. Chlorophylla concentrations were low and small nutrient additions may eventually be necessary to enhance productivity. Results indicated that combined calcium hydroxide and calcium carbonate treatment is a simple, effective, and relatively inexpensive water management tool for reclaiming acidic lakes of the precambrian shield.

8. Adamus, P. R. 1988. Criteria for created or restored wetlands. Pages 369–372 *in* D. D. Hook, ed. The ecology and management of wetlands. Vol. 2. Timber Press, Portland, Oreg.

   Response: SUCCESS

   Genus: None

   Discusses criteria for determining the effectiveness of wetland replacement (i.e., in attempting to answer the question of whether or not new or restored wetlands are as "good" as the wetlands they replace). Failure to successfully create or recreate most natural wetland conditions and functions is weighed against benefits of mitigation for at least some of the losses. Discusses wetland evaluation techniques.

9. Adamus, P. R. 1987. Wetland evaluation technique for bottomland hardwood functions. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oreg. Draft Rep. 74 pp.

   Response: None

   Genus: None

   Presents a wetland evaluation technique for bottomland hardwoods on river floodplains in the Mississippi Valley alluvial plain, Gulf Coastal plain, and South Atlantic coastal plain. Includes an assessment of social significance and wetland functions: groundwater discharge, flood flow alteration, sediment stabilization, sediment–toxicant retention, nutrient removal–transformation, production export, and finfish, shellfish, and wildlife habitat. Discusses of the U.S. Environmental Protection Agency's bottomland hardwood initiatives, relation of this assessment technique to other assessment methods, the importance of bottomland hardwoods to wetland functions, and implementation of the technique.

10. Ailstock, M. S. 1987. A review of beach prisms: their application for wetlands creation under moderate to high energy conditions. Pages 7–16 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community Coll., Plant City, Fla.

    Response: SOIL

    Genus: *Spartina*

    Evaluates effectiveness of using beach prisms to stabilize a sand spit at the mouth of Forked Creek, a small tributary of the Magothy River, Anne Arundel County, Maryland. Beach prisms are modular, precast, preassembled erosion control systems that function as permeable, detached breakwaters, and affect deposition of sediments suspended in the water column. Sediments are first deposited behind the prisms and eventually out in front as the shoreline profile becomes modified to a gradual run-up configuration. A net accretion of coarse sand sediments was observed both above and below mean low water behind the prisms after 9 months. Accreted sediments were not stable and planting of cordgrass (*Spartina*) was recommended to minimize loss of accumulated material during storm events.

11. Allen, H. H. 1983. Planting techniques to stabilize reservoir shoreline at Lake Wallula, Oregon/Washington. Pages 1–3 *in* Environmental and Water Quality Operational Studies. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Inf. Exchange Bull. Vol. E-83-3.

    Response: VEG, SOIL

    Genus: *Carex, Phalaris, Salix*

    Describes planting techniques used to stabilize a sandy beach subject to wind and wave action along the shoreline at Lake Wallula, Oregon–Washington. Ten woody and 15 herbaceous plant species were transplanted in monotypic plots along three elevational contours on the beach. A 1.2-m high snow fence was erected in front of the plots in an attempt to still any wave action. Four plots each of willow (*Salix* sp.) fascines, willow mats, and reed rolls were tested. All three techniques have been successively used for stream bank stabilization in other studies; however, the techniques failed at Lake Wallula. The revised technique was a willow–fence combination using much earlier season willow stock and willow switches planted upright to avoid smothering by shifting sand. This modified technique resulted in 75–100% survival and 135–138% cover increase.

12. Allen, H. H., E. J. Clairain, R. J. Diaz, A. W. Ford, L. F. Hunt, and B. R. Wells. 1978. Habitat development field investigations—Bolivar Peninsula marsh and upland habitat development site, Galveston, Texas; summary report. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-15. 73 pp.

    Response: FISH, INVERT, SHELLF, MAMMALS, SHOREB, VEG, SOIL, ECON, SUCCESS

Genus: *Andropogon, Croton, Cynodon, Myrica, Panicum, Quercus, Rhus, Spartina, Tamarix*

Describes habitat development on dredged spoil material at Bolivar Peninsula, Galveston, Texas. Plantings of marsh grasses and upland vegetation were successful after 2.5 years. Plants were protected from wind, waves, and grazing animals. A sandbag dike was constructed, but consideration of more cost-effective alternatives was recommended. Elevation was the most important determinant of marsh grass success. Smooth cordgrass (*Spartina alterniflora*) thrived best at elevations below mean high tide; saltmeadow cordgrass thrived best above mean high tide. Preliminary observations indicated that development of this marsh was associated with increases in benthic organisms, insects, and fish; bird diversity and activity in the planted areas also increased.

13. Allen, H. H., and C. V. Klimas. 1986. Reservoir shoreline revegetation guidelines. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech Rep. E-86-13. 87 pp.

Response: VEG, HUSE, SOIL, ECON, SUCCESS

Genus: *Carex, Cornus, Deschampsia, Eleocharis, Juncus, Panicum, Polygonum, Rosa, Sagittaria, Salix, Scirpus, Typha*, many

Examines the feasibility of establishing vegetation on shorelines subjected to varying water levels at Lake Oahe, South Dakota; Lake Wallula, Oregon–Washington; and Lake Texoma, Oklahoma–Texas. Guidelines for developing vegetation include site planning, site preparation, planting methods, costs, postplanting operations, monitoring, and maintenance. Focuses on reduced costs of vegetation establishment and specialized planting techniques. Discusses results and problems from each site.

14. Allen, H. H., and J. W. Webb. 1982. Influence of breakwaters on artificial salt marsh establishment on dredged material. Pages 18–35 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Spartina*

Smooth cordgrass (*Spartina alterniflora*) was planted on dredged material dikes on Theodore Disposal Island, Mobile Bay, Alabama. Sprigs planted in exposed areas without protection from waves were washed out in 1 month. Subsequent plantings were protected by two breakwater systems; those behind the floating tire breakwater had a 55.7% survival rate, the fixed breakwater a 24.3% rate, and no breakwater a 4.0% rate. Fertilized and unfertilized plant survival rates were not significantly different. Survival of transplants spaced at 1.0 m was 34.3%; at 0.5-m spacing, survival was 21.8%.

15. Allen, H. H., J. W. Webb, and S. O. Shirley. 1984. Wetlands development in moderate wave-energy climates. Pages 943–955 *in* R. L. Montgomery and J. W. Leach, eds. Dredging and dredged material disposal. Vol. 2. Proceedings of the conference dredging 1984. American Society of Civil Engineers, New York.

Response: VEG, SOIL, ECON

Genus: *Spartina*

Discusses smooth cordgrass (*Spartina alterniflora*) establishment techniques used to stabilize erodible areas of Theodore Island, a dredged material island in Mobile Bay, Alabama. Some of the experimental plots had previously washed out due to wave action after two or three planting attempts using bare-rooted, single-stemmed sprigs. Various treatments using mats, tires, plant wrappings, and bare-root plants were used. Three techniques seemed promising for erosion control at a reasonable cost: plant rolls, burlap bundles, and plants sprigged in slits of 1.1 kg/m^2 paratex mat. These treatments were 1.5–7 times more expensive than conventionally planted single-stemed transplants, but had 2–3.3 times more plant survival after 5 months.

16. Ambrose, R. E., C. R. Hinkle, and C. R. Wenzel. 1983. Practices for protecting and enhancing fish and wildlife on coal surface-mined land in the southcentral United States. U.S. Fish Wildl. Serv., FWS/OBS-83-11. 229 pp.

Response: ECON

Genus: *Carya, Cephalanthus, Ilex, Pinus, Populus, Potamogeton, Quercus, Scirpus, Typha*, many

A handbook on current practices used to minimize disturbances and adverse effeets of surface mining on fish and wildlife resources of the southcentral United States. Topics include: planning for various fish and wildlife needs, protecting resources during mining, reclamation techniques to enhance fish and wildlife resources, and examples of regional reclamation planning. Reclamation techniques include seeding, planting, stabilizing banks, creating impoundments, stocking fish, developing islands, and providing nesting habitat, cover, and food plots. Provide risks, limitations, approximate costs, and maintenance and management requirements of each practice.

17. Amen, R. D., G. E. Carter, and R. J. Kelly. 1970. The nature of seed dormancy and germination in the salt marsh grass *Distichlis spicata*. New Phytol. 69:1005–1013.

Response: VEG

Genus: *Distichlis*

Discusses seed dormancy and germination in seashore saltgrass (*Distichlis spicata*) collected from Southport, North Carolina . The dormancy of *Distichlis* seeds was broken by a brief (4 weeks) low-temperature (4° C) period after ripening. Localized scarification and nitrate also were effective agents in breaking dormancy and promoting seed germination. The pericarp or testa are impermeable to organic plant-growth regulators, but not to water or inorganic salts. Gibberellic aeid and kinetin are ineffective in breaking dormancy and do not affect germination. Abscisic acid, however, effectively inhibits stratified and scarified seeds. Dormancy and germination seem to be hormonally controlled.

18. American Fisheries Society—Western Division. 1982. The best management practices for the management and protection of western riparian stream ecosystems. American Fisheries Society, Western Division, Orem, Utah. 45 pp.

Response: None

Genus: None

Presents best management practices for western riparian stream ecosystems and addresses seven primary effects: livestock grazing, mining, water development and irrigation, road construction, agriculture and urbanization, and timber harvest. Includes damages caused by various effects, planning management schemes, designing habitat restoration or protection measures, regulations for protecting riparian stream ecosystems, and management practices. Wetland creation–restoration projects include construction of tailing ponds in mined areas, pond reclamation, enhancement of channelized

streams, stream relocation, revegetation techniques, and restoration of riparian habitats.

19. Amoros, C., G. Pautou, and J. Bravard. 1987. The reversible process concept applied to the environmental management of large river systems. Environ. Manage. 11(5):607–617.

Response: SUCCESS

Genus: None

Describes ecological succession and reversible processes in terms of river system restoration. Studies (in France) include a braided section of the upper Rhone River and a meandering section of the lower Ain River. Both stability and reversible processes influence the recovery capacity (without human action) of ecosystems. The probability of ecosystem regeneration (on various temporal and spatial time scales) and cost of restoration (with human action) can be estimated by evaluating the degree of reversibility and the energy inputs required to reverse system changes. Discusses the preservation of pioneer and transient short-life stages within large river systems.

20. Anderson, B. W., J. Disano, D. L. Brooks, and R. D. Ohmart. 1984. Mortality and growth of cottonwood on dredge-spoil. Pages 438–444 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55., University of California Press, Berkeley.

Response: VEG

Genus: *Populus*

Describes a study that reintroduced Fremont cottonwood (*Populus fremontii*) along the lower Colorado River in Imperial County, California. Riparian trees were planted on a 30-ha site to determine growth under a variety of tillage and irrigation conditions. Trees were placed in augered tilled holes, 1.2 and 3 m deep, with time-release fertilizer. All trees were irrigated with 121 L of water per day for 150 days; after which, different groups of trees were subjected to various irrigation patterns. The average growth rate of the trees was 0.007 m/day. The fastest growth of 0.014 m/day occurred during August-October; the slowest growth occurred in the 90 days following planting. Discusses the relations between growth and irrigation and growth and tillage. Includes a list of planting recommendations.

21. Anderson, B. W., and R. D. Ohmart. 1979. Riparian revegetation: an approach to mitigating for a disseeming habitat in the southwest. Pages 481–487 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: MAMMALS, NGBIRDS, VEG, ECON, SUCCESS

Genus: *Atriplex, Cercidium, Lycium, Phoradendron, Populus, Prosopis, Salix, Suaeda, Tamarix*

Describes a riparian revegetation project along the Colorado River. Planning for mitigation included: use of baseline wildlife data; thorough data analysis; use of predictive models; site preparation, equipment needs, and costs; implementation of design (labor requirements); and monitoring. Site preparation included removal of saltcedar (Tamarix), and backhoeing or augering a hole for each tree to be planted. Birds were the primary test group because of their more visible response to habitat changes. Revegetation of 400 ha in the lower Colorado River valley required 10 years (3 years for clearing and planting, 7 years for monitoring) and cost $3.5–$4.5 million.

22. Anderson, B. W., and R. D. Ohmart. 1985. Riparian revegetation as a mitigating process in stream and river restoration. Pages 41–79 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: MAMMALS, WFOWL, NGBIRDS, VEG, ECON, SUCCESS

Genus: *Atriplex, Cercidium, Populus, Prosopis, Salix, Tamarix*

Describes the revegetation of desert riparian systems, with the focus on a study along the Colorado River near the United States–Mexico border. Plans were developed for elimination of the exotic saltcedar (*Tamarix*) and maximum growth and survival of native plants. Preliminary studies included analyses of vegetation, avian habitat, and rodent habitat. Collection of data was followed by 3 years of revegetation experiments. Saltcedars were removed by clearing, burning, and root-ripping to 30 cm below the surface. Deep tillage improved growth and survival of planted cottonwood (*Populus*) and willow (*Salix*). Describes avian response to revegetation in detail by season. Evaluates revegetation costs in detail, including cost per acre, cost per tree, labor, management, equipment, material and supplies, and monitoring. Presents an outline for mitigation planning.

23. Anderson, B. W., and R. D. Ohmart. 1984. Avian use of revegetated riparian zones. Pages 626–631 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55., University of California Press, Berkley.

Response: NGBIRDS, VEG

Genus: *Atriplex, Populus, Salix, Suaeda, Tamarix*

Describes a study of avian densities on a revegetated portion of the lower Colorado River in California. Fremont cottonwood (*Populus fremontii*), (*Salix gooddingii*), and (*Atriplex lentiformes*) were reintroduced on three 10- to 30-ha sites. Avian transects were established on barren dredge-spoil and a previously mixed salteedar–willow (*Tamarix–Salix*) stand cleared of saltcedar. Avian variables were numbers of permanent resident insectivores, visiting insectivores, and granivores. Avian colonization occurred on the revegetated site after 17 months and on the cleared site after 5 months. The clearing of saltcedar from an area has little deleterious effect on bird populations. Dead trees and trees with snags should not be removed because they are important habitat components for several bird species.

24. Anderson, B. W., and R. D. Ohmart. 1982. Revegetation for wildlife enhancement along the lower Colorado River. U.S. Dep. Int., Bur. Reclam., Boulder City, Nev., Contract No. 7-07-30-V0009. 215 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, REPT, VEG, ECON

Genus: *Atriplex, Bassia, Cercidium, Phoradendron, Populus, Prosopis, Salix, Salsola, Suaeda, Tamarix*

Describes revegetation efforts to enhance wildlife habitat along the lower Colorado River. All three revegetation sites are near Palo Verde, California. Two sites were barren dredge spoil; the third site was on the Cibola National Wildlife Refuge, Yuma County, Arizona. Bird populations had been censused on the latter area for 3 years before clearing the site; compares bird communities before and after clearing. Willow (*Salix*),

cottonwood (*Populus*), quailbush, inkweed, smotherweed, and honey mesquite were planted on the refuge site; saltcedar (*Tamarix*) was cleared. Discusses avian community structures and density changes, reptile populations, small mammals in revegetated areas, costs of reintroducing native vegetation, irrigation systems, soil analyses, and tree growth and survival.

25. Anderson, B. W., R. D. Ohmart, and J. Disano. 1979. Revegetating the riparian floodplain for wildlife. Pages 318–331 *in* R. R. Johnson and J. F. McCormick, tech. coords. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. For. Serv. Gen. Tech. Rep. WO-12.

Response: INVERT, MAMMALS, NGBIRDS, VEG, SUCCESS

Genus: *Atriplex, Bassia, Phoradendron, Populus, Salix, Salsola, Tamarix*

Describes a study of wildlife value of riparian vegetation along the lower reaches of the Colorado River. The first phase, begun in 1973, focused on describing wildlife habitat vegetation characteristics. From this information, a model for revegetating riparian areas for wildlife was developed. Three successional vegetative communities were established simultaneously on one study area. The early stage was dominated by annuals that developed rapidly and had high wildlife value. This stage quickly offset losses from land clearing. The second stage (shrubs) persisted without watering and also offset initial losses from land clearing.

26. Anderson, J. W., R. G. Riley, and R. M. Bean. 1978. Recruitment of benthic animals as a function of petroleum hydrocarbon concentrations in the sediment. J. Fish. Res. Board Can. 35:776–790.

Response: INVERT, SOIL, CHEM

Genus: None

Discusses results of three field installations, consisting of clean and oiled sediment in fiberglass trays placed in the intertidal zone of Sequin Bay, Washington, to determine rates of hydrocarbon depuration and recruitment of benthic invertebrates. Individual compounds and hydrocarbon classes were quantified using gas chromatography and mass spectroscopy techniques. Rates of depuration were monitored up to 290 days in surface-oiled, coarse sediments and in finer substrate mixed with oil; rates were much higher in surface-oiled sediments. At initial concentrations of 5,000–6,000 ppm (surface-oiled) and 700 ppm (sediment-oiled), no substantial inhibition of recruitment of benthic organisms was observed.

27. Andersson, G., H. Berggren, and S. Hamrin. 1975. Lake Trummon restoration project. III. Zooplankton, macrobenthos, and fish. Verh. Internatl. Verein Limnol. 19:1097–1106.

Response: FISH, INVERT

Genus: None

Describes preliminary effects of the Lake Trummon (southern Sweden) restoration project on zooplankton, macrobenthos, and fish. Macrophyte vegetation had been removed and nutrient-rich sediments (the cause of algal blooms) were pumped out of the lake to adjacent land. Discusses changes in species composition, abundance, and biomass of communities following restoration.

28. Andrews, N. J., M. Penko, M. D. Mattson, and D. C. Pratt. 1981. The establishment of cattails on a northern Minnesota peatland. Minnesota Department of Natural Resources and Minnesota Energy Agency, Minnesota Peat Program, St. Paul. 79 pp.

Response: VEG, HUSE, SOIL, CHEM

Genus: *Typha*

Describes experiments to establish cattail (*Typha*) as a commercial biomass crop on northern Minnesota peatlands. The study area was in an abandoned rice paddy near Zim and was prepared by diking, removing shrubs, and rotovating the soil. Cattail rhizomes were planted at a rate of 25/m2, and fertilizer was applied. Numerous graphs and charts depict standing crop, shoot density, soil chemistry, height classes, tissue analysis, and substrate–fertilizer conditions. Maximum aboveground and total standing crop for cattail plants averaged 738–1,534 g/m2 compared to natural stands of 950–1,360 g/m^2. Seeded plots resulted in 551 g/m^2 maximum aboveground standing crop and natural cattail seeded areas produced 672 g/m^2.

29. Andrews, N. J., and D. C. Pratt. 1978. Energy potential of cattails (*Typha* spp.) and productivity in managed stands. J. Minn. Acad. Sci. 44:5–8.

Response: VEG

Genus: *Typha*

Discusses biomass production of cattails (*Typha*) grown on peat in experimental paddies at the University of Minnesota, St. Paul. Yields of plants grown on peat were generally 20–30% lower than that reported for natural established stands. Maximum shoot weight occurred in August, whereas maximum belowground biomass was reached in October. Fertilizer applications of 25–100 kg/ha potassium did not significantly increase total production. Differences in initial nutrient content of peat had more of an effect on production than amount of fertilizer added. Significant differences in yield were obtained by increasing the planting rate from 12 to 48 rhizomes per plot.

30. Anonymous. 1983. Build your own bog to neutralize acid mine drainage. Coal Age (June):77.

Response: CHEM, WQUAL

Genus: None

Summarizes the work of West Virginia University researchers investigating the use of bogs to neutralize acidic waters from coal mines. Tub Run bog was found to have an average of 3.0 pH near the input of acid-laced waters from a coal mine; 9–18 m (30–60 feet) from the input was about 4.5 pH. Sulfate reducing bacteria, requiring anaerobic conditions and supplies of sulfate and organic carbon compounds, are responsible for the neutralization action of the bog. Discusses the creation of bogs for this purpose.

31. Apple, L. L., B. H. Smith, J. D. Dunder, and B. W. Baker. 1984. The use of beavers for riparian/aquatic habitat restoration of cold desert, gully-cut stream systems in southwestern Wyoming. Pages 109–116 *in* D. L. Archer, ed. Proceedings of the Bonneville Chapter of the American Fisheries Society, Bonneville Chapter of the American Fisheries Society, Salt Lake City, Utah.

Response: MAMMALS, WFOWL, NGBIRDS, VEG

Genus: *Salix*

Discusses the use of beavers to restore and reestablish degraded riparian and aquatic habitats at several sites in western Wyoming. One study area was fenced to exclude livestock

grazing, one was left unfenced, and several other areas were fenced and placed under grazing management systems. Beaver were reintroduced to the fenced areas; beaver returned on their own to the unfenced area. Aspen trees were delivered to sites to provide large materials for stable dam building. The newly built beaver dams are trapping sediment, reducing stream velocity, elevating the water table, and reducing the effects of seasonally fluctuating water table levels. This process is encouraging willow (*Salix*) development and improving riparian and aquatic habitat.

32. Ashe, D. M. 1982. Fish and wildlife mitigation: description and analysis of estuarine applications. J. Coast. Zone Manage. 10(1/2):1–52.

Response: None

Genus: None

Provides a comprehensive overview of the concept of fish and wildlife mitigation, with emphasis on its use as a tool in estuarine management. Discusses the statuatory basis for fish and wildlife mitigation and presents a framework for evaluating the conceptual integrity of potential mitigation efforts. This conceptual framework is applied to a series of alternative approaches to estuarine mitigation and to policy emerging within the federal regulatory regime. Preferable alternatives of effective mitigation policy (i.e., approaches consistent with ecosystem objectives and involving predictable outcomes) are indemnification (using a mitigation bank framework), upland transformation, and restoration of previously altered habitats.

33. Athanas, C. 1988. Wetlands creation for stormwater treatment. Pages 61–66 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, CHEM, WQUAL

Genus: *Alisma, Eleocharis, Leersia, Sagittaria, Scirpus, Typha*

Presents an overview of the use of wetland creation for stormwater treatment and discusses research being conducted at several wetland stormwater basins by the University of Maryland. Artificial wetlands are receiving increasing attention for treating stormwater runoff, but little direct evidence is available to support their ability to perform this function. However, indirect evidence suggests that these wetlands may be useful tools in improving water quality of stormwater runoff. The University of Maryland is addressing this issue, as well as vegetative aspects of artificial wetland creation. An important factor influencing the natural development of wetland vegetation may be the presence of buried seed or other propagules in the substrate. Preliminary evidence indicated that the artificially established vegetation may decrease the number of volunteer species.

34. Atkins, K. 1981. Biotic response to drawdown and reflooding in a clay settling pond. Pages 169–187 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, REPT, AMPHIB, MAMMALS, SHOREB, WFOWL, NGBIRDS, VEG, SOIL

Genus: *Aeschynomene, Amaranthus, Ambrosia, Andropogon, Baccharis, Bidens, Cassia, Chenopodium, Colocasia, Conyza, Cynodon, Cyperus, Digitaria, Echinochloa, Eclipta, Erechtites, Eupatorium, Heterotheca, Indigofera, Ipomoea, Lantana, Lepidium, Ludwigia, Mikania, Panicum, Paspalum, Phytolacca, Pluchea, Rhynchelytrum, Ruellia, Salix, Schinus, Scirpus, Scoparia, Setaria, Typha, Urena*, many

Summarizes the biotic resources found in a clay settling pond in Polk County, Florida. Dewatering of the pond initiated a rapid vegetative response; reflooding of the system occurred 11 months later and subsequent biological changes were noted. The study site has many attributes of natural wetland systems and provides important habitat for a variety of wetland species. The area is dominated by wetland plants with wind-dispersed seeds (e.g., cattail [*Typha*] and willow [*Salix*]). Seventy species of birds, 8 species of mammals, and 10 species of reptiles and amphibians were observed at the study site.

35. Atkins, K. 1987. A qualitative assessment of wetlands reclaimed as natural system habitat. Pages 17–36 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: FISH, INVERT, SHELLF, MAMMALS, NGBIRDS, SHOREB, AMPHIB, REPT, SUCCESS

Genus: *Aeschynomene, Bacopa, Carpinus, Cephalanthus, Cornus, Diospyros, Eleocharis, Fimbristylis, Fraxinus, Gordonia, Ilex, Indigofera, Juncus, Juniperus, Liquidambar, Ludwigia, Magnolia, Micranthemum, Najas, Nyssa, Panicum, Paspalum, Persea, Pinus, Polygonum, Pontederia, Quercus, Rhus, Sagittaria, Salix, Sambucus, Scirpus, Spartina, Thalia, Typha*, many

Presents a qualitative habitat assessment of three International Minerals and Chemical Corporation wetland reclamation projects in Polk and eastern Hillsborough counties, Florida. The phosphate-mined wetlands were reclaimed primarily by natural system capping (overlaying phosphatic waste clays with sand tailings), grading, seeding, mulching (spreading organic soil from donor wetland), fertilizing, and planting or transplanting woody plants. The three study areas have been evolving for 6 months to 6 years. Site inventories documented the presence of 212 plant species, 76 bird species, 10 mammals, 10 reptiles, 6 amphibians, and 5 fishes (species lists included in paper). Each study site attracted a diversity of wildlife species.

36. Atlantic Waterfowl Council. 1959. An illustrated small marsh construction manual based on standard designs. Vermont Fish and Game Service, Montpelier. 153 pp.

Response: WFOWL, ECON

Genus: None

Presents small marsh construction designs, based on requirements for New York State, for use in wetland development for waterfowl. Topics include: marsh site selection, small-marsh survey, marsh design, and small marsh construction. Techniques include: determining water levels and runoff coefficients, designing and constructing spillways, installing water control structures, grading and seeding, applying lime and fertilizer, using mulch, and estimating construction costs. Includes diagrams of various designs to illustrate techniques.

37. Auble, G. T., D. B. Hamilton, J. E. Roelle, J. Clayton, and L. H. Fredrickson. 1988. A prototype expert system for moist soil management. Pages 137–143 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American west. Society of Wetland Scientists, Rocky Mountain Chapter, Denver, Colo.

Response: SOIL

Genus: None

Describes a computer program that suggests management regimes for seasonally flooded man-made impoundments. The objectives of such management are to provide suitable hydrologic conditions and food for migrating waterfowl. Includes planning problems, prototype limitations, program description, and hardware-software requirements.

38. Austin, C. B., and A. Thorhaug. 1977. The economic costs of transplanting seagrasses: *Thalassia*. Pages 69–75 *in* R. Lewis and D. Cole, eds. Proceedings of the Fourth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Thalassia*

Describes a method for estimating the costs of restoring beds of turtlegrass (*Thalassia*). Estimates are based on a transplant project in South Biscayne Bay, Dade County, Florida. Costs per seed handled for each transplant phase (collection, nursery, and planting) are incorporated in a cost model. Three sets of variables are considered in this process: seed mortality and growth rates; size of the area to be planted, density of vegetative cover desired, and time required to reach desired density; and monetary costs.

39. Babcock, W. H. 1982. Tenmile Creek—a study of stream relocation. Colo. Div. Wildl. Spec. Rep. 52. 22 pp.

Response: FISH, WQUAL, SUCCESS

Genus: Many

Describes the relocation of Tenmile Creek as a result of the construction of Interstate 70 through Tenmile Canyon near Frisco, Colorado. One of the goals of the project was to mitigate for loss of fish habitat. The channel was excavated and fish habitat structures were installed. The creek was monitored for several years after construction; streamside revegetation efforts were not very successful, but fish populations were increasing. Provides water chemistry parameters for several sites along the reconstructed stream.

40. Baker, J. M. 1973. Recovery of salt marsh vegetation from successive oil spillages. Environ. Pollut. 4(3):223–230.

Response: VEG

Genus: *Agrostis, Armeria, Festuca, Glaux, Juncus, Puccinellia, Salicornia, Spartina, Spergularia, Triglochin*

Presents results of field experiments involving successive oilings of three types of salt marsh vegetation on the coast of Wales in 1968. Dominant plants were *Spartina anglica* (lower marsh), seashore alkaligrass (*Puccinellia maritima*; mid-marsh), and *Juncus maritimus* (upper marsh). Recovery from up to four oilings was generally good, but considerable changes in recovery and species dominance resulted from 8 to 12 oilings even after 5 years, indicating that recovery would likely be slow.

41. Baker, J. M. 1979. Responses of salt marsh vegetation to oil spills and refinery effluents. Pages 529–542 *in* R. L. Jeffries and A. J. Davy, eds. Ecological processes in coastal environments. Blackwell Scientific Publications, London.

Response: VEG

Genus: *Agrostis, Juncus, Oenanthe, Salicornia, Spartina*

Describes the responses of salt marsh plants to oil spills. Effects of single spills are listed in a table that displays date, locality, oil type, observations, and references. Plant responses to experimental successive spillages were examined on the North Gower coast, South Wales. Describes the tolerance of different species to oil spills and growth stimulation following oil pollution.

42. Baldwin, W. P. 1967. Impoundments for waterfowl on South Atlantic and Gulf coastal marshes. Pages 127–133 *in* J. D. Newsom, ed. Proceedings of the Marsh and Estuary Management Symposium, Louisiana State University, Baton Rouge.

Response: FISH, WFOWL, VEG

Genus: *Brasenia, Cladium, Distichlis, Echinochloa, Eleocharis, Gyrotheca, Juncus, Najas, Nymphaea, Polygonum, Potamogeton, Scirpus, Spartina, Typha, Zannichellia*

Presents an overview of the use of impoundments to provide waterfowl habitat within coastal marshes from Virginia to Texas. Discusses manipulation of water levels, culture of aquatic plants, regulation of salinity, and control of undesirable plants and carp for four marsh classifications: regularly flooded salt marshes, irregularly flooded salt marshes, salt meadows and salt flats, and coastal fresh marshes.

43. Banner, A. 1979. Mitigation under the corps regulatory program. Pages 396–399 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: SUCCESS

Genus: None

Provides an overview of mitigation options and activities. Mitigation is generally used to enhance water retention, circulation, or quality and to improve substrate characteristics, thus promoting the growth of beneficial or desirable plants. Restrictions to permit mitigation actions include: work must be accomplished on site, the applicant must be able to make beneficial use of the property, and actions must be self-sustaining and permanent. Describes several studies of mitigation projects in Florida. Discusses methods of handling mitigation cases.

44. Banner, A. 1977. Coastal restoration in South Florida. J. Fla. Bar 51(8):571–575.

Response: None

Genus: None

Describes selected problems and solutions concerning coastal restoration in South Florida. General concerns include: filling wetlands to provide for boating access or residential and commercial development and dredging wetlands for fill materials on adjacent lands or for navigational purposes. Lack of public appreciation for wetlands indicates silent approval of wetland destruction without returning benefits to the public. Describes court procedures for handling unauthorized dredge and fill activities. Discusses general cost–benefit problems.

45. Banner, A. 1977. Revegetation and maturation of restored shoreline in the Indian River, Florida. Pages 13–42 *in* R. Lewis and D. Cole, eds. Proceedings of the Fourth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: INVERT, VEG, SHOREB, FISH

Genus: *Avicennia, Halodule, Halophila, Laguncularia, Rhizophora, Ruppia, Spartina*

Describes the restoration of severely disturbed shoreline (sterile sand substrate) in a shallow cove along Indian River, Florida. Alternating segments of shoreline were planted with man-

groves, cordgrass (*Spartina*), or both. Unplanted sections served as controls. Accretion of organic matter (especially in areas planted with cordgrass [*Spartina*]) was monitored. *Spartina* plantings flourished, as did widgeon grass (*Ruppia*) interspersed with (*Halophila*) and drift algae. The seagrasses attracted various invertebrates (mostly detritus consumers), fish, and wading birds. Mangrove plantings were not as successful; presents colonization rates in a series of tables.

46. Banner, A. 1982. Florida Keys environmental mitigation trust fund. Pages 155–165 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: ECON, SUCCESS

Genus: None

Describes the development of the Florida Keys Environmental Trust Fund, which provides for the creation–restoration of wetlands to compensate for those lost to dredge and fill violations where direct restoration is not possible. Objectives of the fund are "...enhancement, restoration, or replacement of marine and wetland habitat in the Florida Keys to compensate for the destruction of such habitat at the Port Largo development." Actions include removal of fill material, channel construction, and culvert replacement.

47. Banner, A., and J. Moulding. 1987. Mitigation management of an impounded brackish-water marsh. Pages 37–47 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: FISH, SHOREB, HYDRO, WQUAL, SUCCESS

Genus: *Distichlis, Juncus, Polystichum, Spartina*

Discusses restoration plans for the Sykes Creek Marsh on Merritt Island, Brevard County, Florida. The 810-ha (2,000-acre) marsh was isolated from the adjoining Banana River Lagoon by construction of encircling levees in the mid-1950's and was managed for mosquito control. As a result, the marsh lost its historic functions as a spawning and nursery ground for marine invertebrates and fishes, and as a source of detritus for the adjacent estuarine ecosystem. Restoration plans include installing gated culverts through the levees to allow water and fish exchange from marsh to estuary. Reconnection of the marsh with the estuary is expected to ultimately flush out high concentrations of fine particles.

48. Barko, J. W., and R. M. Smart. 1983. Effects of organic matter additions to sediment on the growth of aquatic plants. J. Ecol. 71:161–175.

Response: VEG, SOIL, CHEM

Genus: *Elodea, Hydrilla, Myriophyllum, Potamogeton, Sagittaria*

Examines growth of three completely submerged plant species on sediments from Lake Washington, Seattle, Washington. Growth of emergent species was generally less inhibited by the addition of 5% organic matter than that of submerged species receiving the same level of organic matter. Greater additions of organic matter severely inhibited *Hydrilla* and pondweed (*Potamogeton*). Growth of all species was negatively correlated with mean dissolved organic carbon concentration in the interstitial water of the sediments. Growth inhibition may have resulted from accumulation of toxic, soluble organic carbon compounds during anaerobic decomposition. Discusses the role of organic accretion in sediments in relation to patterns of aquatic plant distribution and succession.

49. Barko, J. W., and R. M. Smart. 1981. Sediment-based nutrition of submersed macrophytes. Aquat. Bot. 10:339–352.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Bacopa, Myriophyllum, Potamogeton, Proserpinaca*

Discusses the capabilities of four submersed freshwater macrophyte species to mobilize nitrogen, phosphorus, and potassium from lake sediments dredged from Branched Oak and Pawnee reservoirs in Nebraska and Keystone Reservoir in Oklahoma. Nitrogen and phosphorus were readily mobilized from the sediments and concentrated in plant shoots at levels well above those required for growth. Mobilization of potassium from sediments was much less effective and may have limited growth; potassium is probably supplied to these plants primarily from the water. Considerable quantities of these nutrients are released to the water due to plant senescence and associated decay processes, representing an important mode of sediment-nutrient cycling in aquatic systems.

50. Barko, J. W., R. M. Smart, C. R. Lee, M. C. Landin, T. C. Sturgis, and R. N. Gordon. 1977. Establishment and growth of selected freshwater and coastal marsh plants in relation to characteristics of dredged sediments. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-2. 41 pp.

Response: VEG, SOIL, CHEM

Genus: *Cyperus, Distichlis, Scirpus, Spartina, Triglochin*

Describes a controlled condition laboratory experiment that determined the establishment and growth of several wetland plant species in relation to dredged sediment characteristics. Freshwater, brackish, and estuarine (salt marsh) plants were softstem bulrush (*Scirpus validus*), chufa flatsedge (*Cyperus esculentus*), seashore saltgrass (*Distichlis spicata*), seaside arrowgrass (*Triglochin maritima*), (*S. robustus*), smooth cordgrass (*Spartina alterniflora*), and *S. foliosa*. Sediment substrates were clay, silty clay, and sand. Monitors plant biomass and aereal density. Planting was by seeds and transplants. Except for saltgrass (*Distichlis*; which was successfully established from seed), plants were established more successfully from vegetative propagules. All types of propagules flourished on freshwater sediments, but transplants were more successful on estuarine sediments. Growth of plants in sand was nutrient-limited. Discusses effects of salinity in terms of limiting plant growth.

51. Barkuloo, J. 1980. Reclaiming Florida phosphate mined lands to wetlands. U.S. Fish Wildl. Serv., Biol. Serv. Prog. 13 pp.

Response: VEG, FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT

Genus: *Acer, Cladium, Nyssa, Pinus, Polygonum, Pontederia, Populus, Potamogeton, Quercus, Sagittaria, Taxodium*, many

Investigated methods of establishing "equivalent" wildlife habitat that replaces but does not duplicate original wetland habitat. The study site is phosphate-mined land on the Peace River floodplain of westcentral Florida. A 22-ha (55-acre) test site was excavated, creating two gently sloping stream channels and a 0.2-ha (0.5-acre) permanent pond to provide open water for aquatic life. One-hundred and nineteen trees and 10,400 seedlings were planted in 26 plots. In addition, 2,300 seedlings were randomly planted at the site. Data collected on growth, vigor, and survival showed nearly 100% survival. The survival and growth of the plantings are related to tidal changes, ground

water levels, precipitation, surface water flows, soil moisture, and water quality. Documents bird, mammal, fish, amphibian, and reptile species using the area.

52. Barnard, T. A., Jr., and W. I. Priest, III. 1985. Virginia's wetland mitigation/compensation policy: its evolution and current status. Pages 327–333 *in* Wetlands of the Chesapeake. Conference proceedings 9–11 April 1985, Easton, Md.

Response: None

Genus: None

Defines the mitigation policy, describes its development, and discusses the management philosophy of mitigation as a compensation tool in managing the wetland systems of Virginia's Chesapeake bay. General conclusions regarding compensation philosophy include lack of understanding of wetland systems and poor planning preparation for compensation projects.

53. Barroin, G. 1981. Sediment treatment for phosphorus inactivation. Pages 115–118 *in* Restoration of lakes and inland waters. International Symposium on Inland Waters and Lake Restoration. U.S. Environmental Protection Agency, Portland, Maine, EPA 440/5-81-010.

Response: VEG, SOIL, CHEM, WQUAL

Genus: None

Discusses sediment treatment to restore a 0.35-ha experimental lake bordering the south shore of Lake Geneva, France. Aluminum sulfate was injected into the top layer of the sediment to improve its capacity to adsorb phosphorus. Describes the prototype device designed for this purpose. Monitoring of water quality parameters and phytoplankton production indicated that the treatment significantly reduced the phosphorus in the lake even under anoxic conditions and reduced algal abundance for at least 4 years.

54. Baskett, R. K. 1988. Grand Pass Wildlife Area, Missouri: modern wetland restoration strategy at work. Pages 220–224 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation Washington, D.C.

Response: WFOWL, NGBIRDS, SHOREB, VEG, HYDRO, SOIL

Genus: None

Discusses restoration and management strategies for the Grand Pass Wildlife Area in westcentral Missouri. Construction of the wildlife area, principally aimed at improving waterfowl habitat, will consist of 14 km (9 miles) of levees, 6 km (4 miles) of water distribution canals, 45 control structures, and pumps to supply water for the Missouri River and remove water from the units. Water management will be possible in 25 separate impoundments, which will be managed for moist-soil plants and marsh habitat. Describes water management schedules and discusses the preferred water depths and vegetation for waterfowl, shorebirds, and other nongame birds.

55. Bates, A. L., E. Pickard, and W. M. Dennis. 1979. Tree plantings—a diversified management tool for reservoir shorelines. Pages 190–194 *in* R. R. Johnson and J. F. McCormick, eds. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. For. Serv. Gen. Tech. Rep.WO-12.

Response: INVERT, VEG

Genus: *Platanus, Taxodium*

Describes the results of tree plantings along the shorelines of impoundments constructed by the Tennessee Valley Authority at Mallard Creek (Lawrence County, Alabama), Birdsong Creek (Benton County, Tennessee), Duck River (Humphreys County, Tennessee), and Hiwassee Reservoir (Murphy County, North Carolina). The primary purpose for establishing trees was control of mosquito populations. As vegetative succession is hastened from open herbaceous communities to woody, closed-canopy communities, mosquito populations are reduced and species composition changes to favor less aggressive species. Baldcypress (*Taxodium distichum*) plantings were most successful due to rapid growth rates and ability of seedlings to withstand prolonged flooding. Plantings also stablize the shore and enhance wildlife habitat.

56. Bauer, A. M. 1982. Manipulating mining operations to create wildlife habitats: a pre-mining planning process. Pages 41–43 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: None

Genus: None

Describes the planning considerations necessary to enable gravel mining operations to develop productive postmining landscapes as well as to efficiently mine the resource. When reclamation plans are formulated before mining is initiated, the best (and most cost-effective) results may be obtained. Discusses earth materials used for land shaping, overburden distribution, earth moving equipment, and mining procedures. End use criteria may include desired water depths, lake edge and bottom configurations, specific sand and gravel deposit materials required for a specific environment, and special landforms.

57. Bauer, A. M. 1965. Simultaneous excavation and rehabilitation of sand and gravel sites. National Sand and Gravel Association, Silver Spring, Md. 60 pp.

Response: VEG, HUSE

Genus: None

Provides an overview of sand and gravel mining and land reclamation techniques and procedures. Recommendations include incorporating reclamation considerations for grading, seeding, and planting with gravel mining operations. Provides two studies sites: Lincoln Lakes near Lincoln, Illinois, and (2) Sansabar Estates, a floodplain 10 km (6 miles) north of Indianapolis, Indiana. Deseribes site analysis, operation analysis, master plan, stockpile plan, and development program (i.e., reclamation) in each study.

58. Baumann, R. H. 1980. Mechanisms of maintaining marsh elevation in a subsiding environment. M.S. thesis, Louisiana State University, Baton Rouge. 89 pp.

Response: HYDRO, SOIL, WQUAL

Genus: *Nyssa, Spartina, Taxodium*

Examines marsh elevation, inundation regime, and seasonality of sedimentation for a coastal wetland in the Barataria Basin, Louisiana. Mean elevation of the saline marsh was slightly higher than local mean water level. Seasonality of sedimentation has switched from a Mississippi River flood, spring-dominated situation to a storm-related, winter and hurricane season-dominated situation in the basin. Sedimentation rates compared to the rate of sea level rise indicated that present sedimentation processes are not sufficient to maintain marsh

elevation, resulting in the continued deterioration of wetlands in the Barataria Basin.

59. Baumann, R. H., and R. D. Adams. 1981. Creation and restoration of wetlands by natural processes in the lower Atchafalaya River system: possible conflicts with navigation and flood control objectives. Pages 1–24 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: HYDRO, SOIL

Genus: None

The Atchafalaya River in Louisiana is creating new wetlands in the Atchafalaya Bay delta and restoring wetlands in adjacent marshes. Documents this process by examination of LANDSAT images. During 1973 to 1980, area trends shifted from wetland losses of 421 ha/year to wetland gains of 66 ha/year. A direct relation between suspended sediment influx and wetland creation–restoration exists. Other important factors in this process are river discharge, wetland location, wind direction, and tidal stage. Discusses navigation and flood control projects in terms of their potential effects on this natural creation process.

60. Bays, J. S. 1983. Zooplankton/trophic state relationships and the potential for prediction of ecosystem structure in reclaimed Florida lakes. Pages 17–32 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, WQUAL

Genus: None

Discusses the use of nutrient loading models for predicting trophic state during the process of lake creation or restoration. Describes the relations between trophic state, fish biomass, and zooplankton in 39 Florida lakes. As trophic state increases, so does the percentage of microzooplankton, fish biomass, and proportion of rough fish (e.g., gizzard shad [*Dorosoma cepedianum*], gar [*Lepisosteus*]) to sport fish (e.g., bass, bluegill [*Lepomis mocrochirus*]), whereas the percentage of macrozooplankton decreases. Plans for lake restoration should include trophic state prediction for a range of densities for various zooplankton species, and an estimation of fish production, species composition, and harvest potential. Lake ecosystem function is reflected in nutrient cycling, microzooplankton, and algal blooms.

61. Beaman, B. 1973. Patterns of plant community structure and vegetational zones on spoil islands in Sarasota Bay and Charlotte Harbor, Florida. New College, Division of Natural Resources, Sarasota, Fla. 69 pp.

Response: VEG

Genus: *Avicennia, Baccharis, Batis, Casuarina, Cynodon, Laguncularia, Paspalum, Rhizophora, Salicornia, Sesuvium, Spartina*, many

Describes vegetative succession on spoil islands created by dredging in Sarasota Bay and Charlotte Harbor, Florida. Discusses four major plant communities: a pioneering comunity of strand plants on open beaches and spits; a community of mangroves in the intertidal zones of leeward shores, from mangrove seedlings in the first community; a community at the storm tide zone dominated by the Australian pine (*Casuarina*); and an open, sandy upland area community consisting of herbaceous plants and shrubs. Factors affecting succession of plant communities on spoil islands include: distance from island to established community, presence of pines that limit diversity of plant community, availability of soil water, elevation and topography, soil nutrients, and animal life.

62. Bedish, J. W. 1967. Cattail moisture requirements and their significance to marsh management. Am. Midl. Nat. 78(2):288–300.

Response: VEG

Genus: *Alisma, Polygonum, Sagittaria, Scirpus, Typha*

Presents results of seed germination tests on the hybrid common cattail × narrowleaf cattail (*Typha latifolia* × *Typha angustifolia*) in the laboratory and at Goose Lake near Jewell, Hamilton County, Iowa. Seeds in greenhouse tests required flooding for germination, but no differences in percent germination were detected between water depths of 2.5 cm (1 in.) and 15.2 cm (6 in.). Germination was reduced 50% by storage of seed for 1 year at room temperature. The fastest rate and amount of growth were recorded for plants in 2.5 cm (1 in.) of water. No germination of artificially established seed occurred in the field, possibly due to an unknown inhibiting factor present in the marsh for several years. Discusses management implications.

63. Bedish, J. W. 1964. Studies of the germination and growth of cattail in relation to marsh management. M.S. thesis, Iowa State University, Ames. 83 pp.

Response: WFOWL, VEG, HYDRO, ECON

Genus: *Alisma, Bidens, Leersia, Sagittaria, Typha*

Presents results of greenhouse and laboratory experiments on the germination and growth of cattail (*Typha*). Field studies on the effects of soil moisture and water depth were conducted on mud substrate along the edge of Goose Lake, Hamilton County, Iowa. A 2.5-cm (1-in.) water depth provided optimum moisture conditions for seed germination, growth of plants produced from rhizome shoots, and vegetative reproduction. Either the overwintering rhizome shoot or a portion of a plant base (culm) was needed to produce a new cattail plant. Artificial propagation of cattail by planting rhizomes was economically unsound because of the need for muskrat control and fencing, as well as labor involved in obtaining and planting rhizomes. Includes a review of literature pertaining to the importance of cattails to marsh animals.

64. Beeman, S. 1983. Techniques for the creation and maintenance of intertidal saltmarsh wetlands for landscaping and shoreline protection. Pages 33–43 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Distichlis, Spartina, Sporobolus*

Describes the creation and maintenance of vegetated estuarine shoreline areas between Duval and Palm Beach counties, Florida. Planting success was achieved when the following procedures were implemented: construction of an energy barrier along the shore between mean high water and mean low water (shore slope was 5–15 degrees), construction of a berm at the upper edge of the slope (20–25 degrees for this upper tidal zone), plantings zoned from water to upland as they would occur naturally, and plantings of large plugs at a density of 1 plant per 0.6 m. A long-term management program would be beneficial for the maintenance of healthy vegetation.

65. Beeman, S., and R. Bullard. 1980. Plants on shorelines. Pages 149–153 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: None

Presents an overview of one approach to shoreline stabilization and erosion reduction at several sites in eastern and central Florida. Focuses on establishment of littoral marshes on gently-sloping shorelines and construction of coquina or concrete revetments to support plantings of intertidal or aquatic plants on high-energy shorelines. These techniques have proven to be at least as successful as traditional bulkhead designs.

66. Beeman, S., and L. Greenfield. 1985. Monitoring of two artificial waterway systems in Jupiter, Florida. Pages 37–46 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Avicennia, Batis, Borrichia, Distichlis, Juncus, Laguncularia, Paspalum, Rhizophora, Salicornia, Sesuvium, Spartina, Typha*

Summarizes the results of revegetation efforts at artificial waterways in Jupiter, Florida. Smooth cordgrass (*Spartina alterniflora*) and Red mangrove (*Rhizophora mangle*) proliferated initially; populations then stabilized to comprise 55% of the total plant community. The establishment of proper elevations relative to tidal fluctuations was a significant factor in successful wetland establishment. Fauna in these artificial waterways and marshes were similar to those in nearby natural areas. Dissolved oxygen, temperature, salinity, nutrients, and pH were measured regularly. Heavy metals and protein content were measured in cordgrass. The permeability and ion exchange capacity of sediments also were monitored.

67. Bell, A. L., E. D. Holcombe, and V. H. Hicks. 1974. Vegetating stream channels—a multipurpose approach. Soil Conserv. 40(5):16–18.

Response: VEG

Genus: Many

Describes the vegetative treatment of stream channels after channel modification for flood prevention and watershed protection. To minimize disturbance of natural vegetation, excavations were done on alternate sides of the channel. The completed stream–channel cross section was then divided into several areas that required different vegetative treatments. The channel bottom was planted for stabilization, whereas channel cut slopes were planted for erosion control as well as food and cover for wildlife. The crown of the dredged material deposit was planted with various grasses; the backslope was planted with a grass mixture and clusters of selected woody plants for wildlife food and cover.

68. Belsky, J. 1975. An oil spill in an alpine habitat. Northwest Sci. 49(3):141–146.

Response: VEG

Genus: *Carex, Cassiope, Hieraceum, Luetkea, Phyllodoce, Tsuga*, many

Describes the vegetational damage caused by a spill of 26,495 L (7,000 gal) of no. 2 diesel fuel into an alpine meadow near Mount Baker, Washington. Most of the herbaceous plants in the *Carex nigricans* and red mountainheadheath (*Phyllodoce empetriformis-Cassiope mertensiana*) association were killed; woody species were severely damaged, but survived. Root systems of plants escaped major damage, possibly due to the oil flowing over the water-saturated soil surface. Within 1 year after the spill, heathers, sedges, and mosses were invading the area.

69. Benner, C. S., P. L. Knutson, R. A. Broehu, and A. K. Hurme. 1982. Vegetative erosion control in an oligohaline environment: Currituck Sound, North Carolina. Wetlands 2:105–117.

Response: VEG, SOIL, SUCCESS

Genus: *Ammophila, Daucus, Fimbristylis, Iva, Juncus, Panicum, Phragmites, Ptilimnium, Sium, Spartina, Typha*, many

Describes long-term shoreline changes resulting from planting marsh plants in the oligohaline environment of Currituck Sound, North Carolina. Vegetation was planted to dampen wave energy and reduce erosion. Species were selected for their tolerance of low salinities, height, rigidity, and structure for transplanting. Sprigs were planted in rows perpendicular to the shore 0.6 m apart and 30.5 m soundward. The average annual shoreline position retreated 1.6 m in the planted area during 8 years and retreated 2.1 m/year in the unplanted area. In the eighth year of monitoring, the planted shoreline retreated 0.2 m. Twenty marsh plant species had invaded the study site by fall 1981.

70. Best, G. R., and K. L. Erwin. 1984. Effects of hydroperiod on survival and growth of tree seedlings in a phosphate surface-mined reclaimed wetland. Pages 221–225 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publication, Lexington.

Response: VEG

Genus: *Acer, Fraxinus, Gordonia, Ilex, Liquidambar, Nyssa, Persea, Platanus, Taxodium, Ulmus*

Discusses survival and growth of tree seedlings planted in a phosphate surface-mined reclaimed wetland in southwest Polk County, Florida. Several wetland, transitional, and upland species were planted, including baldcypress (*Taxodium*), sweet gum (*Liquidambar*), loblolly bay (*Gordocies*), red maple (*Acer rubrum*), ash (*Fraxinus*), sycamore (*Platanus*), elm (*Ulmus*), holly (*Ilex*), black gum (*Nyssa*), and red bay (*Persea borbovia*). Overall survival after three growing seasons was 72%, with highest survival of ash (99%), black gum (90%), and sycamore (84%) and lowest survival for loblolly bay (23%) and holly (41%). Growth rate data were indicative of seedling stress: species showing the greatest rate of survival also had the greatest increase in mean height. Growth rates of baldcypress seedlings were higher in shallow water (less than 20 cm) than in deep water.

71. Beule, J. D. 1979. Control and management of cattails in southeastern Wisconsin wetlands. Wis. Dep. Nat. Resour. Tech. Bull. 112. 39 pp.

Response: FISH, WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Carex, Ceratophyllum, Cyperus, Leersia, Lemna, Lythrum, Phalaris, Potamogeton, Sagittaria, Salix, Scirpus, Sparganium, Typha, Utricularia, Verbena*, many

Presents results of experiments used to create openings in large blocks of monotypic cattail (*Typha*). Stands at Eldorado Marsh Wildlife Area and Horicon Marsh in southeastern Wis-

consin. Cattail stands were subjected to various treatments of covering, crushing, cutting, scraping, fire, or herbicides. Presents, in tables, occurrence and density of various marsh plant species over a 6-year period. Data on bird use of the habitat created by cattail control measures indicated that the openings provided additional temporary habitat for a variety of waterfowl and marsh birds. Management guidelines for cattail control included the use of herbicides and cutting for deep water zones; cutting stems below the water on ice and crushing for intermediate zones; and crushing, herbicides, and soil excavation in shallow water zones.

72. Bilby, R. E., and G. E. Likens. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61(5):1107–1113.

Response: CHEM, WQUAL

Genus: None

Discusses the effects of organic debris dams on streams of the Hubbard Brook Valley, New Hampshire. Removal of organic debris dams from a 175-m stretch of a second-order stream increased output of dissolved organic carbon by 18%, export of fine particulate organic carbon by 632%, and export of coarse particulate organic matter by 138%. Debris dams contained nearly 75% of the standing stock of organic matter in first-order streams, 58% in second-order streams, and 20% in third-order streams. Thus, organic debris dams are extremely important components of the small stream ecosystem.

73. Birkitt, B. 1984. Considerations for the functional restoration of impounded wetlands. Pages 44–59 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, VEG, HYDRO, WQUAL

Genus: *Avicennia, Batis, Salicornia*

Management plans are being developed for impounded marsh and mangrove areas along Florida's east coast. These areas were impounded for mosquito control; management plans include maintenance of mosquito control as well as restoration of some natural wetland functions (e.g., fisheries). Primary restoration objectives are: maintenance or reestablishment of wetland vegetation, restoration of estuary-marsh water flows (tidal exchange) and biotic exchange, and water quality improvement. Most changes are expected to occur through water level manipulation (i.e., seasonal opening of impoundments, lowering of impounded water levels, improved water circulation, and occasional overflooding of the marsh area).

74. Bishop, R. A., R. D. Andrews, and R. J. Bridges. 1979. Marsh management and its relationship to vegetation, waterfowl, and muskrats. Proc. Iowa Acad. Sci. 86(2):50–56.

Response: MAMMALS, WFOWL, VEG

Genus: *Bidens, Phragmites, Sagittaria, Scirpus, Typha*

Presents data on emergent vegetation, muskrat (*Ondatra zibethicus*), and waterfowl breeding populations on four marshes in northcentral Iowa under various controlled water level regimes over an 8-year period. Blue-winged teal (*Anas discors*) populations responded more closely than mallard (*Anas platyrhynchos*) to changes in percent area containing emergent vegetation. Waterfowl populations were not totally dependent on vegetative conditions of the marsh; spring water levels on surrounding private lands, flyway-wide breeding habitat, and population status influenced breeding populations. Muskrat populations were directly related to habitat quality and fall water levels. A cycle of 5–7 years between complete drawdowns was recommended for the most beneficial waterfowl management program.

75. Bjork, S. 1977. Recovery and restoration of damaged lakes in Sweden. Pages 110–133 *in* J. Cairns, Jr., K. L. Dickson, and E. E. Herricks, eds. Recovery and restoration of damaged ecosystems. University Press Virginia, Charlottesville.

Response: WFOWL, VEG, HUSE, CHEM, WQUAL, ECON, SUCCESS

Genus: *Myriophyllum, Potamogeton, Utricularia*

Discusses the recovery and restoration of damaged lakes in Sweden. Lake Hornborga was irreversibly damaged by dewatering. Dense growths of reeds and sedges were cut and the lake bottom was cultivated before the water level was raised and before submerged plant communities could effectively replace emergent vegetation. The waterfowl habitat value of the lake was eventually restored. Lake Trummon was damaged by a long history of sewage pollution. Restoration of the lake was necessary before any recovery would be evident from sewage treatment or diversion. Discusses restoration techniques, planning, and costs.

76. Bjork, S. 1972. Swedish lake restoration program gets results. Ambio 1(5):153–165.

Response: VEG, HUSE, WQUAL

Genus: *Carex, Chara, Myriophyllum, Phragmites, Potamogeton, Schoenoplectus*

Describes three lake restoration projects in Sweden: Lake Trummon near Vaxjo, Jarla Lake near Stockholm, and Hornborga Lake. Describes experience gained from sediment pumping, aeration, and removal of vegetation. Lake Trummon was subject to sewage pollution and, at times, total oxygen deficiency; restoration focused on suction-dredging a layer of black mud that covered the well-consolidated sediment (prepollution). In Jarla Lake, the hypolimnion was aerated without disturbing thermal stratification. Hornborga Lake was restored from a shallow, drained area dominated by monocultures of reeds (*Phragmites*), sedges (*Carex*), and willows (*Salix*) to a combination of open water and emergent marsh and submergents such as *Chara*, pondweed (*Potamogeton*), and *Myriophyllum*. Discusses plans for restoring the Lake of Tunis (in Tunisia).

77. Bjork, S. 1974. European lake rehabilitation activities. Conference on Lake Protection and Management, Madison, Wis. 23 pp.

Response: INVERT, WFOWL, NGBIRDS, VEG, SOIL, CHEM, WQUAL, ECON, SUCCESS

Genus: *Carex, Equisetum, Microcystis, Nuphar, Phragmites, Scirpus, Typha*

Presents an overview of European lake restoration activities with respect to historical development, geographical distribution, and application of restoration techniques. Lakes undergoing restoration have usually been damaged by sewage discharge and water-level lowering. Restoration techniques include removing nutrient-rich water with pumps or siphons, aerating the lake, removing sediments by dredging, constructing settling ponds, treating water with aluminum sulphate, raising water levels, and cutting emergents to create mosaics of small open-water areas within dense stands to provide a more diverse wildlife habitat. Discusses success of these vari-

ous techniques in relation to studies. Includes costs of some restoration projects.

78. Bjork, S., L. Bengtsson, H. Berggren, G. Cronberg, G. Digerfeldt, et al. 1972. Ecosystem studies in connection with the restoration of lakes. Verh. Internatl. Verein. Limnol. 18:379–387.

Response: INVERT, SHOREB, VEG, CHEM, WQUAL

Genus: *Calamagrostis, Carex, Chara, Isoetes, Myriophyllum, Phragmites, Potamogeton, Selenastrum, Utricularia*

Discusses two projects that are part of the lake restoration research program at the University of Lund, Sweden. The research concerns comparative studies of the ecosystems before, during, and after intervention at the Lake Trummon project in southcentral Sweden and the Lake Hornborga project between the great lakes Vanern and Vattern.

79. Blake. L. M. 1981. Liming acid ponds in New York. J. N.Y. Fish Game. 28:208–214.

Response: CHEM, WQUAL, ECON

Genus: None

Compares various liming methods used to treat 22 ponds and lakes in New York. Size of ponds varied from 0.4 ha to 83 ha (1 to 204 acres). Lime was applied by boat or helicopter during various months of the year. Cost-benefit data indicated that liming is an effective and economically feasible management tool to counteract the adverse effect of acid precipitation and maintain selected fisheries.

80. Blomberg, G. E. D. 1982. Duck use of gravel pits near Fort Collins, Colorado. Pages 162–169 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17–1982.

Response: WFOWL

Genus: *Anacharis, Chara, Echinochloa, Myriophyllum, Najas, Nitella, Potamogeton, Ranunculus, Scirpus, Typha, Zannichellia*

Describes gravel pit characteristics that relate to duck use in several gravel mined areas in Fort Collins, Colorado. Three characteristics identified as most significantly affecting duck use were: surface area of ponds, mean bank height-to-surface area ratios, and mean density index of submerged food plants. Recommendations for gravel pit management include discussions of pond or lake size, substrate, planting considerations, carp control, bank slope, water depth, and creation of islands.

81. Bloom, S. A. 1980. Multivariate quantification of community recovery. Pages 141–151 *in* J. Cairns Jr., ed. The recovery process in damaged ecosystems. Ann Arbor Scientific Publications, Ann Arbor, Mich.

Response: SUCCESS

Genus: None

Describes the use of multivariate quantification as a technique for determining community recovery from change. The mathematical procedures employed by this technique are available as computer packages. Quantitative biotic information that can be evaluated includes number of species, species composition, and number of individuals per species in a given sample size. "Before and after" perturbation data are converted to a representation of the distance to recovery through time. Recovery, successional transitions, and existence of multistable states can be quantified.

82. Blumer, K. 1978. The use of wetlands for treating wastes—wisdom in diversity. Pages 182–201 *in* M. A. Drew, ed. Environmental quality through wetlands utilization. Coordinating Council on the restoration of the Kissimmee River valley and Taylor Creek-Nubbin Slough Basin, Tallahasee, Fla.

Response: CHEM, WQUAL

Genus: *Bidens, Juncus, Leersia, Lemna, Nymphaea, Phalaris, Scirpus, Typha*

Discusses modification of artificial wetlands used for treating farm wastes in the Kissimmee River basin, Florida. The previous systems consisted of linear configurations of a marsh-pond and a meadow-marsh-pond. Data collected from these systems suggest that the retention of phosphorus and nitrogen per unit area is greater when a variety of ecocomponents are used in a sequence than if only one type of system in used. Practical applications may include providing ponds to alternate with marsh wetlands or designing wetlands with island meadows.

83. Dobie, B. 1986. Private financing for wetland restoration. Pages 14–28 *in* J. L. Piehl, ed. Proceedings, wetland restoration: a techniques workshop. Minnesota Chapter of the Wildlife Society, Fergus Falls.

Response: ECON

Genus: None

Describes various plans developed by the Minnesota Waterfowl Association for financing wetland restoration projects. Describes the Association's processing of assistance requests and includes several forms and information sheets. Habitat project application forms include criteria for selection of wetland habitat projects; questions are specific and results are scored according to rationale described after each question.

84. Bonance, R. T. 1983. Selected biological, physical, and chemical aspects of stream diversions; a consequence of surface mining. M.A. thesis, Southern Illinois University, Carbondale. 106 pp.

Response: FISH, INVERT, VEG, HYDRO, SOIL, WQUAL, SUCCESS

Genus: None

Examines six surface mine stream diversions and five control portions of streams in the Galum and Panther Creek watersheds, Perry County, Illinois. These relocated (diverted) streams vary in age from 2 months to more than 10 years. Restoration efforts varied from none to construction of riffles, pools, and meanders. High diversity of macroinvertebrates was associated with riffles, substratum diversity, vegetation, and detritus. Water quality differences were associated with adjacent land use. Fish diversity generally increased with stream size. Recommendations for stream construction include locating the channel through heterogeneous substratum and establishing riparian vegetation rapidly. Discusses water carrying capacity of channels.

85. Bongiorno, S. F., J. R. Trautman, T. J. Steinke, S. Kawa-Raymond, and D. Warner. 1984. A study of restoration in Pine Creek salt marsh, Fairfield, Connecticut. Pages 11–23 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Acnida, Aster, Atriplex, Baccharis, Distichlis, Elymus, Iva, Juncus, Lactuca, Limonium, Myrica, Phragmites, Pluchea, Salicornia, Solidago, Spartina*

A 30-ha salt marsh near Fairfield, Connecticut, was cut off from normal tidal flow by a dike. After 11 years, upland plants had significantly invaded the marsh. Examines vegetative response for three growing seasons following a breaching of the dike. As normal tidal flow was restored, woody shrubs, *phragmites*, and other nonmarsh plants decreased dramatically. After 1 year, 12 nonmarsh species were no longer found at the site. The percentage of bare ground was 49% before restoration and decreased to 22.6% in the third growing season following the restoration of normal tidal flow. The marsh quickly became dominated by *Salicornia*, cordgrass (*Spartina*), and saltgrass (*Distichlis*). The total number of shrubs declined from 194 to 6 in 3 years following the breaching of the dike.

86. Bontje, M. P. 1988. The application of science and engineering to restore a salt marsh, 1987. Pages 267–273 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, CHEM, WQUAL

Genus: *Phragmites, Spartina*

Discusses restoration of a 26-ha (63-acre) site adjacent to the New Jersey turnpike in Secaucus. The tidal marsh consisted of dense stands of common reed (*Phragmites australis*). The renovated marsh consists of 15% channels or mud flats, 10% dry berms, and 75% cordgrass (*Spartina*) meadows. Comparisons with an unmitigated site, similar to the original marsh, revealed that the mitigated marsh contained twice as many bird species and seven times as many birds. Benthic invertebrate diversity was twice as high and numbers tripled in the renovated marsh, compared to the unmitigated site. The same techniques historically used by wildlife managers can be effectively applied to environmentally distressed urban sites.

87. Boody, O. C., IV. 1983. Physico-chemical analysis of reclaimed and natural lakes in central Florida's phosphate region. Pages 339–350 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow.

Response: CHEM, WQUAL

Genus: None

Compares the physical and chemical characteristics of reclaimed and natural lakes in central Florida's phosphate region. Reclamation consisted primarily of leveling and shaping the mined areas. Spoil piles were contoured for uplands; the remaining void became the lake. Lake stratification did not occur in natural systems, but reclaimed systems started stratifying in late January or early February and remained stratified until late October or early November. Reclaimed lakes did not have a uniform bathymetry, as did natural lakes.

88. Boody, O. C. IV, C. D. Pollman, G. H. Tourtellotte, R. E. Dickinson, and A. N. Arcuri. 1985. Ecological considerations of reclaimed lakes in central Florida's phosphate region. Final report. Vol. I and II. Fla. Inst. Phosphate Res. Publ. 03-018-029. Vol. 1. 92 pp.; Publ. 03-018-030. Vol. 2. 540 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Alternanthera, Brachiaria, Colocasia, Eichhornia, Eleocharis, Hydrilla, Hydrocotyle, Leersia, Najas, Nelumbo, Panicum, Paspalidium, Paspalum, Polygonum, Typha*, many

This report consist of two volumes of extensive baseline information on the physical, chemical, and biological conditions of 12 reclaimed and 4 natural lakes in central Florida's phosphate region. Water temperature and dissolved oxygen were the primary physico-chemical differences between reclaimed and natural lakes. Smoother bottoms and shallower conditions of natural lakes prevented the persistent stratification common in reclaimed lakes. Biological productivity of reclaimed lakes was within the extremes represented in natural lakes. Reclaimed lakes physically connected to natural stream habitats had larger fish populations than isolated lakes. Presents recommended design features for reclaimed lakes.

89. Boone, C. G., and R. E. Hoeppel. 1976. Feasibility of transplantation, revegetation, and restoration of eelgrass in San Diego Bay, California. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Misc. Pap. Y-76-2. 46 pp.

Response: VEG, SOIL, CHEM

Genus: *Zostera*

Discusses the feasibility of using several methods of Common eelgrass (*Zostera marina*) transplantation, restoration, and revegetation on a proposed 3-ha (8-acre) dredged material site in San Diego Bay, California. Summarizes results of a literature survey of current eelgrass transplant methods. Recommends the turion and plug methods for transplanting eelgrass. Compares techniques and costs.

90. Boreman, J. 1974. Effects of stream improvement on juvenile rainbow trout in Cayuga Inlet, New York. Trans. Am. Fish. Soc. 103(3):637–641.

Response: FISH

Genus: None

Compares standing crops of juvenile rainbow trout (*Oncorhynchus mykiss*) in altered areas of Cayuga Inlet, New York, with those in natural prime trout habitat. Stream alteration consisted of 11 pool diggers and 16 bank cribs within a 1.5-km study area. No differences in biomass, average weight, or number of trout were observed between altered and natural areas. Trout comprised a greater percentage of the total fish biomass in bank crib sections compared to pool digger sections. Discusses standing crops of sculpins and minnows in relation to altered pools.

91. Born, S. M. 1979. Lake rehabilitation: a status report. Environ. Manage. 3(2):145–153.

Response: CHEM, WQUAL

Genus: None

Presents an overview of lake rehabilitation techniques used in the United States and Europe to curb the influx of nutrients, sediment, or other problem sources. The most successful techniques to date have been the diverting of waters outside of a lakes's drainage basin and the use of wastewater treatment. In-lake techniques that seem to be the most useful include: dredging to alter physical characteristics (depth, morphology, water circulation patterns) or to remove nutrient-rich or polluted sediments, and nutrient inactivation. Aeration may prove to be effective for selected rehabilitation projects; however, costs are relatively high. Discusses examples of successful applications of these various techniques.

92. Bottone, P. J., and R. A. Mattson. 1987. Preliminary report on transplanting of the benthic green algae *Caulerpa prolifera*. Pages 63–74 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: FISH, INVERT, SHELLF, VEG, ECON

Genus: *Caulerpa*

Presents results of an expermental algal transplanting project in Tampa Bay, Florida, designed and implemented in conjunction with maintenance dredging of the MacDill Air Force Base marina entrance channel. Mats of 21 cm^2 of the benthic green alga *Caulerpa prolifera* were installed on centers of approximately 0.3 m, 0.6 m, and 1.0 m. Persistence and survival of transplanted material was 85–90% 10 days following transplanting. Survival after 5 months was 100% on 0.3-m centers, 79% on 0.6-m centers, and 72% on 1.0-m centers. Results suggested that transplanting this alga is both feasible and cost-effective.

93. Bouldin, D. R., D. J. Lathwell, E. A. Goyette, and D. A. Lauer. 1973. Changes in water chemistry in marshes over a 12-year period following establishment. J. N.Y. Fish Game 20(2):129–149.

Response: WQUAL, CHEM

Genus: None

Provides an overview of specific changes in water chemistry in 20 artificial marshes in New York over a 12-year-period following establishment. The key variable was the inorganic carbon content of the water, which was correlated with changes in types of marsh vegetation. Emergent vegetation is especially important in shallow marshes, where it accumulates large amounts of organic matter during the growing season. Emergents decompose during winter. After several years, enough organic carbon accumulates so that rate of decay of submerged aquatics exceeds the rate of photosynthesis. Thus, the water of shallow marshes usually contains large amounts of inorganic carbon. Water chemistry is primarily dependent on the ratio of surface area of depths <0.6 m (<2 feet) to surface area of depths >0.6 m, (>2 feet).

94. Boule, M. E. 1987. Wetland creation and enhancement in the Pacific northwest. Pages 130–136 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: None

Genus: None

Describes several elements in the design of wetland creation or mitigation projects, including: determination of baseline conditions and potential effects; identificaion of mitigation goals, opportunities, and constraints; development of conceptual design alternatives; assessment of potential benefits and costs; selection of a preferred alternative; development of detailed design plans; implementation of construction management; and establishment of project monitoring. Includes five major elements of project design.

95. Bourne, G. R. 1987. Flooded fallow rice fields and the structure of bird communities. Pages 75–87 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: WFOWL, NGBIRDS, SHOREB, VEG, HYDRO

Genus: None

Compares bird species diversity of flooded and unflooded fallow ricefields in Guyana, South America. A 3-year-old flooded fallow field had the highest bird species diversity, whereas an unflooded 3-year-old field and a 6-month-old flooded field had the same bird species diversity. A 6-month-old unflooded field had the lowest bird species diversity. Aquatic birds accounted for 76–83% of species diversity in flooded fields and 0–27% of species diversity in unflooded fields. Although vegetation diversity was the best predictor of community bird species diversity, aquatic bird diversity was directly related to percent of area flooded and water depth.

96. Bowers, J. K. 1988. Johns Hopkins University non-tidal wetland mitigation area. Pages 314–317 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: None

Genus: *Acer, Bidens, Carex, Cyperus, Echinochloa, Epilobium, Glyceria, Impatiens, Leersia, Phalaris, Poa, Polygonum, Salix, Typha*

Describes the creation of an approximately 2.5-ha nontidal emergent wetland as in-kind replacement for a wetland drained and covered with earth to accommodate an intramural field and community recreation area at Johns Hopkins University, Baltimore, Maryland. Summarizes predevelopment conditions and describes the design and construction of the wetland. Site preparation included constructing a berm to retain water, installing inlet and outlet structures for water flow, grading and compacting slopes, transplanting plants and soil from the effected wetland, and seeding slopes for erosion control. The wetland will be monitored for the next 2 years to determine plant survival rates and germination of the seed bank and root stock.

97. Bowers, K. 1988. Non-tidal, emergent wetland tranplant. Restor. Manage. Notes 6(1):41–42.

Response: None

Genus: *Carex, Echinochloa, Impatiens, Juncus, Phalaris, Typha*

Describes the creation of a 0.4-ha mitigation wetland near Johns Hopkins University, Maryland. Soil and plants from a wetland that was filled, were used at the new wetland site. The new wetland was graded and connected to a small tributary stream by a perforated pipe. The pipe is buried under small riprap and allows water to seep out over the wetland area. Side slopes were seeded with grasses for erosion control.

98. Boyce, J. S. 1976. Soil-plant relationships in dredged material marshes with particular reference to heavy metal and nutrient availability. Pages 496–511 *in* P. A. Krenkel, J. Harrison, and J. C. Burdick, III, eds. Proceedings of the specialty conference on dredging and its environmental effects. American Society of Civil Engineers, New York.

Response: VEG, CHEM

Genus: *Borrichia, Cyperus, Distichlis, Iva, Juncus, Phragmites, Scirpus, Spartina, Triglochin, Ulva*

Discusses the use of dredged material as a substrate for saltwater and freshwater marshes along U.S. coasts. Topics include: establishment of plants on dredged material, water

quality, and uptake of heavy metals by marsh plants. Preliminary results of habitat development projects indicated that smooth cordgrass (*Spartina alterniflora*) can be established over large portions of the intertidal zone and several other species of salt grasses establish well in the upper reaches of the intertidal zone. The high fertility of estuarine systems may be a result of coupling of the marsh and adjacent mud flat through passing of nutrients aeross the mud flat. Research on heavy metal uptake thus far indicates that plants may concentrate mercury.

99. Boyd, M. J. 1982. Salt marsh faunas: colonization and monitoring. Pages 75–83 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Publ. Rep. T-CSGCP-007.

Response: FISH, INVERT, MAMMALS, NGBIRDS, SHOREB, WFOWL, REPT, AMPHIB

Genus: *Distichlis, Enteromorpha, Salicornia, Spartina, Ulva, Vaucheria*

Presents preliminary findings on colonization and establishment of animal species at a restored marsh on Humboldt Bay. Compares findings to data from a marsh on San Francisco Bay. Considers molluscs, polychaetes, crustaceans, insects and arachnids, fish, birds, mammals, amphibians, and reptiles. Species composition and population density (particularly for key species) are critical components in salt marsh fauna establishments. Describes sampling techniques. General establishment of salt marsh fauna can be monitored by noting which species are present and combining this with data on population density of gastropods and biomass of polychaetes. Discusses optimum monitoring frequency.

100. Bradley, B. O., and A. H. Cook. 1951. Small marsh development in New York. Trans. N. Am. Wildl. Conf. 16:251–266.

Response: VEG, MAMMALS, WFOWL

Genus: *Carex, Eleocharis, Juncus, Potamogeton, Sparganium, Typha*, many

Discusses development of permanent shallow water ponds, 0.4–8 ha (1–20 acres) in size, to provide habitat for wildlife (primarily waterfowl and muskrats) on privately owned farmlands in New York during the late 1940's. Topics include a discussion of muskrat management, the soil conservation district's program of promoting farm pond development in New York through the use of Pittman-Robertson funds, and brief case histories of six typical sites developed through this program.

101. Branch, W. L. 1985. Design and construction of replacement wetlands on lands mined for sand and gravel. Pages 173–179 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: FISH, WFOWL, VEG, HUSE, ECON, SUCCESS

Genus: *Acer, Lonicera, Panicum, Peltandra, Poa, Quercus, Sagittaria, Salix, Scirpus, Setaria, Taxodium*, many

Describes the design and construction of a 5-ha nontidal freshwater wetland on an abandoned, unrestored sand and gravel pit along the Patuxent River in Maryland. Spoil piles and outlet obstructions were removed to allow for flood energy dissipation. Bare soil was impounded, limed, fertilized, and planted with woody shrub seeds and grass clumps to control erosion. Wildlife habitat was enhanced by constructing islands, installing nesting boxes, and designing irregular shoreline configurations. Total cost, including a water level control device, of the project was $190,000.

102. Breekenridge, R. P., L. R. Wheeler, and J. R. Ginsburg. 1983. Biomass production and chemical cycling in a man-made geothermal wetland. Wetlands 3:26–43.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Ceratophyllum Egeria, Phragmites, Potamogeton, Scirpus, Typha*

Evaluates biomass production and chemical cycling in an artificial wetland in southcentral Idaho near the Utah border. Geothermal water was used to create the wetland system, which consisted of an upper pond, a lower pond, and an algal pond. Cooled geothermal effluent flowed into the upper pond (submergent vegetation) and was then pumped through a series of pipes tot he emergent-dominated lower pond and into the algal pond. Soils and water were sampled for 11 elements and pH. Biomass production of reeds (*Phragmites*), cattail (*Typha*), and bulrush (*Scirpus*) were recorded. Disadvantages of this method were accumulated concentrations of elements and a need for additional manipulation of flow rate, wetland size, and evapotranspiration control.

103. Breedlove, B. W. 1983. Wetlands reclamation: a drainage basin approach. Pages 90–99 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow.

Response: None

Genus: None

Compares current restoration approaches to wetland reclamation in the phosphate region of central and northern Florida, with a broader drainage basin perspective. Reclamation decisions can be developed through the consensus of regulatory, industrial, academic, and environmental consulting groups, based on technically valid evaluation and design criteria. The authors recommend a drainage basin approach to wetland evaluation and reclamation design. Some guidelines for this approach include evaluating the hydrologic position of the premining wetland in the basin or region and determining wetland functions and values.

104. Breener, F. J. 1988. Surface mine reclamation: an opportunity for wetland development. Pages 338–343 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, ECON

Genus: *Acer, Betula, Cephalanthus, Ceratophyllum, Cornus, Echinochloa, Eleocharis, Eragrostis, Nelumbo, Potamogeton, Quercus, Sagittaria, Scirpus, Spartina, Taxodium, Typha*, many

Presents an overview of wetland development on surface coal mines, particularly in the eastern and midwestern United States. Discusses a case history of wetland development on two mine sites in northwestern Pennsylvania. Wetlands along with treatment and slurry ponds may be converted into productive wetlands with little additional cost. Twenty-two hectares of wetlands were established on the two mine sites in Pennsylvania at about the same cost that would have been incurred if the land was returned to the approximate original contour accord-

ing to current regulations. During the first year, more than 30 wildlife species used these wetlands, including 5 species of concern in Pennsylvania. Discusses reclamation techniques and their value to wildlife.

105. Brice, J. R., and O. C. Boody, IV. 1983. Fish populations in reclaimed and natural lakes in central Florida's phosphate region: a preliminary report. Pages 359–372 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow, Fla.

Response: FISH

Genus: None

Compares the fish population structure of 12 reclaimed lakes and 4 natural or unmined lakes in central Florida's phosphate region. Only three reclaimed lakes (>10 years old) exhibited fish assemblages greater than or equal to the natural lakes. Fish species not uniformly represented in the remaining reclaimed lakes included rough fish (gar [*Lepisosteus*] bowfin [*Amia calva*]) and various species of catfish. Although fish species diversity generally exhibited a positive relation with lake age and flow-through systems, not all systems evaluated followed these trends.

106. Broadfoot, W. M. 1967. Shallow-water impoundment increases soil moisture and growth of hardwoods. Proc. Soil Sci. Am. 31(4):562–564.

Response: VEG, HYDRO

Genus: *Acer, Carya, Celtis, Diospyros, Fraxinus, Gleditsia, Liquidambar, Populus, Quercus*

Discusses an 8-year experiment on the effect of water impoundment early in the growing season on soil moisture supply for hardwoods on the Mississippi River floodplain near Greenville, Mississippi. Impounding winter and spring rainfall until 1 July significantly increased soil moisture and radial tree growth. In early July, average moisture per 30 cm of soil was 19.5 cm for the flooded area and 13 cm for the control area. Oxygen in the water was depleted after 15 days of dry weather, but was quickly replenished by rain. An extended period of no rain could cause oxygen supplies to become critical and may explain why timber varies greatly in its ability to withstand extended flooding. In this study, rainfall of less than 1 cm replenished oxygen supplies.

107. Broadfoot, W. M. 1973. Water table depth and growth of young cottonwood. U.S. For. Serv. Res. Note SO-167. 4 pp.

Response: VEG

Genus: *Populus*

Describes the results of an experiment examining growth of cottonwood cuttings under the following conditions: no water table (control), water table 0.6 m (2 feet) from the surface, water table 0.3 m (1 foot) from the surface, and water table at the soil surface. The 0.6-m (2-feet) deep water table was best for growth; however, where the water table was high into the root zone and the soil was saturated, death of juvenile cottonwoods (*Populus*) was likely to occur at the end of the second growing season.

108. Brodie, G. A., D. A. Hammer, and D. A. Tomljanovich. 1986. Man-made wetlands for acid mine drainage control. Paper presented at the Eighth Annual National Abandoned Mine Lands Conference, 10–15 August, Billings, Mont.

Response: VEG, CHEM, WQUAL, ECON

Genus: *Alisma, Bidens, Carex, Cyperus, Echinodorus, Eleocharis, Equisetum, Juncus, Leersia, Philonotes, Polygonum, Potamogeton, Sagittaria, Scirpus, Typha, Utricularia*, many

Describes the construction of a wetland to mitigate effects of acid seepage from a coal slurry disposal pond at the Tennessee Valley Authority's Fabius coal preparation facility, Jackson County, Alabama. Existing woodlands were cleared and sandbag dikes were set up to create small impoundments. Plants from nearby acid seeps were transplanted to the construction site. Mosquitofish (*Gambusia affinis*) and fathead minnows (*Bembrops*) were stocked (for mosquito control). Within 3 weeks of completion of the wetlands, water quality monitoring showed significant improvement. Total cost of the system was $28,000. Major research needs include determining design criteria and longevity of a functioning system.

109. Brodie, G. A., D. A. Hammer, and D. A. Tomljanovich. 1987. Constructed wetlands for acid drainage control in the Tennessee Valley. Paper presented at conference on increasing our wetland resources, 4–7 October, Washington, D.C.

Response: VEG, CHEM, WQUAL, ECON

Genus: *Carex, Eleocharis, Equisetum, Juncus, Scirpus, Sparganium, Typha, Utricularia*

Provides an overview of 11 wetlands constructed by the Tennessee Valley Authority (TVA) in Jackson County, Alabama, and Roane County, Tennessee, to treat acid mine drainage. Discusses design, construction, operation, maintenance, and monitoring. Design, construction, and operation costs of a typical impoundment were $40,000. Overall, artificial wetlands are a preferred alternative to conventional methods of treating acid drainage from coal mines. Treatments for pH and for removal of manganese and iron are no longer needed at six of the constructed wetlands.

110. Brodie, G. A., D. A. Hammer, D. A. Tomljanovich. 1987. Treatment of acid drainage from coal facilities with man-made wetlands. Pages 903–912 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: FISH, VEG, CHEM, WQUAL, ECON

Genus: *Eleocharis, Equisetum, Hypnum, Juncus, Philonotes, Polytrichum, Scirpus, Sphagnum, Typha*

Northeast Alabama was the site for construction of an artificial marsh-pond wetland system used to treat acid drainage from coal facilities that were negatively effecting aquatic systems and drinking water supplies. Channeling, diking, and creating impoundments provided conditions necessary for planting. After completion of the wetland system, dissolved oxygen increased to nearly 8.0 mg/L, total iron decreased to 1.1 mg/L, total magnesium averaged 2.8 mg/L, and total suspended solids were 2.8 mg/L. The use of slurry lake water significantly lowered pH levels. Construction costs were approximately $28,000.

111. Brookes, A. 1987. Recovery and adjustment of aquatic vegetation within channelization works in England and Wales. J. Environ. Manage. 24:365–382.

Response: VEG, SOIL

Genus: *Alisma, Apium, Betula, Callitriche, Cladophora, Elodea, Mentha, Myosotis, Myriophyllum, Nasturtium, Nuphar, Oenanthe, Ranunculus, Sagittaria, Sparganium, Veronica*

Assesses short-term recovery of aquatic vegetation following channelization at seven sites in southcentral England in terms

of standing crop and species composition. Recovery was dependent on plant rhizomes still present in the bed of the channel after construction, on species present in the unaffected channel upstream, and on morphological variables that changed during construction, most notably the width, depth, and grain-size composition of the substrate. Vegetation surveys at an additional 22 sites in England and Wales, for up to 24 years, indicated that destruction of the original substrate, significant changes of width or depth, and removal of bankside vegetation may have long-term effects on aquatic vegetation.

112. Brooks, R. P. 1984. Optimal designs for restored wetlands. Pages 19–29 *in* J. E. Burris, ed. Treatment of mine drainage by wetlands. Penn. State Univ. Contrib. 264.

Response: SOIL, CHEM, WQUAL

Genus: *Sphagnum, Typha*

Describes several optimal designs for restoring or creating wetlands to treat acid mine drainage. Wetland diversity on 36 surface mine sites in western Pennsylvania is being studied in terms of wildlife habitat relations. Several considerations for design include: site suitability, wetland use in addition to water quality improvement, and wetland size. Varying pond shapes and meandering natural systems are recommended. Sheet flow through aquatic vegetation is essential. Includes diagrams and a question–answer discussion session.

113. Brooks, R. P., J. P. Hepp, and J. B. Hill. 1988. Wetland creation opportunities on coal mined lands. Pages 181–184 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: INVERT, VEG, CHEM, WQUAL, SUCCESS

Genus: *Juncus, Scirpus, Typha*

Identifies key morphometric, vegetation, and water quality parameters that contributed to biotic diversity during studies of established and newly-created palustrine wetlands on coal-mined lands in western Pennsylvania. Topics include erosion and sedimentation control, abatement of mine drainage, wildlife and fisheries habitat, and landscape enhancement. Guidelines for wetland creation are proposed that enable land managers to plan, construct, and assess success with realistic technical, regulatory, and economic constraints.

114. Brooks, R. P., and R. M. Hughes. 1986. Guidelines for assessing the biotic communities of freshwater wetlands. Pages 276–282 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of impacts and losses. Association of State Wetland Managers, Berne, N.Y.

Response: ECON, SUCCESS

Genus: None

Describes assessment guidelines for the quantitative field sampling of biotic communities for effective assessment and comparison of wetlands. Guidelines include selection of reference wetlands; sampling logistics; sampling biotic communities; sampling of vertebrates, invertebrates, and vegetation; hydrologic sampling; and morphometric sampling. Includes data analysis, costs, and recommendations.

115. Broome, S. W., C. E. Craft, and E. D. Seneca. 1988. Creation and development of brackish-water marsh habitat. Pages 197–205 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, SOIL, CHEM, SUCCESS

Genus: *Juncus, Spartina*

Compares growth of three species of cordgrass (*Spartina*) and needle rush (*Juncus roemerianus*) transplanted at different elevation zones near South Creek, a tributary of the Pamlico Estuary, North Carolina. This site was previously used as borrow pits or undisturbed uplands by the phosphate mining industry. A 2.5-ha area was graded to various elevations and a dendritic pattern of creeks was installed. Greenhouse grown seedlings of smooth cordgrass (*S. alterniflora*) were planted every 15–21 cm along drainage creeks, big cordgrass (*S. cynosuroides*) and *J. roemerianus* from 21–37 cm apart, and marshhay cordgrass (*S. patens*) from 37–43 cm apart. Growth was variable the first year because of the acidic soil. After 4 years, aboveground standing crop was greater for *S. alterniflora* in the created marsh compared to a nearby natural marsh, whereas standing crop of the other 3 species was less.

116. Broome, S. W., E. D. Seneca, and W. W. Woodhouse, Jr. 1988. Tidal salt marsh restoration. Aquat. Bot. 32:1–22.

Response: VEG, ECON

Genus: *Halimione, Puccinellia, Salicornia, Spartina*

Presents an overview of tidal salt marsh restoration and summarizes information available from various restoration projects throughout the world. Recovery of marshes after human perturbation such as dredging, discharges of wastes, and spillage of petroleum products or other toxic chemicals is often slow under natural conditions and can be accelerated by planting. Factors that affect successful revegetation include elevation of the site in relation to tidal regime, slope, exposure to wave action, soil chemical and physical characteristics, nutrient supply, salinity and availability of viable propagules of the appropriate plant species.

117. Broome, S. W., E. D. Seneca, and W. W. Woodhouse, Jr. 1982. Establishing brackish marshes on graded upland sites in North Carolina. Wetlands 2:152–178.

Response: VEG, SOIL, CHEM, WQUAL, SUCCESS

Genus: *Distichlis, Juncus, Spartina*

Describes an experiment to establish three cordgrass (*Spartina*) species on a brackish, graded upland marsh in Bond Creek, adjacent to the Pamlico River Estuary, North Carolina. The experimental site was part of a phosphate mining operation requiring compensation for marsh disturbance. A series of borrow pits was constructed and graded to elevations between 0.06 and 0.43 m msl. Field-dug plants of smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), and big cordgrass (*S. cynosuroides*) and greenhouse-grown seedlings of *S. alterniflora* were planted. Correct elevation for each species was most critical for planting success. Compared results to conditions present in a nearby natural marsh.

118. Broome, S. W., E. D. Seneca, W. W. Woodhouse, Jr. 1981. Planting marsh grasses for erosion control. Univ. N.C. Sea Grant Coll. Prog. Publ. UNC-SG-81-09. 11 pp.

Response: VEG, SOIL

Genus: *Spartina*

Describes the use of salt marsh grasses for erosion control along the coast of North Carolina. Includes discussions of site suitability, plant establishment procedure, transplanting methods, and some species descriptions with the focus on smooth cordgrass (*Spartina alterniflora*), giant cordgrass

(*S. cynosuroides*), and American beachgrass (*Ammoiphila breviligulata*).

119. Broome, S. W., E. D. Seneca, and W. W. Woodhouse. 1986. Long-term growth and development of transplants of the salt-marsh grass *Spartina alterniflora*. Estuaries 9:63–74.

Response: VEG, SUCCESS

Genus: *Spartina*

Describes the long-term sampling of smooth cordgrass (*Spartina alterniflora*) transplants along eroding estuarine shorelines in North Carolina. The effects of transplant spacing (45, 60, and 90 cm) were tested; 45- and 60-cm spacings were more successful on sites near the lower elevation limits of *Spartina*. Differences between the planted sites and natural marsh were apparent at first, but decreased over time. Annual production and decomposition of the belowground standing crop were nearly equal. After 10 years, the artificial marsh was self-sustaining, successful in shoreline erosion control, and equal in primary productivity to the natural marsh.

120. Broome, S. W., E. D. Seneca, and W. W. Woodhouse. 1983. Creation of brackish-water marsh habitat. Pages 319–331 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow.

Response: VEG, SOIL, CHEM

Genus: *Distichlis, Juncus, Spartina*

Discusses the feasibility of converting a 0.4-ha upland site to brackish-water marsh adjacent to an estuary near Aurora, North Carolina. Soils were phosphorus deficient and fertilization with phosphorus and nitrogen was essential for satisfactory establishment and growth of cordgrass (*Spartina*). Broadcast application and incorporation of fertilizer before transplanting was the most practical fertilization method for large areas. Fall seeding in a greenhouse was necessary for spring transplants of needle rush (*Juncus roemerianus*). Transplanting on a new surface graded to the proper elevation accelerated first stages of marsh plant community succession.

121. Broome, S. W., W. W. Woodhouse, Jr., and E. D. Seneca. 1985. The influence of duration-of-inundation on development of a man-initiated *Spartina alterniflora* Loisel. marsh in North Carolina. J. Exp. Mar. Biol. Ecol. 94:259–268.

Response: VEG, SUCCESS

Genus: *Aster, Borrichia, Cyperus, Iva, Phragmites, Sabatia, Scirpus, Spartina, Suaeda, Vigna*, many

Records the growth responses of smooth cordgrass (*Spartina alterniflora*) to duration of inundation in the Cape Fear River estuary, North Carolina. Culms were planted in 15 plots in 4 zones perpendicular to the shoreline. In all four zones, standing crop increased from 56 to 100%, 17 months after planting. Although this experimental planting was almost all *S. alterniflora* during the first 17 months, the upper elevation zones became a mixed–species marsh from the third to the twelfth growing season. Lower elevation zones remained dominated by *S. alterniflora*, which had spread 30 m toward the open water of the estuary by the twelfth season.

122. Broome, S. W., and W. W. Woodhouse. 1973. An investigation of propagation and the mineral nutrition of *Spartina alterniflora*. Univ. N.C. Sea Grant Publ. UNC-SG-7314. 121 pp.

Response: VEG, CHEM

Genus: *Spartina*

Discusses propagation of smooth grass (*Spartina alterniflora*) from seed and the relation of mineral nutrients to growth of this species in estuaries of North Carolina. A series of experiments was used to determine the best method of collection, storage, and seeding for *S. alterniflora*. A short period of dry, cold storage increased germination. Direct seeding can be an effective method of establishing new stands on dredge spoil material. Seedlings can be expeeted to survive on the upper 20–50% of the elevational range of naturally occurring stands in a given area. Nitrogen and phosphorous fertilizers enhanced the growth of seedlings and transplants artificially established on sandy dredge spoil.

123. Broome, S. W., W. W. Woodhouse, and E. D. Seneca. 1974. Propagation of smooth cordgrass, *Spartina alterniflora*, from seed in North Carolina. Chesapeake Sci. 15(4):214–221.

Response: VEG

Genus: *Spartina*

Discusses the germination and establishment of smooth cordgrass (*Spartina alterniflora*) at various estuarine sites, including dredged material areas, along the coast of North Carolina (Oregon Inlet, Ocracoke, Beaufort, Surf City, Oak Island, and Snow's Cut). Successful seed germination and survival were attributed to a combination of techniques: (1) the storage of seeds at 2–3° C, first in burlap sheets, then in estuarine or sea water over the winter, and (2) direct seeding between April and early June. Seedling survival was best in the upper 20–50% of the elevational range of naturally growing cordgrass (*Spartina*). In one growing season, aboveground standing crop produced from seeds may be similar to that of well-established marshes.

124. Brown, M. T., F. Gross, and J. Higman. 1984. Studies of a method of wetland reconstruction following phosphate mining. Pages 24–45 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: HYDRO, VEG, ECON

Genus: *Eupatorium, Indigofera, Liquidambar, Nyssa, Panicum, Polygonum, Sesbania, Taxodium*

Two methods were used to apply peat from existing wetlands to several phosphate mine sites. After one growing season, wetland species died in control sites that had no applied peat. Sites that were applied with peat had good growth of wetland and transitional species; overall vegetative cover was 100%, compared to 30% for the nonpeat control. Peat-mulched areas had greater plant biomass and species diversity. Germination, survival, and growth of wetland species might have been limited by short hydroperiods (74% of plots had hydroperiods of less than 30 days). Cost of peat-mulching varied from $5 to 12/m^3 and was competitive with other methods.

125. Brown, R. G., and J. R. Stark. 1987. Comparison of groundwater and surface-water interactions in two wetlands. Pages 77–80 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, North Carolina.

Response: HYDRO

Genus: *Larix, Picea, Sphagnum, Typha*

Compares hydrologic data from two wetlands near St. Joseph, Minnesota, and Phelps, Wisconsin. The St. Joseph wetland is a flat glacial outwash plain adjacent to a river; the Phelps

wetland is a surface water depression area, part of the headwaters of a small stream. Hydrologic budgets were based on precipitation, surface water outflow, groundwater outflow, and change in storage. Ground- and surface-water interaction was evident at St. Joseph, but not at Phelps. Hydrologic differences between these two sites illustrate the importance of describing ground- and surface-water interaction before development of a hydrologic budget.

126. Brown, R. L., and A. L. Hafenrichter. 1948. Factors influencing the production and use of beachgrass and dunegrass clones for erosion control: III. Influence of kinds and amounts of fertilizer on production. J. Am. Soc. Agron. 40(8):677–684.

Response: VEG, SOIL

Genus: *Ammophila*

Presents results of experiments on the use of fertilizers to promote the growth of European beachgrass (*Ammophila arenaria*) on coastal dunes in Oregon. Three inorganic fertilizers and six organic nitrogen fertilizers were applied in early spring to test plots over a 3-year period. Inorganic fertilizers were more effective than organic fertilizers for increasing rate of production. Ammonium compounds were more effective than sodium nitrate as inorganic sources of nitrogen. Single applications of fertilizer resulted in better production than split applications. Applications of 18.2 kg/ha (40 lb/acre) of nitrogen were necessary to increase production, but 36 kg (80 lb) did not increase production enough to warrant the additional cost.

127. Brunori, C.R. 1988. Examples of wetland creation and enhancement in Maryland. Pages 306–313 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: FISH, WFOWL, VEG

Genus: *Acer, Acorus, Alnus, Carex, Ceratophyllum, Echinochloa, Fraxinus, Hibiscus, Juncus, Leersia, Lemna, Myriophyllum, Najas, Peltandra, Phragmites, Pinus, Polygonum, Polygonum, Pontederia, Potamogeton, Sagittaria, Salix, Scirpus, Spartina, Typha, Zannichellia, Zizania*

Discusses creation and enhancement of three wetlands in the Chesapeake Bay area, Maryland, and resulting wildlife use of the wetlands. The projects consisted of creation of a 28-ha nontidal pond, a 2.6-ha diked tidal fresh marsh, and a 4-ha diked tidal brackish marsh. Techniques included water level manipulation, herbicide treatment of reeds (*Phragmites*), and creation of islands, in addition to modifications by diking. Progress and modifications of each wetland plan are included. All projects were planned in the last 5 years and were completed within the last 2 years. Early monitoring indicated that waterfowl use of the areas has increased. Further plans for increasing this use include installation of nest boxes and maintenance of a 50:50 ratio of emergents to open water.

128. Brusven, M. A., F. J. Watts, R. Luedtke, and T. L. Kelley. 1974. A model design for physical and biotic rehabilitation of a silted stream. Univ. Idaho Res. Tech. Completion Rep. Proj. A-032-IDA. 96 pp.

Response: INVERT, SOIL

Genus: None

Discusses the effects of stream alterations on sediment transport and insect communities in Emerald Creek, a tributary of the St. Maries River in northern Idaho. Instream alterations proved to be effective means for increasing sediment transport, thereby improving insect and fish habitat. Debris jam removal, channel diversion, and gabion deflectors caused flushing of fine sediment from runs and pools. Log-drop structures scoured pools, thereby increasing the pool to riffle ratio. Higher values of percent cobble, average sediment size, mean channel depth, and greater diversity and abundance of insects resulted from in-stream alterations. Flow models were used to predict effects on sediment.

129. Buck, J. K., and R. J. Houston. 1986. Direct revegetation of four coal waste sites in Pennsylvania—four approaches. Pages 385–429 *in* C. L. Carlson and J. H. Swisher, eds. Innovative approaches to mined land reclamation. Southern Illinois University Press, Carbondale.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: Many

Includes four studies; one dealing with wetland restoration. The Pennsylvania Power and Light Harwood reprocessed anthrocite waste site, Luzerne County, Pennsylvania, was selected for an experimental study on revegetation using fly ash as a major soil amendment. Fly ash and coal wastes were combined and analyzed for pH, lime requirements, nutrients, trace elements, and toxic elements. On the site, 200 tons of fly ash per acre were incorporated to a depth of 25 cm (10 inches). Growth and diversity of plants on the fly ash site are compared to those in the soil-covered control plot. Chemical monitoring of soil and water is described and costs are compared.

130. Buckley, F. G., and McCaffrey. 1978. Use of dredged material islands by colonial seabirds and wading birds in New Jersey. Appendix B: Vegetation analysis. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-1. 226 pp.

Response: SHOREB

Genus: *Lonicera, Phragmites*, many

Describes the vegetation on 21 selected dredged material islands along the New Jersey intracoastal waterway. Eleven of these islands harbor colonial nesting birds. Vegetation maps indicate 14 major plant communities. Average frequency, percent cover, and height classes of dominant species were recorded. Mapping units were reed (*Phragmites*), *Phragmites*-shrub, shrub, bare substrate, shrub–dense grassland, sparse grassland, dense grassland, dike, shrub-forest, intertidal areas, *Lonicera*, impounded water, and *Lonicera*-shrub. Describes plant succession.

131. Bucknauage, M. J., and E. C. Aharrah. 1984. Determination of the algal growth-limiting nutrients in strip-mine ponds. Pages 191–196 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publication, Lexington.

Response: VEG, CHEM, WQUAL

Genus: *Ankistrodesmus, Potamogeton, Typha*

Discusses results of test alga (*Ankistrodesmus faloatus*) and natural phytoplankton assays used to determine algal growth limiting nutrients in two strip-mine ponds in Clarion County, Pennsylvania. Results indicated that phosphorus was the primary limiting nutrient and nitrogen was a secondary limitor. The presence of bacteria influenced nutrient availability in one of the ponds, maintaining lower concentrations of algal growth. Discusses the various factors that determine bioavailability of chemical nutrients in aquatic systems.

132. Bureau of Land Management. 1983. Environmental assessment on state of reclamation techniques on phosphate mined lands in Florida and their application to phosphate mining in the Osceola National Forest. U.S. Department of the Interior, Bureau of Land Management, Alexandria, Va. 82 pp.

Response: VEG

Genus: Many

Describes current reclamation techniques that might be used on proposed phosphate mine sites in the Osceola National Forest, Florida. Discusses conventional methods such as lake construction; sand tailing, clay waste, and overburden fills; and several experimental methods. Conclusive data on reclamation of hardwood wetlands is lacking and sufficient technological capabilities do not exist to ensure reasonably successful reclamation for proposed mined sites in the National Forest.

133. Bureau of Sport Fisheries and Wildlife. 1964. Fish and wildlife in man-made and man-modified aquatic environments. Project Mar: the conservation and management of temperate marshes, bogs, and other wetlands. 1(3):369–382.

Response: None

Genus: None

Provides an overview of the use of created or restored wetlands by fish and wildlife (especially waterfowl). Discusses sewage disposal lagoons, impoundments, farm ponds, gravel pits, irrigated land, fish ponds, and brackish coastal wetlands in terms of fish and wildlife potential or use.

134. Burgess, S. A. 1985. Some effects of stream habitat improvement on the aquatic and riparian community of a small mountain stream. Pages 223–246 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: FISH, INVERT, MAMMALS

Genus: None

Describes the effects of a stream habitat improvement program on a spring-fed stream 105 km northwest of Montreal, Quebec. To increase trout biomass, habitat improvement techniques such as small rock dams and deflectors and instream cover (logs and rafts of alders) were used on one of two parallel (100-m) sections of the stream. The other section served as a control. Over the 2 years of this study, the improved section produced an average of 218% greater trout biomass, increases in all age classes of fish, and larger crayfish populations. Discusses observations of mink and raccoon activity in the area Management implications for trout-producing streams are noted.

135. Burt, C. J. 1973. Partial recovery of vegetation in a pollution-damaged marsh. University of Massachusetts, Water Resources Research Center, Amherst. 28 pp.

Response: VEG

Genus: *Elodea, Leersia, Marsilia, Nuphar, Potamogeton*, many

Describes a study of the vegetation of Arcadia Wildlife Sanctuary marsh, at the mouth of the Mill River in Northampton, Massachusetts, during a period of recovery from oil and other industrial pollutants. Quantitative studies revealed an increase in total cover and in diversity. Notes the successional nature of marshes; the relative resilience of marsh vegetation along polluted streams is in part attributable to the adaptation of dominant species to early stages of the hydrosere.

136. Burt, C. J. 1988. Characteristics of the plant communities growing in the drawdown zone of Schoharie Reservoir in upstate New York. Pages 274–281 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, SOIL

Genus: *Anthemis, Apocynum, Bidens, Brassica, Carex, Cyperus, Gnaphalium, Onoclea, Phalaris, Populus, Salix, Scirpus, Spiraea, Thelypteris*

Describes the wetland plant communities growing in the drawdown zone of Schoharie Reservoir, east–central New York. The reservoir experiences a summer–fall annual drawdown; flooding regime, aspect, slope, and elevation are important factors influencing plant growth in the drawdown area. The timing and extent of water supply withdrawal was one of the major factors controlling the distribution of plant species. Dense growth of numerous herbaceous plants in areas previously dominated by chufa (*Cyperus esculentus*) resulted from a short full-pool period (10 days) and a lack of water in backwaters (22 days). Describes species composition of various elevation zones and compares standing crop measurements of several species in different elevation zones.

137. Burt, C. J. 1977. A four year analysis of vegetation following an oil spill in a freshwater marsh. J. Appl. Ecol. 14:515–522.

Response: VEG

Genus: *Acer, Alisma, Carex, Ceratophyllum, Dulichium, Eleocharis, Elodea, Equisetum, Lemna, Lysimachia, Nuphar, Polygonum, Potamogeton, Sagittaria, Salix, Scirpus, Scutellaria, Sium, Veronica, Vitis*, many

Documents the recovery of vegetation following an oil spill at Arcadia Wildlife Sanctuary at the mouth of the Mill River in Northampton, Massachusetts. The affected marsh vegetation had been studied for 1 year before the spill. For 2 years after the spill, total plant cover and number of species were reduced. Perennial species were initially less affected than annuals. Describes shifts in dominant species in different areas of the marsh.

138. Burton, T. M., D. L. King, and J. L. Ervin. 1978. Aquatic plant harvesting as a lake restoration technique. Pages 177–185 *in* Lake Restoration; proceedings of a national conference. U.S. Environal Protection Agency, Washington, D.C.

Response: VEG, CHEM

Genus: *Ceratophyllum, Chara, Eichhornia, Elodea, Hydrilla, Lemna, Myriophyllum, Phragmites, Potamogeton, Spirodela, Typha, Vallisneria*

Discusses the advantages, disadvantages, ecological consequences, and costs of using aquatic plant harvesting as a lake restoration technique. This technique can work only where nutrient loading has been reduced to low levels (net loading of phosphorus less than 1 g/m^2/year) and the lake supports dense stands of macrophytes. Floating species such as water hyacinths and emergent species such as cattail can produce more biomass and remove greater amounts of nitrogen and phosphorus than submerged macrophytes. Harvest can maintain recreational potential, for example, by reducing winter kill and keeping waterways open. Estimates of harvest for various plant species and locations are presented, as well as estimates of nitrogen and phosphorous removal by the plants.

139. Busch, W. D. N. , and L. M. Lewis. 1984. Wetlands and lake interrelationships. Pages 519–524 *in* Proceedings, Third Annual Conference of the North American Lake Management

Society: Lake and reservoir management. U. S. Environ. Prot. Agency, EPA 440/5/84-001.

Response: VEG

Genus: *Calamagrostis, Ceratophyllum, Cornus, Elodea, Fraxinus, Pontederia, Sparganium, Typha*, many

Describes a study of two Lake Ontario wetlands to determine vegetation responses to water level fluctuations. Historical habitat and vegetation conditions were examined through the use of aerial photographs of Campbell Marsh, Jefferson County, New York, and Sage Creek Marsh, Oswego County, New York. Contours and habitat types were digitized for detailed computer analysis, which revealed that vegetation types occur within distinct ranges in elevation, shifting and adjusting as water levels change. Provides area of habitat types for each marsh in 1958, 1966, and 1978.

140. Byerly, D. W. , J. B. Maddox, C. S. Fletcher, and D. T. Eagle. 1978. Reclamation of mined land in the Piney Creek watershed—an interim report. Pages 267–275 *in* D. E. Samuel, J. R. Stauffer, and C. H. Hocutt, eds. Proceedings of a symposium: surface mining and fish/wildlife needs in the eastern United States. U.S. Fish Wildl. Serv., FWS/OBS-78/81.

Response: VEG, CHEM, WQUAL

Genus: *Elaeagnus, Lespedeza, Malus, Pinus, Prunus, Quercus, Robinia*

Discusses effects of restorative measures applied to 174 ha of coal mined land within the Piney Creek watershed, Van Buren County, Tennessee. Treatments, including planting of trees and shrubs, seeding grasses and legumes, fertilizing, liming, building silt-retaining structures, and plugging underground mines, resulted in improved vegetative cover and water quality. After 2 years, average manganese and sulfate concentrations had been reduced by about 30%, iron by 50%, and specific-conductance by 30%. Summarizes costs of reclamation.

141. Byron, G. J. 1985. Man-made wetlands as a post-mining land use: regulatory issues and conflicts. Pages 181–183 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University School of Forestry Resources, University Park.

Response: None

Genus: None

Discusses laws and regulations concerning surface mining within 30. 5 m of natural wetlands and the adverse hydrologic or water quality effects of mining activity. Wetland construction should be designed to guarantee suitable water quality on a permanant basis for wildlife habitat. Future regulations regarding biological treatment should address questions relating to the pH of the final effluent, receiving water quality, maintainance of a sufficient water level to support vegetation, presence of seeps and discharges, use of biological treatment on the discharge area, and liability issues associated with the treatment system. Biological treatment using vegetation is a viable alternative for controlling acid mine drainage.

142. Cairns, J., Jr. 1983. Management options for rehabilitation and enhancement of surface-mined ecosystems. Miner. Environ. 5(1):32–38.

Response: None

Genus: None

Describes four basic management options for surface-mined land: restoration to original condition, rehabilitation of some desirable characteristics, development of alternative ecosystems that may be quite unlike the original but may be desirable for a variety of reasons, and neglect or natural reclamation when evidence suggests that unaided natural processess will produce better results than human intervention. The author provides checklists so that essential information is available in selecting the most suitable option and includes examples of the option selected for a particular site.

143. Cairns, J., Jr. 1978. Waterway recovery. Water Spectrum 10(4):26–32.

Response: SUCCESS

Genus: None

Provides a brief overview of aquatic ecosystems and their general recovery characteristics. Factors that contribute to rapid recovery are described along with a rating system by which all factors are combined to produce a recovery index for a specific site. These factors include existence of nearby epicenters for providing "seed" organisms to reinvade a damaged system, transportation of organisms to a new area, chemical-physical environmental quality after pollution stress, and management capabilities for direct and immediate control of the damaged area. Discusses the state of the art on restoration of communities, with some examples.

144. Cairns, J., Jr. 1985. Facing some awkward questions concerning rehabilitation management practices on mined lands. Pages 9–17 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University School of Forestry Resources, University Park.

Response: SUCCESS

Genus: None

Discussed seven major questions relating to rehabilitation management practices on surface-mined land. Examines criteria for determining the following: at what point is a self-maintaining system produced, can an ecosystem be restored to its original condition, when should only selected characteristics or qualities of the system be rehabilitated, and when is rehabilitation not feasible? Discusses planning for species selection, professional personnel requirements, and research opportunities.

145. Cairns, J., Jr., J. S. Crossman, K. L. Dickson, and E. E. Herricks. 1971. The recovery of damaged streams. Assoc. Southeast. Biol. Bull. 18(3):79–106.

Response: FISH, INVERT

Genus: None

This paper examines biological recovery of streams in Virginia (Mill Creek, Clinch River, Roanoke River) and Pennsylvania (Indian Creek and Little Scrubgrass Creek) damaged by acidic or caustic material. Short-term acute stresses elicited an immediate reduction in diversity and density of macroinvertebrates and fishes. Recovery was fairly rapid unless the materials had residual toxicities, which resulted in the establishment of an interim, atypical community structure lasting as long as the toxicity persisted. The rate of recolonization of damaged areas seems to be dependent on the distance an area is located from the site of the original spill and the existence of undamaged tributaries. Reaches of the river

further downstream were slower to recover; rate of recovery was faster below healthy tributaries.

146. Cairns, J., Jr., J. Stauffer, Jr., and C. H. Hocutt. 1979. Opportunities for maintenance and rehabilitation of riparian habitats: eastern United States. Pages 304–317 *in* R. R. Johnson and J. F. McCormick, eds. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. For. Serv. Gen. Tech. Rep. WO-12.

Response: FISH, ECON, SUCCESS

Genus: None

Provides an overview of the requirements for maintaining ecosystem quality in terms of baseline studies, hazard evaluation, and biological monitoring. Discusses rehabilitation of riparian ecosystems. Several studies demonstrate that rehabilitation of damaged aquatic systems can be achieved at a reasonable cost. Includes tables that display systems for rating the critical factors in ecosystem elasticity and inertia; provides demonstrations of the application of these concepts to fish data from the Monongahela River and Susquehanna River drainages.

147. Cairns, J., and K. Dickson. 1977. Recovery of streams from spills of hazardous materials. Pages 24–42 *in* J. Cairns, Jr., K. L. Dickson, and E. E. Herricks, eds. Recovery and restoration of damaged ecosystems. Virginia University Press, Charlottesville.

Response: SUCCESS

Genus: None

Describes the recovery of the Clinch and Roanoke rivers, Virginia, damaged by hazardous materials (e.g., caustic wastes, sulfuric acid, ethylbenzene-creosote). Ecosystem characteristics related to the process of recovery include the following: vulnerability to irreversible damage, ability to recover (elasticity), ability to resist displacement of structural or functional characteristics, and resiliency—the number of times an ecosystem can recover from stress. Discusses methods of determining characteristics for a given ecosystem or site.

148. California State Coastal Conservancy. 1982. Regional wetland restoration study: Los Angeles and Orange Counties. Final draft report. California State Coastal Conservancy, Oakland. 78 pp.

Response: FISH, HUSE, WFOWL, NGBIRDS, SHOREB, SUCCESS

Genus: *Salicornia, Scirpus, Spartina, Typha, Zostera*

Presents wetland restoration site plan guidelines for Los Angeles and Orange Counties, California. Includes a regional assessment of historical and present wetlands and regional goals. Discusses design criteria, performance standards, and other guidelines necessary to ensure that individual restoration site plans have a "high predictability of success." Topics include watershed management, adjacent land management and development, passive receational and educational access, buffer zones, corridor development, migratory birds, endangered species, design of ponds, mosquito control, design of tidal areas, islands, and dikes and levees. Analyzes ten specific upland sites suitable for restoration. Appendixes include information on bird and fish use of regional wetlands.

149. California State Coastal Conservancy. 1982. Los Cerritos wetlands: alternative wetland restoration plans report. California State Coastal Conservancy. 133 pp.

Response: None

Genus: None

Presents four alternative plans for enhancing the Los Cerritos wetlands, Long Beach, California. Each alternative serves to increase amount of quality habitat for the region's endangered wetland species, increase relatively scarce habitats, enhance populations of coastal dependent migratory waterfowl and shorebirds, have a high predictability of success, create mix of fresh water and salt water habitats, and provide adequate buffers along development edges. Discusses plans and alternatives preferred by various agencies. Appendices include reports on existing wetland resources, site constraints, and wetland enhancement criteria.

150. Cammen, L. M. 1975. Accumulation rate and turnover time of organic carbon in a salt marsh sediment. Limnol. Oceanogr. 20:1012–1015.

Response: VEG, SOIL, CHEM

Genus: *Spartina*

Describes a study of organic carbon in salt marsh sediment at several sites (natural marsh, unvegetated dredged spoil, and spoil planted with smooth cordgrass [*Spartina alterniflora*]) near Drum Inlet, North Carolina. Both spoil areas accumulated organic carbon; however, the annual accumulation rate was higher where *Spartina* was present. The turnover time for organic carbon in the natural marsh was calculated at 3. 7–4.5 years. The main source of carbon was probably a combination of detrital matter transported by tidal action and benthic algae.

151. Cammen, L. M. 1976. Abundance and production of macroinvertebrates from natural and artificially established salt marshes in North Carolina. Am. Midl. Nat. 96(2):487–493.

Response: INVERT

Genus: *Spartina*

Compares the abundance and production of macroinvertebrates in several salt marshes in Drum Inlet and Snow's Cut, North Carolina. Marsh types were dredge material planted with cordgrass (*Spartina*), bare marsh spoil, and natural emergent marsh and creeks. Differences in elevation between Drum Inlet and Snow's Cut accounted for differences in faunal composition. Planted material increased because of sediment trapping by *Spartina*, and estuarine fauna were gradually replaced by more terrestrial fauna such as insect larvae. Creek production was higher than that of emergent marsh. Initially, marsh creation may result in reduced secondary productivity; however, *Spartina* production will support detritus-based communities in creeks and estuaries, resulting in a net gain in secondary productivity for the ecosystem.

152. Cammen, L. M. 1976. Macroinvertebrate colonization of *Spartina* marshes artificially established on dredge spoil. Estuarine and Coastal Mar. Sci. 4(4):357–372.

Response: INVERT, SOIL, VEG, CHEM, SUCCESS

Genus: *Spartina*

Compares macroinvertebrate colonization on dredged material sites in Drum Inlet and Snow's Cut, North Carolina. Samples were taken at unplanted plots (bare soil), artificially planted plots, and natural marsh areas at both sites. Sediment analysis revealed that the source of organic carbon was probably benthic microalgae and detritus. The turnover time for sediment organic carbon (3. 7–4. 5 years at Drum Inlet and 22.6–26. 6 years at Snow's Cut) approximates the time taken for spoil plots to reach organic carbon concentrations equal to those of the natural marsh. Faunal distribution was affected by

elevation, sediment particle size, proximity of spoil to natural marsh, and maturity of natural marsh faunal communities.

153. Cammen, L. M., E. D. Seneca, and B. J. Copeland. 1976. Animal colonization of man-made salt marshes on dredge spoil. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Pap. 76–7. 58 pp.

Response: INVERT, SUCCESS

Genus: *Spartina*

Compares natural and artificial marshes to determine whether dredged spoils planted with smooth cordgrass (*Spartina alterniflora*) function similarly to natural marshes. The study areas were at Drum Inlet, Carteret County, North Carolina, and Snow's Cut, New Hanover County, North Carolina. Describes patterns of faunal development. Using organic carbon content of the sediment as an indicator, estimates for the length of time taken for dredge spoil to resemble natural marsh were about 4 years (from last spoil deposited) at Drum Inlet and about 25 years at Snow's Cut. Factors affecting marsh development are as follows: how closely spoil resembles natural sediment, natural sedimentation rate of the area, and the elevation and maturity of natural marsh compared to spoil.

154. Camp Dresser & McKee, Inc. 1980. Bracut Marsh restoration project: a report on the environmental and engineering surveys. California State Coastal Conservancy, Oakland. 25 pp.

Response: None

Genus: *Grindelia, Jaumea, Limonium, Orthocarpus, Plantago, Puccinellia, Salicornia, Salix, Spartina, Spartina*

Presents results of environmental and engineering surveys conducted to evaluate the suitability of the proposed Bracut Marsh restoration site in Humboldt Bay, Eureka, California. Environmental variables include tidal hydraulics, bay circulation and flushing patterns, sedimentation, soils, vegetation, and wildlife. The investigation included a survey of State and local agencies to determine general interest and to obtain advice on project feasibility. Survey results indicated that the site was suitable for marsh restoration assuming the addition of appropriate fill material to provide adequate structural stability and sufficient nutrient supply to support desired marsh vegetation.

155. Campbell, C. J., and W. Green. 1968. Perpetual succession of stream-channel vegetation in a semiarid region. J. Ariz. Acad. Sci. 5(2):86–98.

Response: VEG

Genus: *Acacia, Amsinckia, Baccharis, Bouteloua, Cassia, Cupressus, Erodium, Euphorbia, Franseria, Fraxinus, Hymenoclea, Juglans, Juniperus, Larrea, Lycium, Mimosa, Pectis, Pinus, Plagiobothrys, Platanus, Pluchea, Populus, Prosopis, Pseudotsuga, Quercus, Salix, Sambucus, Schismus*, many

Discusses channel vegetation communities with respect to changing elevation at Sycamore Creek, Maricopa County, Arizona. Ninety–five percent of the shrub species sampled and approximately 50% of the tree species are indigenous to the semiarid mountain slopes and are not dependent on additional subsurface moisture in the channel. These species, which have a wide ecological amplitude with respect to soil moisture variation, are termed "pseudoriparian." They invade the channel sites perpendicularly from adjacent slopes and remain confined to their area of introduction. Riparian species exist only where subsurface moisture is available in addition to annual precipitation. Mosaics of various seral stages with different dominant species characterize the vegetation communities.

156. Campbell, R. S., and O. T. Lind. 1969. Water quality and aging of strip-mine lakes. J. Water Pollut. Control Fed.

Response: CHEM, WQUAL

Genus: None

Describes the physical and chemical characteristics of five strip–mine lakes of varying age and pH (2.8–8.1). The initial successional stage of acid-mine lakes is characterized by low pH, absence of bicarbonates, and large concentrations of dissolved minerals, which produce high conductivity measurements. Sulfate is the predominate anion. Water color characteristic is usually bright red, blue, or green. These conditions become less pronounced as sulfuric acid pollution lessens. During this less acidic phase, the lakes are homeothermous. Later alkaline stages are comparable to stages of early eutrophy in natural lakes.

157. Campbell, R. S., O. T. Lind, W. T. Geiling, and G. L. Harp. 1965. Recovery from acid pollution in shallow strip-mine lakes in Missouri. Proceedings of the Nineteenth Industrial Waste Conference, Purdue University, Utah.

Response: FISH, INVERT, VEG, CHEM, WQUAL

Genus: None

Discusses recovery from acid pollution in shallow strip-mine lakes in Calloway County, Missouri. A sequence of stages of recovery from acid pollution was readily identified by an increase in pH and an increase in species diversity of zooplankton, benthos, fish, and phytoplankton over a 23-year period. However, the rate of recovery was highly variable, even for adjacent lakes constructed at the same time. The presence of waste coal piles in the watershed delayed recovery in one lake for 45 years. Recovery from acid pollution was accelerated in another lake by alkaline drainage from farmlands.

158. Carangelo, P. D. 1988. Creation of sea grass habitat in Texas: results of research investigations and applied programs. Pages 286–300 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, SOIL, CHEM

Genus: *Avicennia, Halodule, Halophila, Laurencia, Ruppia, Spartina, Syringodium, Thalassia*

Summarizes creation techniques and results of experimental seagrass plantings conducted since 1974 and larger-scale plantings conducted since 1982 in south Texas. Describes four seagrass mitigation projects in detail: Hog Island, Huffco, Petrus-Hughes, and Clark Island. Diagnostic evaluation of these projects suggested that the degree to which a prepared planting surface acted as a sediment, leaf blade, drift algal, or detrital sink resulted in varying levels of project efficacy. When a project did not respond as a sink, and where sediment stability was achieved, the project seemed successful. Discusses some general principles and guidelines.

159. Carangelo, P. D., C. H. Oppenheimer, and P. E. Picarazzi. 1979. Biological application for the stabilization of dredged materials, Corpus Christi, Texas: submergent plantings. Pages 243–262 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM

Genus: *Halodule, Halophila, Ruppia, Syringodium, Thalassia*

Describes the planting of several test plots on dredged material and other barren disturbed sites in Corpus Christi Bay, Texas. Upland, emergent, and submergent species were transplanted; only discusses the submergents here. Provides information on the types of plants that can be used effectively to revegetate and stabilize nonvegetated estuarine areas with minimum cost and effort. Growth and survival rate of submergents were examined at Laguna Madre, Rincon, and Mud Island. Planting considerations include water depth, timing (after spring revitalization or before winter dieback), restoration of predisturbance elevation and substrate type, and avoidance of high-wave energy sites.

160. Cardamone, M. A. 1985. Wetlands and the surface mining of coal: protection and values assessment. M. S. thesis, University of Kentucky, Louisville. 148 pp.

Response: SUCCESS

Genus: *Phragmites, Sphagnum, Typha*

Examines management options for protecting wetlands during surface coal mining, particularly for the eastern interior coal region in Kentucky, Indiana, and Illinois. Discusses interactions between wetlands and surface coal mining, using a conceptual systems model. Provides an analysis of mining effects on wetlands and general legal and regulatory information on wetland protection and surface coal mining. Wetland protection procedures include preventing impacts, mitigation, and reclamation techniques. Presents a hypothetical wetland restoration plan. Discusses selection of which wetlands are to be protected in terms of an overview of wetland values and the current methods used for values assessment and decision-making processes.

161. Carlson, D. B., R. G. Gilmore, and J. R. Rey, Jr. 1985. Salt marsh impoundment management on Florida's central east coast: reintegrating isolated high marshes to the estuary. Pages 47–63 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, VEG

Genus: *Avicennia, Batis, Laguncularia, Rhizophora, Ruppia, Salicornia*

Describes the reopening of a salt-marsh mosquito impoundment to the adjacent estuary. The study site is Indian River impoundment #12, a high marsh on a barrier island between Indian River and St. Lucie counties, Florida. Purposes of the study were to reestablish exchange of organisms and detritus between marsh and estuary, and control mosquito populations. When the impoundment site was reopened to tidal influence, there was a major increase in species richness and considerable revegetation by *Batis* and *Salicornia*. Mosquito larvae formed an insignificant portion of the diet of marsh fish; continued mosquito control apparently requires the pumping of water into the marsh during spring and summer, when natural water levels become low enough to provide breeding sites for mosquitoes.

162. Carlson, J. E. 1982. Preliminary report on the restoration of farmed freshwater marshes at Corkscrew Swamp sanctuary. Pages 212–227 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Andropogon, Aster, Bacopa, Centella, Cyperus, Diodia, Eichhornia, Eleocharis, Hydrocotyle, Ipomoea, Lippia, Ludwigia, Melaleuca, Nymphoides, Panicum, Pluchea, Polygonum, Pontederia, Proserpinaca, Sagittaria, Schinus, Spartina, Urena, Utricularia*

Freshwater marshes at Corkscrew Swamp, Florida, were modified by dikes and ditches. In 1981, restoration of one-third of the disturbed area was initiated by grading and restoration of natural ground elevations. Elevation profiles and vegetation transects were recorded. Species composition, percent cover, height, and vegetation biomass were measured in both restored and control areas. A major factor affecting success of natural profile restoration was amount of organic accumulation on dikes and in ditches. After one growing season, filled ditches had similar vegetation height and percent cover and greater living biomass, compared to natural marsh and old field areas.

163. Carlson, J. R. 1979. Streamside revegetation. U.S. Soil Conserv. Surv. Tech. Notes 55. 9 pp.

Response: VEG, SOIL, WQUAL

Genus: *Acer, Agropyron, Amelanchier, Cornus, Corylus, Festuca, Lotus, Rosa, Salix, Spiraea, Symphoricarpos, Trifolium*

Provides specific information for revegetating streambanks in the Pacific Northwest. Revegetation costs generally do not exceed one-tenth the cost of equivalent protection by riprap. Erosion control efforts are best suited to meandering streams heavily affected by human activities. Success of a revegetation effort requires fitting vegetative treatment to stream hydraulic conditions, and managing the stream corridor for fish and wildlife habitat, human use, and aesthetics. The specifications of a revegetation project are based on site conditions and design criteria that consider plant adaptations and erosion control characteristics, fish and wildlife habitat, hydraulic limitations of revegetation, and effective implementation and maintenance.

164. Carlson, P. 1972. Patterns of succession on spoil islands: a summary report. New College, Sarasota, Fla. 114 pp.

Response: INVERT, MAMMALS, NGBIRDS, SHOREB, VEG, HUSE, SOIL, CHEM, WQUAL

Genus: *Avicennia, Baccharis, Batis, Borrichia, Cakile, Casuarina, Heliotropium, Ipomoea, Paspalum, Salicornia, Scirpus, Sesuvium, Spartina, Sporobolus*, many

Discusses succession of plant and animal communities on spoil islands along the west coast of Florida. Plant species composition, arthropod populations, and physico-chemical parameters of the soil were sampled along transects across the islands. Variables other than age, for example, distance from shore and the physiography of the islands, were found to be important in colonization and succession. The islands are used regularly by many species of birds because of the diversity of suitable feeding and breeding habitats. Presents recommendations regarding management of spoil islands toward conservation and recreational uses.

165. Carlton, J. M. 1974. Land-building and stabilization by mangroves. Environ. Conserv. 1(4):285–294.

Response: VEG, SOIL

Genus: *Avicennia, Laguncularia, Rhizophora*

Provides an overview of mangroves in terms of their use for land-building and shoreline stabilization, particularly at several

sites along the Florida coast. An overview of planting methods and case studies generated the following: mangrove seedlings raised in the lab can later be successfully planted in the field, larger (1–5 m) mangroves have the best survival rate as transplants, black mangroves (*Avicennia germinans*) are more tolerant of cold temperatures and disturbed substrate than red mangroves (*Rhizophora mangle*) and also produce pneumatophores more rapidly and thus may be the more useful species, and mangroves can be useful for substrate stabilization (e.g., with planned filling and seawall construction projects).

166. Carlton, J. M., and M. D. Moffler. 1978. Propagation of mangroves by air-layering. Environ. Conserv. 5:147–150.

Response: VEG, ECON

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the technique of air-layering as another approach to revegetating coastal areas with mangroves. The experiment was conducted in Fort Desoto County Park, Pinellas County, Florida. The technique involves girdling of a mangrove branch (less than 2.5 cm diameter in this study), covering the cut with sphagnum moss soaked in distilled water, and wrapping with aluminum foil. Root growth was observed 5–16 months later. Preliminary information indicated that air-layering may be an effective and economical technique for restoring mangroves.

167. Carlton, J. M., and Z. Williams. 1980. Vegetation establishment—Fontainbleau State Park, Louisiana. Pages 63–80 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Panicum, Phragmites, Rosa, Ruppia, Spartina, Tamarix, Vallisneria*

This demonstration project focused on two methods for preventing shoreline erosion along Lake Pontchartrain, Louisiana. The first method included various structures—revetments, breakwaters, concrete structures, and a brush dike. The second method consisted of vegetative plantings with and without fertilization in the intertidal and upper beach areas. Average survival rates were 22. 6% For the intertidal planting zone and 6.4% For the upper beach planting zone. Estimated cost of planting (including fertilizer) was about $4/foot. Several factors—environmental conditions, condition of plant materials, and offshore structures—were discussed in terms of their effects on vegetative establishment.

168. Carson, J. D. 1982. Progress report of a reclaimed wetland on phosphate mined land in central Florida. Pages 243–250 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, FISH, REPT, NGBIRDS, MAMMALS, VEG

Genus: *Acer, Carya, Cephalanthus, Fraxinus, Liquidambar, Nyssa, Persea, Pinus, Platanus, Quercus, Sabal, Salix, Scirpus, Taxodium*

Documents the reclamation of a wetland on phosphate mined land in Polk County, Florida. The reclaimed area was backfilled and graded and received surface soil from other wetlands (source of seeds and root material). The site is being monitored for revegetation success. So far, the topsoiled areas have 100% ground cover, whereas areas that did not receive topsoil are being invaded by wetland species. One third of the area was topsoiled and one third was planted with rye for temporary cover while wetland species invaded. Fifteen species of trees were planted. Sod was used for erosion control. The area is being used by a variety of wildlife species.

169. Catchpole, C. K., and C. F. Tydeman. 1975. Gravel pits as new wetland habitats for the conservation of breeding bird communities. Biol. Conserv. 8:47–59.

Response: WFOWL, NGBIRDS, SHOREB

Genus: *Carex, Crataegus, Epilobium, Glyceria, Juncus, Phalaris, Phragmites, Rubus, Salix, Typha, Urtica*

Discusses the use of gravel pit wetland habitats by breeding bird communities in Great Britain. Most gravel pits are in urban or agricultural environments and contain a variety of aquatic, marshland, and terrestrial habitats. Breeding bird communities contain a wide variety of species, often at high breeding densities. At least three species of wetland birds have expanded their breeding habitat within Great Britain because of the presence of gravel pits.

170. C. E. Maguire, Inc. 1985. Wetland replacement evaluation. U.S. Army Corps Eng., Norfolk, Va. 186 pp.

Response: VEG, SUCCESS

Genus: *Acer, Chamaecyparis, Distichlis, Fraxinus, Iva, Nyssa, Phragmites, Scirpus, Setaria, Spartina, Taxodium, Typha,* many

Evaluates the success of 32 replacement wetlands in Virginia created as a result of compliance with Section 404 permit conditions. Data for each site included wetland area and classification, vegetation cover characterization, observed fauna, mitigation status, comments concerning compliance with permit conditions, and effectiveness of mitigation activities. Of the 19 sites completed, mitigation was judged successful at 9 sites, likely to be successful with time at 4 sites, and only partially successful at 6 sites. Primary factors associated with successful wetland ereation included proper grading, slope, and erosion control. Factors contributing to poor success included poor site preparation and careless transplanting-sprigging practices.

171. CH2M Hill. 1981. Feasibility of using geothermal effluents for waterfowl wetlands. U.S. Fish Wildl. Serv., FWS/OBS-81/44. 236 pp.

Response: WFOWL, VEG, CHEM, WQUAL, ECON

Genus: Many

Describes the use of geothermal effluent water to create wetlands at 206 sites in 7 States. Evaluation criteria included land-use suitability, topography, groundwater contamination potential, and waterfowl use potential. Sites with the highest potential were the Beaverhead area of Montana, the Camas area of Idaho, and the Nye area of Nevada. Discusses wetland processing of water from geothermal facilities and legal and institutional factors affecting wetland development.

172. Chabreck, R. H. 1980. Effects of marsh impoundments on coastal fish and wildlife resources. Pages 1–16 *in* P. L. Fore and R. D. Peterson, eds. Proceedings of the Gulf of Mexico coastal ecosystems workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/30.

Response: FISH, SHELLF, MAMMALS, WFOWL, SHOREB, REPT

Genus: *Cyperus, Echinochloa, Eleocharis, Hydrocotyle, Panicum, Ruppia, Sagittaria, Scirpus, Sesuvium*

Presents an overview of fish and wildlife use of various types of coastal marsh impoundments. Marsh impoundments were catagorized into three types: permanently flooded with fresh water, manipulated fresh water, and permanently flooded with brackish water. Summarizes the habitat requirements of fish and wildlife for each type of impoundment and for various species groups: waterfowl, rails, wading birds, fur animals, alligators, freshwater fishes, estuarine fishes, and crawfishes. The effects of impoundments on fish and wildlife vary with the resources involved and the type of impoundment.

173. Chabreck, R. H. 1967. Weirs, plugs and artificial potholes for the management of wildlife in coastal marshes. Pages 178–192 *in* J. D. Newsom, ed. Proceedings of the Marsh and Estuary Management Symposium, Louisiana State University, Baton Rouge.

Response: MAMMALS, WFOWL, REPT, VEG, HYDRO, WQUAL, ECON

Genus: *Ceratophyllum, Eleocharis, Juncus, Najas, Potamogeton, Ruppia, Scirpus, Spartina*

Presents a brief overview of the use of weirs, plugs, and artificial potholes to improve coastal marsh habitat for wildlife (primarily waterfowl) of the southeastern United States. Weirs and plugs were used in marshes to regulate water levels, control salinities, and minimize turbidity to promote the production of aquatic vegetation. Potholes and ditches were constructed in marshes to create permanent water areas and to open up dense vegetation. Summarizes results of studies, primarily in Louisiana, that demonstrated the effectiveness of these techniques. Includes a few examples of construction methods and costs.

174. Chabreck, R. H. 1979. Revegetation program for pipeline construction areas in certain Texas and Louisiana wetlands. Transcontinental Gas Pipe Line Corp., Houston, Tex. 28 pp.

Response: VEG

Genus: *Acnida, Aster, Bacopa, Batis, Cyperus, Distichlis, Echinochloa, Eclipta, Eleocharis, Heliotropium, Leptochloa, Limonium, Monanthochloe, Paspalum, Pluchea, Salicornia, Scirpus, Sesuvium, Spartina, Suaeda*

Discusses a wetland revegetation program for portions of the Galveston-High Island pipeline project in Texas and Louisiana. Both the single-ditch and double-ditch methods were used to bury the pipeline. Topsoil was replaced after ditches were backfilled. Sprigs of salt grass (*Distichlis*) and two cordgrass (*Spartina*) species were planted on test plots. After two growing seasons, natural revegetation cover was complete in low salt marsh areas and less than 50% complete in high salt marsh areas. Plantings showed good survival and growth, particularly in brackish marsh areas; however, natural revegetation took place at even greater rates. The double-ditch method produced slightly greater revegetation rates than the single-ditch method.

175. Chabreck, R. H., and C. M. Hoffpauir. 1962. The use of weirs in coastal marsh management in Louisiana. Proc. Southeast. Assoc. Game Fish Comm. Annu. Conf. 16:103–112.

Response: VEG

Genus: *Ceratophyllum, Cyperus, Eleocharis, Juncus, Panicum, Ruppia, Scirpus, Spartina*

This study was conducted to evaluate the effects of weir construction in two areas: Marsh Island Wildlife Refuge, between Vermilion and Cote Blanc bays on the Gulf Coast, and a privately owned area north of Lake Felicity in Terrebonne and Lafourche parishes, Louisiana. Ninety ponds were sampled for vegetation; 53 were behind wiers and 37 were unmanaged (controls). Discusses vegetative growth, salinity, turbidity, water levels, and tidal action. The greatest effect of weir construction was water level stabilization.

176. Chaimson, J. F. 1984. Riparian vegetation planting for flood control. Pages 120–123 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkley. Calif. Water Resour. Rep. 55.

Response: VEG

Genus: *Populus, Salix*

Describes a plan to plant riparian vegetation for erosion control and sediment stabilization on the Murphy Slough, a section of the Sacramento River near Chico, California. The plan included grading the riverside to a 3:1 or 4:1 slope to prevent rain-caused gullying, planting a mixture of bermuda and rye grasses (*Lolium*) on the slope face, and planting willow (*Salix*) and *Populus* on the lower slope in fall. High water washed out most of the planted lower slope. This will be corrected by replanting and using an irrigation system to enhance growth for greater bank stabilization and protection from floods.

177. Chamberlain, R. 1982. Methods used to evaluate fish utilization of a salt marsh restoration site in Humboldt Bay, California. Page 97 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: FISH

Genus: None

Evaluates fish use of a restored salt marsh adjacent to freshwater slough, Humboldt Bay, California. A 6.5-ha (16-acre) pasture was returned to tidal flushing by a dike breach. Samples taken from drop traps and seines indicated that the dominant fish was the threespine stickleback (*Gasterosteus aculeatus*). The channel through the dike breach was also sampled for fish and for physio-chemical and water flow characteristics. Other fish included staghorn sculpin, juvenile arrow (*Clevelandia ios*) and tidewater gobies (*Eucyclogobius newberry*), topsmelts (*Atherinops affinis*), and various osmerids.

178. Chan, E. 1982. Regional wetlands plan for urban runoff treatment, case study of marsh planning, design and creation: Hayward shoreline marsh—Phase II. Assoc. Bay Area Gov., San Francisco, Calif., Water Qual. Tech. Memo. 92. 16 pp.

Response: None

Genus: *Myriophyllum, Potamogeton, Ruppia, Salicornia, Scirpus, Typha*

Discusses plans for design and creation of the second phase of the Hayward shoreline marsh, San Francisco Bay, California. The second phase involves restoration of 62.8 ha (155 acres) of land to fresh and brackish marshes, using existing and newly-created channels and dikes to form a five-basin marsh system. A separate 8-ha (20-acre) pickelweed marsh was set aside as a preserve for the endangered salt marsh harvest mouse. Four areas are delineated for specific management and operation considerations: water quality, mosquito vector control, botulism management, and vegetation management. Fresh water input to the system will be secondary-treated effluent from a treatment plant. Management plans and costs are presented for the various features of the marsh creation.

179. Chaney, A. H., B. R. Chapman, J. P. Karges, D. A. Nelson, R. R. Schmidt, and L. C. Thebeau. 1978. The use of dredged material islands by colonial seabirds and wading birds in Texas. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-8. 238 pp.

Response: SHOREB, VEG, SOIL

Genus: *Ambrosia, Andropogon, Baccharis, Borrichia, Chloris, Eleocharis, Iva, Opuntia, Paspalum, Prosopis, Salicornia, Sophora, Spartina, Sporobolus, Tamarix, Typha*, many

Discusses the use of dredged material islands by nesting colonial seabirds and wading birds in the Galveston-Houston area and upper Laguna Madre near Corpus Christi, Texas. Approximately 60% of the nesting pairs along the Texas gulf coast use dredged material islands for nest sites. Nesting succesion of birds was closely related to succession of vegetation from bare substrate to shrubs or trees. Generally, terns and skimmers preferred bare to sparse forbs; gulls, herons, egrets, ibises, spoonbills, and cormorants preferred dense forbs to dense shrubs and trees. Discusses vegetation, soils and substrates, bird use, predation, and human use of 34 dredged material islands.

180. Chapman, R. J., T. M. Hinckley, L. C. Lee, and R. O. Teskey. 1982. Impact of water level changes on woody riparian and wetland communities, Vol. X: Index and appendum to Volumes I-VIII. U.S. Fish Wildl. Serv., FWS/OBS-82/23. 111 pp.

Response: VEG

Genus: Many

Provides the user with a summary and a general reference document for Vols. I–VIII of the U.S. Fish and Wildlife Service series on effect of water level changes on woody riparian and wetland communities. Topics in this volume include literature updates for Vols. I–VIII; a comprehensive species index to the volumes, including ecoregion and tolerance rating; and a brief discussion of site rehabilitation, which provides a framework by which damage can be assessed, the rate of recovery estimated, and the need for management determined. The reader also is referred to other volumes in this series for making the necessary decisions regarding integration of essential steps for wetland rehabilitation.

181. Chironis, N. P. 1982. Reedgrass greens slurry ponds. Coal Age (April):86–91.

Response: VEG

Genus: *Phragmites*

Describes the use of common reed (*Phragmites australis*) for cover and stabilization of coal slurry impoundments and ponds. The study site was at Monterey coal slurry impoundment in Illinois. Without using topsoil, 1.8- to 2.4-m (6- to 8-feet) rhizomes were collected from nearby impoundments and planted and fertilized in rows 4.6 m (15 feet) apart. After three growing seasons, shoot height was 1.8 m (6 feet) in favorable locations, with stem densities reaching 130/square yards. Most areas had an aboveground dry weight biomass of more than 2. 7 tons/acre. Growth continued despite high acidity, conductivity, and concentrations of soluble iron, manganese, and aluminum in the substrate.

182. Chmura, G., and L. Steere. 1981. Sod removal, replacement tried in tidal marsh restoration (Rhode Island). Restoration Manage. Notes 1(1):15.

Response: VEG, SOIL

Genus: *Distichlis, Spartina*

Discusses attempts to restore a tidal marsh in Barrington, Rhode Island, by replacing the original peat excavated from the marsh surface during sewer construction. The marsh consisted of high marsh vegetation (e.g., cordgrass [*Spartina*] and seashore saltgrass [*Distichlis spicata*]) along the banks of the tidal creek. An area of approximately 15 × 15 m (50 × 50 feet), bisected by a small tidal creek, was disturbed. An excavator was used to strip blocks of peat from the area. The blocks varied from .3 to .4 m^2 (3 to 4 square feet), with a minimum thickness of 15 cm (6 inches) to ensure inclusion of viable rhizomes. Blocks were stored on site from mid-April to mid-July and replaced by a backhoe. Some new growth was noted during fall and monitoring of the site will continue through the next year.

183. Chongxin (Chung-Hsn Chung), Z., Z. Rhongzong, Z. Hungbin, Y. Kuanghan, et al. 1985. Experiments of trial plantings of *Spartina anglica* Hubbard and effects of saline soil amelioration in China. Pages 44–82 *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing Univ., China. (English abstract)

Response: VEG, SOIL, CHEM

Genus: *Medicago, Sesbania, Spartina*

Presents results of trial *Spartina anglica* plantings and amelioration of saline soil experiments conducted at the Nanjing University and Taizhou Institute of Agriculture, Zhejiang Province, China. In general, cordgrass (*Spartina*) plantings in riverine, marsh, and coastal lands have been successful with the exception of open coasts with high wave energy. A single, small rhizome produced more than 9 million sprigs in less than 2.5 years. Optimum planting elevation, season, and spacing are discussed. Increase of organic matter in *Spartina* marsh soil promoted formation of greater granular structure of soil.

184. Christensen, B. A., K. Erickson, and J. Dorman. 1983. Niles channel restoration project: hydraulic model tests evaluating restored and recently revegetated beds exposed to erosion caused by tidal currents. Univ. Fla., Gainesville, Rep. 8301. 17 pp.

Response: VEG, HYDRO, SOIL

Genus: None

Describes a laboratory model that evaluated the resistance of newly revegetated seagrass areas to tidal erosion in the Niles restoration project near Cudjoe Key in the Florida Keys. The usefulness of dikes for protecting planted seagrasses was studied. Dikes affect the size of the ripple area and amount of scouring and erosion around a restored seagrass bed. Presents an equation for estimating necessary dike length to protect the seagrasses. Experimental test plants with 15- to 30-cm (6- to 12-inch) runners were stabilized wtih steel staples. Equations describe the velocity of the currents, average bed roughness, and average bed shear stress of a revegetated sand bed.

185. Christensen, B. A., and D. Tackney. 1984. Anchoring stability of new seagrass plantings. Pages 60–75 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Halodule*

Describes the vegetative establishment of *Halodule* in shallow coastal waters near Cudjoe Key in the Florida Keys. After bottom elevation was restored, shoalweed (*Halodule*) runners were planted 0.5–1.0 m apart. Steel staples or other anchoring

devices were used. Newly vegetated beds exhibit lower resistence to water flow and often fail because of massive erosion of the sandy bottom or uprooting of runners. Describes methods for quantifying the effect of flow on the plant bed, in conjunction with results from lab testing.

186. Christiansen, J. E., and J. B. Low. 1970. Water requirements of waterfowl marshlands in northern Utah. Utah Div. Fish Game Publ. 69–12. 108 pp.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Distichlis, Hordeum, Polypogon, Potamogeton, Scirpus, Typha*

Determines amounts of water required to maintain productive marshlands near the Great Salt Lake in Utah, and salt tolerance of several marsh plant species. Describes equations used to calculate evapotranspiration from inflow-outflow data. Salt tolerance tests indicated that germination, growth, and seed and tuber production of cattail (*Typha*), tule bulrush (*Scirpus acutus*) and alkali bulrush (*S. maritimus*) decreased as salinity increased. Cattail and bulrush exhibited the best growth in fresh water; sago pondweed (*Potamogeton pectinatus*) grew better in slightly saline conditions. Includes several suggestions for water management of the marshlands.

187. Chung, C. H. 1982. Low marshes, China. Pages 131–145 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: WFOWL, VEG, SOIL

Genus: *Phragmites, Spartina, Suaeda*

Discusses the low marshes of China, including marsh values and habitat loss. *Spartina anglica* is described as the most useful plant for revegetating marshes. Describes revegetation techniques, as are factors controlling success or failure. The physiography of planting sites, tide, waves, wind, drought, temperature, human activities, and animals may all play a role in the success rate of planted materials. Habitat values of these revegetated communities include waterfowl habitat, animal fodder, pasture, aquaculture, green manure, amelioration of saline soil, and coastline stabilization.

188. Churchill, A. C., A. E. Cok, and M. I. Riner. 1978. Stabilization of subtidal sediments by the transplantation of the seagrass *Zostera marina* L. Adelphi Univ. Sea Grant Prog. N.Y., Rep. Ser. RS-78-15. 48 pp.

Response: VEG, SOIL, ECON

Genus: *Zostera*

Describes an experiment to transplant common eelgrass (*Zostera marina*) on Sand Hill, a dredged spoil island off the coast of Long Island, New York, to determine its effectiveness in preventing erosion. Transplants were obtained from Fire Island and were planted at the study site the same day. Three transplant techniques were used: single shoot treated with rooting hormone, single shoots treated with slow release fertilizer and miniplugs with no treatment. Documents transplant survival and growth for each treatment. The addition of fertilizer did not significantly enhance the growth of shoots and rhizomes. Total cost for planting 1,655 plants (0.41 ha) was $12,775. Includes a section on flower and seed production.

189. Clairain, E. J., R. A. Cole, R. J. Diaz, A. W. Ford, R. T. Huffman, L. J. Hunt, and B. R. Wells. 1978. Habitat development field investigations, Miller Sands Marsh and upland habitat development site, Columbia River, Oregon; summary report. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-38. 76 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Alisma, Ammophila, Carex, Deschampsia, Eleocharis, Iris, Juncus, Sagittaria, Salix, Scirpus*

Summarizes progress at the Miller Sands Marsh and upland habitat development site (Columbia River, Oregon), one of seven experimental projects for examining the feasibility of using dredged material for development of fish and wildlife habitat. Selected plant species were planted on intertidal and upland areas; responses to tidal inundation, fertilization, wildlife use, planting methods, and invasion by other plant species were noted. Plantings generally were successful, but the wildlife habitat provided by intertidal and upland plantings had not yet significantly affected wildlife populations. Notes some food-nesting preferences of birds and small mammals.

190. Clark, J. R. 1986. Assessment for wetlands restoration. Pages 250–253 *in* J. A. Kusler and P. Riexinger, eds. Proceedings of the national wetland assessment symposium. Association of State Wetland Managers, Chester, Vt.

Response: SUCCESS

Genus: None

Presents an overview of wetland restoration, including policy, assessment approaches, and wilderness versus utility (or economic) wetlands. Assessment of wetlands involves more than simple classification or evaluation; wetland functions and relations to surrounding systems must be considered. Wilderness wetlands are those that should be preserved in their historic condition. Considers utility wetlands as an economic resource to be rehabilitated or replaced as appropriate to meet regional wetland priorites for natural goods and services. Through the processing of U.S. Army Corps of Engineers dredge and fill permits, opportunities exist for conducting demand-oriented strategic wetland restoration programs.

191. Clay, D. H. 1984. High mountain meadow restoration. Pages 477–479 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep 55. University of California Press, Berkley.

Response: VEG, SOIL, ECON, SUCCESS

Genus: *Salix*

Describes an experiment to repair stream erosion and eventually restore meadow vegetation in a creek in Modoc County, California. Procedures for the restoration process were as follows: constructing 3.3-m × 1-m slots in the bank using a backhoe or bulldozer, depositing large rocks into the slots to form a sill across the stream channel, placing excavated soil upstream of the sill to prevent water from passing through the rock, constructing low earth fills and spillways to prevent overland flow, planting vegetation on the sills, and fencing the area to prevent livestock damage. Costs for installation were $700–1,000. Results after 2–3 years include the raising of the channel bottom 0.7–1 m and subsequent raising of the water table, possibly to original elevations. Eroded channels are filled and bank slopes are gradual and covered with vegetation.

192. Clewell, A. F. 1981. Vegetational restoration techniques on reclaimed phosphate strip mines in Florida. Wetlands 1:158–170.

Response: VEG, ECON

Genus: *Azolla, Baccharis, Eichhornia, Fraxinus, Hydrilla, Lemna, Myrica, Najas, Nyssa, Quercus, Salix, Salvinia, Spirodela, Taxodium, Typha*, many

Provides an overview of techniques for restoring wetlands on reclaimed phosphate mines in Florida. Describes marsh creation as the most successful effort; describes specific examples. Discusses advantages and disadvantages of extensive mulching. Compares and contrasts four swamp restoration techniques: planting of tree seedlings, transplanting of saplings from natural swamps, mulching, and natural colonization. Considers economic factors for all methods.

193. Clewell, A. F. 1983. Riverine forest restoration efforts on reclaimed mines at Brewster Phosphates, central Florida. Pages 122–133 *in* D. J. Robertson ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow, Fla.

Response: VEG, SUCCESS

Genus: *Acer, Carya, Celtis, Cornus, Echinochloa, Liquidambar, Nyssa, Panicum, Quercus, Rhynchospora, Salix, Taxodium*, many

Discusses development of methods for the restoration of forested wetlands at two phosphate mines in Hillsborough and Polk counties, Florida. Inventories of natural forests and natural plant colonization on disturbed lands were conducted, as well as various seeding and planting experiments. Based on data collected for plots up to 3 years old. Successful restoration will be dependent on using a combination of techniques, including mulching with riverine topsoil. The first few years will require irrigation, unless near-saturated soils can be maintained through dry seasons. Both planting and seeding of trees should be attempted to ensure a dense initial growth. Canopy will begin to close within 4–5 years, protecting the preferred undergrowth species transferred in the mulch.

194. Coastal Zone Resources Corporation. 1976. Identification of relevant criteria and survey of potential application sites for artificial habitat creation. Vol. II. Survey of potential application situations and description of optimum project areas. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Contract Rep. D-76-2. 348 pp.

Response: SOIL

Genus: None

Describes a detailed evaluation process that applies marsh-island creation criteria for screening potential sites for development. Two general criteria were employed to alleviate the complexities of screening 3,000 sites: the project must require maintenance work, and the work must be performed by a hydraulic pipeline dredge. Each site was described on the basis of dredged material characteristics, public and private controls over the land, cost-benefit features, public attitudes, climatology, hydrology, and hydrography. As a result of the selection process, 10 optimum project sites were chosen, 2 in each geographical region. Extensive data analysis was conducted on data gathered from the project areas and from U.S. Army Corps of Engineer Districts.

195. Coastal Zone Resources Corporation. 1976. Identification of relevant criteria and survey of potential application sites for artificial habitat creation. Vol. I. Relevant criteria for marsh-island site selection and their application. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Contract Rep. D-76-2. 173 pp.

Response: HUSE, SOIL, ECON

Genus: *Aster, Borrichia, Hibiscus, Juncus, Myrica, Pluchea, Sagittaria, Salicornia, Scirpus, Spartina, Zizania*, many

Describes the environmental requirements for creating marsh-island complexes with dredged material and examines sites available for dredged material deposit. Numerous river and estuarine areas along the United States coast were evaluated for tide-elevation interactions, salinity, soil nutrients, soil physical variation, public acceptance, and the energy-sediment-climate of the site. These criteria were tested in the field to select 10 optimum riverine/estuarine areas in 5 geographical regions. Results of the selection provided 50 project areas for further detailed analyses.

196. Coastal Zone Resources Corporation. 1977. A comprehensive study of successional patterns of plants and animals at upland disposal areas. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Contract Rep. D-77-2. 489 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, SOIL

Genus: *Acer, Ammophila, Amorpha, Carex, Cyperus, Distichlis, Equisetum, Fraxinus, Juncus, Panicum, Paspalum, Phragmites, Populus, Quercus, Rhus, Robinia, Salicornia, Salix, Scirpus, Spartina, Taxodium, Typha*, many

Examines plant and animal successional patterns at five dredged material disposal sites: Nott Island in the Connecticut River; six islands in Hillsborough Bay near Tampa, Florida; an area along the Whiskey Bay pilot channel, Atchafalaya River basin, Louisiana; an area along the Gulf Intracoastal Waterway near Galveston, Texas; and Mott Island in the Columbia River near Astoria, Oregon. Descriptions of each site include a history of the disposal area, physical characteristics (topography, soils, microclimate), biological characteristics (existing vegetation and animal populations, past and future patterns of succession), and potential resources of regional upland disposal areas.

197. Colenbrander, H. J. 1978. The rational management of hydrological systems. Pages 363–390 *in* M. W. Holdgate and M. J. Woodman, eds. The breakdown and restoration of ecosystems. Plenum Press, New York.

Response: None

Genus: None

Presents an overview of hydrological systems that need to be considered in water management projects. Topics include surface water systems (man-made channels and lakes), subsurface water systems (groundwater, soil moisture), and balancing of interests (e.g., preservation, agriculture, recreation). To arrive at rational water resources management, "social" problems are often more difficult to solve than physical and technical ones. Socio-economic models and a multilevel organizational hierarchy for decision making are necessary to achieve an optimal overall water management scheme.

198. Comes, R. D., and T. McCreary. 1986. Approaches to revegetate shorelines at Lake Wallula on the Columbia River, Washington-Oregon. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. E-86-2. 91 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Cornus, Deschampsia, Elaeagnus, Eleocharis, Juncus, Morus, Polygonum, Ribes, Robinia, Rosa, Sagittaria, Salix, Sambucus, Scirpus, Trifolium, Typha*

Describes a field study to determine the suitability of 29 plant species for use in reservoir shoreline revegetation projeets. Established three experimental sites: a subimpoundment (control pool) in MeNary Wildlife Park on the Columbia River, Oregon; a protected mudflat on the river; and an exposed sandy beach on the river. Deseribes plant performance for eaeh species. On the natural shoreline sites, softstem bulrush (*Scirpus validus*) was the only consistent survivor. On the control area, where water fluctuations were controlled, *Salix fragilis*, *S. purpurea*, *Eleocharis coloradoensis*, slough sedge (*Carex obnupta*), and beaked sedge (*C. rostrata*) were the most successful speeies.

199. Connell, J. H., and R. O. Slatyer. 1977. Mechanisms of succession in natural communities and their role in community stability and organization. Am. Nat. 111(982):1119–1144.

Response: VEG

Genus: Many

Describes several aspeets of plant succession on disturbed sites. Describes mechanisms of succession along with several models: a facilitation model—earlier species prepare the ground, rendering it suitable for later species; a tolerance model—predictable sequences are produced by species that have different "strategies" for exploiting a site's resources; and an inhibition model—species resist invasion of competitors; early species preempt the site and will inhibit growth of competitors until the early species die or are damaged.

200. Connelly, D. P. 1979. Propagation of seleeted native marsh plants in the San Joaquin valley. Calif. Dep. Fish Game, Sacramento, Wildl. Manage. Leafl. 15. 13 pp.

Response: WFOWL, VEG

Genus: *Aster, Eleocharis, Montia, Paspalum, Polygonum, Rumex, Scirpus*

Diseusses propagation and management of six marsh plant species benefieial to dabbling ducks of the San Joaquin valley, California. Information includes optimal soil depth and temperatures for germination, reduetion of plant competition, survival, maximum waterfowl use, and other benefits of planting these species (e.g., cattail control, creation of favorable aquatie invertebrate habitat). The author stresses that any marsh program should incorporate a mixture of plants to provide diversified habitat and optimal conditions for long-term waterfowl use.

201. Conservation Consultants, Inc. 1979. Wetland reclamation pilot study for W.R. Grace & Company. Annual Report for 1978. Conservation Consultants, Inc., Palmetto, Fla. 56 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Acer, Cornus, Cyperus, Echinochloa, Eleocharis, Ilex, Juncus, Magnolia, Nyssa, Panicum, Polygonum, Sagittaria, Taxodium*, many

Discusses a baseline study of two marshes in Manatee County, Florida, and construction and 1-year monitoring of four pilot-scale wetlands in Hillsborough County, Florida. Four small depressions were constueted on a site containing trace amounts of phosphates. One site was used as a control, one was planted with marsh plants from a nearby natural marsh, one received only a layer of organic marsh material, and the last was planted with trees. Phosphate levels in artificial wetlands were higher, partly because fertilization of surrounding grassland. The mulched marsh showed the greatest diversity of plants, however, continued monitoring is necessary to determine all effects of treatments.

202. Cook, A. H., and C. F. Powers. 1965. Early biochemical ehanges in the soils and waters of artificially created marshes in New York. J. N.Y. Fish Game. 5(1):9–65.

Response: VEG, SOIL, WQUAL, CHEM, HYDRO

Genus: *Anacharis, Bidens, Cyperus, Eleocharis, Eragrostis, Leersia, Lemna, Potamogeton, Sparganium, Typha, Wolffia*, many

Describes a 2-year study of artifieially created marshes in central New York: Swartwood Marsh, West Danby, a 6-ha (15-aere) artifieial impoundment; Future Farmers of America Marsh, Spencer, flooded in 1954; and Howland's Island Game Management Area, near Port Byron in the Seneca River, study site ponds flooded in 1934. Evaluates water quality and changes in marsh soil chemistry following flooding or drainage. Diseusses thermal and chemical stratification of the water, vegetative conditions before and after drainage, fertilization, liming, effects of water level fluctuations, and marsh management.

203. Cooper, C. O., and T. A. Wesche. 1976. Stream ehannel modification to enhance trout habitat under low flow conditions. Univ. Wyo. Water Resour. Res. Inst. Ser. 58. 107 pp.

Response: FISH, VEG, CHEM, WQUAL, ECON

Genus: *Artemisia, Carex, Pinus, Salix*

Provides a method for enhancing stream habitat by flow manipulation on Douglas Creek, Albany and Carbon counties, Wyoming. The stream channel was altered by installing a 1-m (4-feet) parshall flume just downstream of the study area. A gauging station obtained data on discharge rates and channel flows. Artificial overhangs with attached willow (*Salix*) and low-profile gabion structures were installed on the stream bank. Flows >400 cfs were destructive to the vegetation, structures, and stream channel.

204. Cooper, D. J. 1988. Mountain wetland vegetation dynamics. Pages 23–25 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, teeh. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American west. Society of Wetland Scientists, Rocky Mountain Chapyter, Denver, Colo.

Response: VEG

Genus: *Betula, Calamagrostis, Carex, Salix*

Deseribes conditions in mountain wetlands found in basins and along streams and springs in the southern Rocky Mountains. Vegetation in these areas depends on microtopography of the wetland, nutrient input conditions from mire margin to mire expanse, and overall nutrient sources of the wetland along a poor-to-rich gradient. Restoration of these wetlands because of negative effects on these three gradients is discussed. Creation of these wetland types is considered to be extremely limited because the difficulty of creating necessary hydrologic conditions.

205. Cooper, D. J., and B. Smith. 1987. First annual report Chatfield Arboretum wetland creation project. Colorado School of Mines, Golden. 79 pp.

Response: VEG, HYDRO, SOIL

Genus: *Agrostis, Carex, Ceratophyllum, Eleocharis, Juncus, Persicaria, Sagittaria, Scirpus, Spartina, Typha*, many

Presents data on hydrology, soils, and plant communities 1 year after creation of the Chatfield Arboretum wetlands projeet, Jefferson County, Colorado. The wetlands were created as Corps of Engineers Section 404 permit mitigation for filling of 6.9 ha (17 acres) of wetlands at Massey Draw because of metro Denver C-470 highway construetion. Four depressions were excavated until the groundwater table was reaehed. Wetland soils from Massey Draw area were transplanted to the site. More than 70 plant species were present 1 year later. Low water table and coarse soils resulted in inadequate filling of depressions. Surface water flow will be necessary to provide adequate inundation for establishing proposed wetlands.

206. Cooper, J. W. 1986. An overview of estuarine habitat mitigation projects in Washington State. U.S. Fish Wildl. Serv., Olympia, Wash., Unpubl. Rep. 18 pp.

Response: None

Genus: *Salicornia*, *Zostera*

Presents an overview of estuarine habitat mitigation projects in Washington. Four techniques were commonly used: substrate modifieation, shoreline ereation, eelgrass (*Zostera*) transplantation, and marsh complex establishment. Most projects included baseline resource assessment and monitoring components. Fewer projects included contingency plans for potential courses of action in the event of suboptimal project performance or failure of the habitat. Speeific functional standards or success criteria were rarely pinpointed. Mitigation goals or objectives were rarely provided. A concerted effort to provide thorough mitigation plans must be undertaken to protect estuarine habitat. Critical site-specifie factors should be considered, including soils, hydrologic regime, proper contour grading and slopes, erosion control, and careful planting practices.

207. Cooper, P. F., and A. G. Boon. 1987. The use of phragmites for wastewater treatment by the root zone method: the UK approach. Pages 153–174 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: WQUAL, ECON

Genus: *Phragmites*, *Scirpus*, *Typha*

Describes the root zone method of wastewater treatment developed in West Germany and currently being evaluated in the United Kingdom for more than 30 pilot systems. The treatment process is based on bacterial activity in the rhizosphere of phragmites plants and typically consists of plants grown in a 0.6-m deep bed of soil or gravel, sloped at 2–8%, and fully sealed. The system is aesthetically acceptable, consists of a simple design with relatively low costs and low maintenance, and offers wildlife habitat. Presents preliminary suggestions for monitoring the program for the root zone beds.

208. Coss, R. D. 1977. Wildlife habitats provided by aquatic plant communities of surface mine lakes. M.S. thesis, Southern Illinois University, Carbondale. 103 pp.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, CHEM, WQUAL

Genus: *Alisma*, *Chara*, *Eleocharis*, *Jussiaea*, *Leersia*, *Najas*, *Phragmites*, *Potamogeton*, *Sagittaria*, *Scirpus*, *Typha*, many

Characterizes the aquatic plant communities of four surface mine lakes in Perry County, Illinois, and evaluates these communities as wildlife habitat. All lakes had water quality sufficient to support aquatie plants; *Chara* and *Potamogeton* were the dominant genera. Emergent plant communities developed at only one lake; cattle grazing and steep shorelines eurtailed growth at the other three lakes. Management recommendations for enhancing wildlife habitat by the creation of surface mine lakes included grading to develop topographic variation and to create ample littoral areas protected from wind and wave aetion and exclusion of cattle from portions of the shoreline.

209. Coultas, C. L. 1980. Transplanting needlerush. Pages 117–124 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conferenee on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Juncus*

Documents experimentation with transplanting and growth of needlerush (*Juncus roemerianus*). Plants were taken from a marsh at Wakulla Beaeh, Florida; rhizomes and leaves were eut into lengths averaging 6 and 20 cm, respectively. Four factors were examined in various combinations: rhizomes with or without terminal or lateral buds and planting with or without treatments of Rootone, a commercial growth regulator. After 6 months growth in the greenhouse, rhizomes with buds were larger and had more shoots and buds than rhizomes without buds. Rootone had a negative effect on plant growth.

210. Coultas, C. L., G. A. Breitenbeck, W. L. Kruczynski, and D. B. Subrahmanyam. 1978. Vegetative stabilization of dredge spoil in North Florida. J. Soil Water Conserv. 33(4):183–185.

Response: VEG, CHEM

Genus: *Ammophila*, *Baccharis*, *Iva*, *Myrica*, *Panicum*, *Parthenocissus*, *Paspalum*, *Spartina*, *Uniola*

This study was designed to determine the suitability of several grasses for the stabilization of sandy dredged material in supertidal areas of Dickerson Bay near Panancea, Florida. The effect of fertilizer on the growth of sea oats (*Uniola paniculata*), panie grass (*Panicum amarulum*), and American beaehgrass (*Ammophila arenaria*) was tested. Results indicated that these grasses were effective in stabilizing the spoil in the supertidal zone. Where the beach is exposed to high energy wave action, prior mechanical stabilization was necessary for the establishment of intertidal vegetation. Plants were treated with 112 kg/ha (100 lb/acre) of 10–10–10 fertilizer twice during the growing season. All plants benefited, but there was little advantage in applying 224 kg/ha (200 lb/acre) of fertilizer.

211. Courser, W. D., and R. R. Lewis. 1980. The use of marine revegetation for erosion control on the Palm River, Tampa, Florida. Pages 125–136 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Paspalum*, *Spartina*

Describes a revegetation project to control erosion along the Palm River, Tampa, Florida. Sixty meters of river bank were cleared and excavated; smooth cordgrass (*Spartina alterniflora*) and seashore paspalum (*Paspalum vaginatum*) were planted. After 7 months, *P. vaginatum* covered nearly 100% of the planted area. The *S. alterniflora* survival rate was about 20%; however, surviving plants were well established and spreading rapidly. Bahia sod was installed above these plantings and burlap was used to stabilize planted areas. Installation and plant material costs were about $123/m of shoreline; this

was compared to costs for erosion control using a sand-cement bag revetment (approximately $330/m of shoreline). Describes project area maintenance needs.

212. Cowell, E. B., and J. M. Baker. 1969. Recovery of a salt marsh in Pembrokeshire, South-west Wales, from pollution by crude oil. Biol. Conserv. 1(4):291–295.

Response: VEG

Genus: *Artemisia, Aster, Cochlearia, Enteromorpha, Festuca, Glaux, Halimione, Juncus, Limonium, Plantago, Puccinellia, Salicornia, Spartina, Spergularia, Suaeda, Triglochin, Ulothrix, Vaucheria*

Describes the recovery of vegetation at Bentlass salt marsh, near Pembroke, Southwest Wales, after a spill of 250, 000 kg of crude oil in the adjacent Milford Haven Bay on 13 January 1967. Frequency data collected in June 1966–68 indicated that some plant species were more affected by the spill than other species. In June 1967, *Suaeda maritima, Salicornia* sp., *Halimione portulacoides*, and filamentous green algae showed the greatest reduction in frequency; *Cochlearia* sp., seaside arrowgrass (*Triglochin maritima*), seashore alkaligrass (*Puccinellia maritima*), saltmeadow rush (*Juncus gerardi*), *Limonium humile*, and *Spartina townsendi* showed some reduction; and red fescue (*Festuca rubra*), *Plantago maritima, Armeria maritima, Artemisia maritima, Glaux maritima*, and *Spergularia* sp. were not significantly lower than prespill levels.

213. Cox, G.V., and E.B. Cowell. 1979. Mitigating oil spill damage—ecologically responsible clean-up. Pages 121–128 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: None

Genus: *Avicennia, Juncus, Laguncularia, Puccinellia, Rhizophora, Spartina*

Presents an overview of clean-up techniques for mitigating oil spill damage in various wetland types. Techniques include using booms and skimmers, applying solvent-based dispersants, cleaning shores with high pressure waterjets, bulldozing sandy beaches, burning marsh vegetation, and cutting and removing vegetation. The authors urge development of contingency plans before oil spill events for the most effective mitigation of damage.

214. Craft, C. E., S. W. Broome, and E. D. Seneca. 1988. The role of transplanted marshes in processing nitrogen, phosphorus and organic carbon in estuarine waters. Pages 327–332 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, CHEM

Genus: *Spartina*

Compares nitrogen, phosphorus, and organic carbon fluxes between an irregularly flooded transplanted cordgrass (*Spartina*) marsh (established the first year of monitoring) and the Pamlico River estuary, North Carolina. Concentrations of dissolved organic carbon were significantly higher in waters flowing out of the transplanted marsh. Concentrations of dissolved organic nitrogen were higher, although not significantly, in waters flowing out of the transplanted marsh. In contrast, ammonium and phosphates were significantly higher in estuarine water pumped into the marsh. Transplanted marshes serve as sources of dissolved organic materials and as sinks for particulates and inorganic nutrients. The productivity of transplanted marshes seems to be sustained, in part, by external inputs of nitrogen and phosphorous in estuarine waters.

215. Craig, R. M. 1984. Plants for coastal dunes of the Gulf and south Atlantic coasts and Puerto Rico. U.S. Soil Conserv. Surv., Agric. Inf. Bull. 460. 41 pp.

Response: None

Genus: *Canavalia, Cassia, Casuarina, Cenchrus, Chrysobalanus, Coccoloba, Cocos, Conocarpus, Croton, Cynodon, Dalbergia, Distichlis, Ernodea, Eustachys, Gaillardia, Helianthus, Hydrocotyle, Ilex, Ipomoea, Iva, Lantana, Myrica, Opuntia, Panicum, Paspalum, Prunus, Quercus, Sabal, Scaevola, Schizachyrium, Serenoa, Sesuvium, Spartina, Sporobolus, Stenotaphrum, Suriana, Tournefortia, Uniola, Yucca*

Discusses revegetation of coastal dunes along the Gulf and south Atlantic coasts and Puerto Rico. The section on planning includes a brief discussion of walkways, sand-trapping devices, and surface mulch. Descriptions of individual species of grasses (13 species), other herbaceous plants (9 species), trees (11 species), and shrubs (10 species) include recommended propagation techniques.

216. Crandall, M. E., and J. L. Lindsey. 1981. Establishment of controlled freshwater diversions of the Mississippi River into the Louisiana coastal zone. Pages 139–146 in R. D. Cross and D. L. Williams, eds. Proceedings of the national symposium on freshwater inflow to estuaries. U.S. Fish Wildl. Serv., FWS/OBS-81/04.

Response: FISH

Genus: None

Provides an overview of the Louisiana coastal program and how this program, which started in the 1970's, led to the development of guidelines for regulating the deterioration of coastal wetlands. Solutions included establishing and implementing guidelines designed to restore or mimic the natural processes of the wetlands. A potential exists for increasing wetland areas by using freshwater sites to divert water and sediment to the problem areas. A small scale project in the St. Bernard parish was dredged in the early 1960's and resulted in increased salinity and erosion levels. The restoration effort included the construction of a siphon to deliver fresh water from February-March, the period of traditional overbank flooding.

217. Crawford, R. D., and J. A. Rossiter. 1982. General design considerations in creating artificial wetlands for wildlife. Pages 44–47 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: WFOWL, NGBIRDS, SHOREB

Genus: *Scirpus, Typha*

Describes a monitoring study of 18 constructed wetland basins in Pembina, Pierce, and Barnes counties, North Dakota. These counties were 3–5 years old. Four natural basin wetlands were compared. Provides a brief overview of the first 2 years of the study. Design recommendations include discussion of bottom contouring, vegetative growth, clay sealing for prevention of leakage, use of hay to accelerate development of detritus food chain, use of muck from existing wetlands for seed bank and organic matter, island construction, shoreline slope considerations, and upland vegetation management.

218. Crewz, D. W., and M. D. Moffler. 1984. An evaluation of air-layering with three speeies of mangroves. Pages 46–61 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Avicennia, Laguncularia, Rhizophora*

Air-layering was effective for the propagation of white mangroves (*Laguncularia racemosa*), but not for black mangroves (*Avicennia germinans*) or red mangroves (*Rhizophora mangle*). Production of air layers may take a year; white mangrove forms an adequate root system in 4–6 months. Application of hormones and osmotic agents had no significant effects on rooting of mangroves.

219. Crossman, J. S., J. Cairns, Jr., and R. L. Kaesler. 1973. Aquatic invertebrate recovery in the Clinch River following hazardous spills and floods. Va. Polyteeh. Inst. State Univ., Water Resour. Cent. Bull. 63. 66 pp.

Response: FISH, INVERT, HYDRO, CHEM, WQUAL

Genus: None

Evaluates the recovery of benthic macroinvertebrates and fish in the Clinch River in southwestern Virginia following two major industrial contaminant spills and flooding. A spill from a fly-ash holding pond in 1967 and a sulfuric acid spill in 1970 eliminated benthic organisms and killed approximately 5,300 fish. Four stations, located above the spill site served as control stations and 12 sites located below the spill were surveyed to assess recovery. Cluster analysis of the data provided information on species density, diversity, and recolonization rate. Includes comparative charts on species diversity, tolerance, and density.

220. Cumming, K. B., and D. M. Hill. 1971. Stream faunal recovery after manganese strip-mine reclamation. U.S. Environ. Prot. Agency, Water Pollut. Control Res. Ser. 18050 DOH 06/71. 36 pp.

Response: FISH, INVERT, CHEM, WQUAL

Genus: None

Compares some of the chemical, physical, and biological variables of streams draining manganese strip-mine spoils in three stages of reclamation within the upper drainage of the south fork of the Holston River, Smyth County, Virginia. Spoil reclamation stages were classified as reclaimed, partially reclaimed, and unreclaimed; details of reclamation are not included in the report. Seasonal monitoring indicated that the community structure of fish and benthic macroinvertebrates in these streams remains severely depressed until complete reclamation of the spoils has been accomplished. Six years after reclamation, only the faunal community in the stream draining the fully reclaimed area has recovered. Siltation and turbidity seemed to be the limiting factors in recovery of faunal communities.

221. Cuneo, K. L. C. 1987. A predictive formula for use in planning salt marsh restorations in San Francisco Bay, California. Pages 112–115 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: VEG

Genus: *Salicornia*

Describes a study of 10 relatively undisturbed marshes in the San Francisco Bay area to establish correlations between the elevation at which *Salicornia* is found, relative percent cover, mean elevations of various reference planes, distance from the Golden Gate, and amount of suspended sediment in ambient bay water. Prediction of elevation for *Salicornia* in the bay area will be useful in estimating amount of earthwork required to restore former wetlands (that have been leveed) to a more natural condition.

222. Cutlip, C. G. 1984. An evaluation of reclaimed wetlands on five phosphate mined sites in central Florida. Pages 62–72 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Acer, Alternanthera, Andropogon, Baccharis, Betula, Canna, Carex, Carpinus, Carya, Catalpa, Cephalanthus, Chenopodium, Cyperus, Cyrilla, Echinochloa, Eichhornia, Equisetum, Eupatorium, Fraxinus, Fuirena, Gordonia, Hibiscus, Hydrocotyle, Ilex, Juncus, Juniperus, Lemna, Limnobium, Liquidambar, Ludwigia, Magnolia, Micranthemum, Myrica, Nyssa, Ostrya, Panicum, Paspalum, Persea, Pinus, Pistia, Platanus, Pluchea, Polygonum, Pontederia, Quercus, Sabal, Sagittaria, Salix, Salvinia, Sambucus, Scirpus, Serenoa, Spartina, Taxodium, Thelypteris, Typha, Ulmus, Urena, Zizania*, many

The international minerals and chemicals corporation phosphate mine reclamation process includes planning, execution, monitoring, and adjustments. Evaluates five Florida sites reclaimed to freshwater wetlands. Includes recommendations for future reclamation projects: reclamation projects should be hydrologically connected to adjacent natural systems; upland and wetland species should be planted at different elevations; when possible, reclamation should begin at the top of a watershed; reclaimed areas should occur in large blocks; and mulch should be viewed as a seed source and spread over a large area.

223. D'avanzo, C. 1986. Vegetation in freshwater replacement wetlands in the northeast. Pages 53–81 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass., Environ. Inst., Publ. 87-1.

Response: VEG, SUCCESS

Genus: None

Describes in detail the role of vegetation for each of 10 major wetland functions. More research is needed in relating structure to function in wetland systems to allow for more effective mitigation. To date, most mitigation efforts have not been evaluated in terms of successful reestablishment of wetland functions. Discusses three case studies of the effectiveness of wetland mitigation efforts. Describes problems that resulted in ineffective or marginally successful mitigation. Discusses a proposal for a vegetation study to determine the effectiveness of created or restored wetlands.

224. Dahl, B. E., B. A. Fall, A. Lohse, and S. G. Appan. 1975. Construction and stabilization of coastal foredunes with vegetation: Padre Island, Texas. U.S. Army Corps Eng., Fort Belvoir, Va. 188 pp.

Response: VEG

Genus: *Ammophila, Indigofera, Ipomoea, Panicum, Scaevola, Spartina, Uniola*, many

Discusses experiments establishing technical specifications and methodologies for the use of beach grasses to construct and stabilize foredunes as storm surge barriers along the Gulf Coast, Padre Island, Texas. *Panicum amarum* and *Uniola paniculata* were the best adapted species for beach plantings. The most successful method of establishing a vegetated dune ridge was transplanting these grasses on the backshore, where they trapped, grew through, and stabilized accumulating sand. Stabilizing barren dunes with sand fencing was more diffieult and costly. Winter through spring was the most favorable period for transplanting both grasses. Fertilization the first year improved initial sand-trapping ability, but subsequent fertilization was unnecessary.

225. Dahl, T. E., and D. E. Nomsen. 1987. Seed bank of a drained prairie wetland. Pages 304–308 *in* K.M. Mutz and L. C. Lee, eds. Wetland and riparian ecosystems of the American west. Eighth Annual Meeting of the Society of Wetland Seientists, Seattle, Wash.

Response: VEG

Genus: Many

Describes the abundance and diversity of ungerminated seeds from 10 soil cores taken from a previously drained wetland basin in Ottertail County, Minnesota. Seeds of 36 plant species, including European waterplantain (*Alisma plantago aquatica*), barnyardgrass (*Echinochloa*), witchgrass (*Panicum capillare*), curltop ladysthumb (*Polygonum lapathifolium*), and bulrush (*Scirpus validus*), were collected. Seed bank density was approximately 4,212 seeds per square meter. Total seed numbers do not reflect number germinated because seed viability is a percentage of total seed numbers, and germinating seeds are a fraction of the viable population.

226. Dai, T. S., and I. K. Hill. 1977. The role of vegetation in stabilizing the lower Great Lakes Canadian shoreline. J. Great Lakes Res. 3(1–2):46–56.

Response: VEG, SOIL

Genus: *Acer, Daucus, Melilotus, Ostrya, Populus, Rhus, Salix, Solidago, Thuja, Typha, Vitis*, many

Examines the natural vegetation of the Canadian shoreline of lakes Ontario, Erie, and St. Clair. The effects of microclimate, soil, properties, physiognomic features of the bluffs, and degree of alteration of the shorelines were considered with respeet to vegetation cover; no single environmental factor seemed to control vegetation type. Five major groups of shoreline plant communities were identified. Includes features of sites with minimal erosion: gentle slope forms, less than 25 degrees; sandy loam soils on backshores; minor scepage with no running gullies; and tree cover on top of the bluff. The loss of deciduous trees along shorelines has contributed to erosion problems.

227. Daiber, F. C. 1986. Dredge material for wetland restoration. Pages 140–177 *in* F. C. Daiber, ed. Conservation of tidal marshes. Van Nostrand Reinhold Co., New York.

Response: INVERT, SOIL, VEG, ECON

Genus: *Amaranthus, Borrichia, Distichlis, Iva, Juncus, Panicum, Pluchea, Salicornia, Spartina*, many

Describes the use of dredge spoil for wetland creation. Appropriate plantings may be determined by salinity, tidal range, location, and elevation. Plant communities must be able to establish and compete successfully. Describes site preparation factors (e.g., slope and surface elevation) and plant species selection. Plant materials, including seeds, should be obtained from local marshes similar to the one being established. Discusses propagation methods, plant zonation, role of invading species, fertilization, density and biomass, sediments, toxic materials, and faunal communities. Estimates for length of time required for a man-made marsh on a spoil site to reach the level of maturity of adjacent natural sites vary from 4 to 30 years (based on organic carbon content). Species evenness-richness and soil structure are other criteria used to evaluate marsh restoration results.

228. Dames, H. R. 1984. Evaluation of two man-made borrow pits on South River: fish population and diversity. Culver-Stockton College, Canton, Miss. 47 pp.

Response: FISH, CHEM, WQUAL, HUSE

Genus: None

Evaluates fish populations at two borrow pits (2 and 3 ha [5 and 8 aeres] eaeh) used for flood control along the South River, Marion County, Missouri. Water quality and fish length measurements were collected in addition to fish diversity and numbers during May-July. The pits contained 27 species of fish. The presence of high numbers of fry showed that the pits were also important spawning and nursery areas for several species. Large numbers of crappies (*Pomoxis*) >20 cm (8 inches) and bass greater than 30 cm (12 inches) were found, indicating a viable sport fishing habitat.

229. Dane, C. W. 1959. Succession of aquatic marsh plants in small artificial marshes in New York State. J. N.Y. Fish Game. 6(1):57–76.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Acorus, Alisma, Anacharis, Chara, Juncus, Leersia, Lemna, Potamogeton, Sagittaria, Salix, Scirpus, Sparganium, Spiraea, Typha, Zizania*, many

Describes and evaluates changes in vegetation of 22 small artificial marshes in the southern tier and Genesee-Niagara areas of New York. These areas differ in water level fluctuation, soil fertility, watershed slopes, marsh basin slopes, and water chemistry. Determines periods between marsh flooding and invasion of vegetation, changes in species occurrence and abundance, and factors influencing plant succession in marshes. Discusses marsh creation in acid soil areas.

230. Darovec, J. E., J. M. Carlton, T. R. Pulver, M. D. Moffler, G. B. Smith, et al. 1975. Techniques for coastal restoration and fishery enhancement in Florida. Florida Department of Natural Resources, St. Petersburg. 27 pp.

Response: FISH, SHELLF, VEG, ECON

Genus: *Avicennia, Distichlis, Halodule, Halophila, Juncus, Laguncularia, Panicum, Rhizophora, Ruppia, Schizachyrium, Spartina, Syringodium, Thalassia, Uniola*

Outlines interim guidelines for the reestablishment of sand dune, mangrove, salt marsh, seagrass, and artificial reef communities along the Florida coast. Discusses sources of seeds and transplants, spacing, timing of planting, fertilization, planting techniques, seed collection and handling, species selection, and elevation. Community-specific guidelines include stabilization of primary dunes, transplanting of original salt marsh vegetation *Spartina alterniflora*, *Juncus roemerianus*, and size of mangrove transplants (larger trees are preferable to seedlings). Discusses permit regulations, construction guidelines,

materials, and oyster cultivation techniques for artificial reef communities.

231. Davis, J. H., Jr. 1975. Stabilization of beaches and dunes by vegetation in Florida. Univ. Fla. Sea Grant Coll. Prog. Rep. 7. 52 pp.

Response: VEG, SOIL, ECON

Genus: *Andropogon, Atriplex, Cakile, Casuarina, Cenchrus, Chrysapsis, Coccoloba, Cocos, Croton, Cynodon, Digitaria, Distichlis, Hydrocotyle, Ilex, Ipomoea, Iva, Myrica, Oenothera, Opuntia, Panicum, Quercus, Serenoa, Spartina, Sporobolus, Suaeda, Uniola, Yucca*, many

Discusses the role of vegetation in stabilizing beaches and dunes in Florida and presents some general guidelines for beach and dune restoration. Topics include plant compositions in various regions of Florida, use of sand fences and other methods of making fills, and techniques and costs for various types of plantings.

232. Dawson, K. J. 1984. Planting design inventory techniques for modeling the restoration of native riparian landscapes. Pages 465–470 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55, University of California Press, Berkeley.

Response: None

Genus: None

Reviews techniques for assessing vegetation distribution patterns of native riparian communities to formulate planting designs in flood control and water resource projects in California. Describes historical native systems in terms of on-site riparian information that can be applied to comparable areas. A basic plan involving a sample plot is developed for determining species distribution. Useful sampling techniques are random-grid, vegetation association, soil types, topography, and species clustering. Transect elevations can assist in delineating vegetation patterns. Planting design features inelude fire lanes, levees, channel alterations, and recreational facilities. The planting plan is based on successional patterns of pioneer, low terrace, and high terrace stages.

233. Day, E. A. 1986. Mitigation of transportation-related wetland losses (Wisconsin). Restor. Manage. News 4(1):30–31.

Response: WFOWL, AMPHIB, REPT, VEG

Genus: *Calamagrostis, Carex, Nymphaea, Phragmites, Potamogeton, Sagittaria, Scirpus, Sparganium, Spartina, Typha*, many

Describes a plan to restore an 8.1-ha and 2.0-ha wetland in Dane County, Wisconsin. The process will involve removing fill from former wetlands and grading and sloping the underlying peat. Arrowhead (*Sagittaria*), bulrush (*Scirpus*), waterlily (*Nymphaea*), reed (*Phragmites*), prairie cordgrass (*Spartina pectinata*), and pondweed (*Potamogeton*) will be hand-planted; sideslopes will be sceded with native grasses and forbs. The upper 60 cm of soil from existing high-quality wetlands will provide rhizomes, roots, organie soil, and a seed bank for the new site. In addition, five pothole sites will be excavated by dragline to enhance waterfowl habitat and provide overwintering habitat for reptiles and amphibians; native shallow and high marsh species will be planted.

234. Day, R. T., P. A. Keddy, J. McNeill, and T. Carleton. 1988. Fertility and disturbance gradients: a summary model for riverine marsh vegetation. Ecology 69(4):1044–1054.

Response: VEG

Genus: *Eleocharis, Scirpus, Sparganium, Typha*, many

Discusses use of multivariate vegetation data to describe relations between vegetation and environmental factors in wetlands along the Ottawa River, upriver from Ottawa, Ontario. Records mean abundance of 58 species of plants, along with 16 environmental measures for four major vegetation types: giant burreed (*Sparganium eurycarpum*), spikerush (*Eleocharis smallii*), common cattail (*Typha latifolia*), and American bulrush (*Scirpus americanus*). A summary model of patterns and processes is presented. Two major multivariate gradients were apparent: elevation and standing crop/litter. The program Twinspan was used to classify vegetation types.

235. Daylor, R. F. 1986. Engineering considerations in wetlands mitigation. Pages 101–114 *in* J.S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass. Publ. 87–1.

Response: None

Genus: None

Provides a summary of engineering perspectives of mitigation methods in nontidal freshwater wetlands of the northeastern United States. Includes a review of regulatory processes. Describes hydrologic characteristics, water quality, and ecological character in terms of engineering considerations. Provides suggestions for dealing with various subject areas, including surveying and mapping, geological investigation, botanical studies, modeling for flood occurrence, habitat assessment models, construction techniques, and water quality considerations.

236. De Jong, J. 1976. The purification of wastewater with the aid of rush or reed ponds. Pages 133–139 *in* J. Tourbier and R. W. Pierson, Jr., eds. Biological control of water pollution. University of Pennsylvania Press, Philadelphia.

Response: VEG, SOIL, CHEM, ECON, WQUAL

Genus: *Phragmites, Scirpus*

Describes the use of rush (*Scirpus lacustris*) and common reed (*Phragmites australis*) to treat wastewater in the Netherlands near Amsterdam. An experimental 1-ha pond was used to treat sewage from a campsite and ditches were dug to compare the properties of rush, reed, and polypropene fibers in purifying sewage. The vegetation systems were able to provide adequate purification of water, based on BOD, COD (chemical oxygen demand), phosphorus, nitrogen, and bacterial counts, as long as the supply of phosphorus and nitrogen did not exceed the uptake capacity of the vegetation. This treatment of sewage was considerably cheaper than activated sludge-type plants. The required area needed for rush or reed ponds was considered too great for treatment of effluent of a planned 40,000-population center.

237. Dean, D., and H. H. Haskin. 1964. Benthic repopulation of the Raritan River estuary following pollution abatement. Limnol. Oceanogr. 9(4):551–564.

Response: INVERT

Genus: None

Discusses repopulation of the Raritan River estuary in New Jersey by benthic invertebrates after pollution was abated in the river by a trunk sewer system in 1958. During 1957, no freshwater species were colleeted from sampling sites. From 1958 to 1960, freshwater species invaded the area and in-

creased until 1960. At this time, biotic recovery had progressed to the point that distribution of species and population densities illustrated the classic u-shaped curve for estuaries, with greater diversity and density in the freshwater and seaward sections than in the center of the estuary.

238. Dean, R. G. 1979. Effects of vegetation on shoreline erosional processes. Pages 415–426 *in* P. E. Greeson, J. R. Clark, and J. E. Clark, eds. Wetland functions and values: the state of our understanding. American Water Resources Association, Minneapolis, Minn.

Response: SOIL

Genus: None

Focuses on the effect of vegetation on modifying sediment erosion on shorelines. Four mechanisms stabilize sediments along bay or ocean shorelines: direct increase in shoreline durability through a more resistant soil–root matrix, damping of water waves by a "stand" of vegetation before the waves arrive at the shoreline, deposition of sediment as a result of reduction in current velocity, and enhancement of the storage of sand in dunes so that the sand will be available as a supply to storm waves. Includes a pictorial description of techniques used. Presents mathematical equations determining tide velocity and grass stalk height relations.

239. Decker, C. S., and D. L. King. 1971. Accelerated recovery of acid strip-mine lakes. Pages 208–216 *in* Proceedings of the 26th Industrial Waste Conference. Part 1. Purdue Univ. Eng. Bull. Exten. Serv. 140.

Response: CHEM, WQUAL, VEG

Genus: None

Discusses accelerated recovery of an acid strip-mine lake near Columbia, Missouri, by the addition of sewage sludge as an energy source for sulfate reducing bacteria, which resulted in the removal of sulfate ions and production of sulfide ions and carbon dioxide. Sulfide forms hydrogen sulfide under acid conditions, which leaves the system as hydrogen sulfide gas and permanently removes some of the total acidity. Concomitant sulfate removal and acidity consumption is accompanied by increased pH values. Compared to lime-limestone neutralization treatment, organic addition seems to offer a more complete treatment and provides a more economical solution to acid strip-mine problems.

240. Delaune, R. D., C. J. Smith, W. H. Patrick, Jr., J. W. Fleeger, and M. D. Tolley. 1984. Effect of oil on salt marsh biota: methods for restoration. Environ. Pollut. 36:207–227.

Response: INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Spartina*

Describes an experiment to test the effects of oil on a Louisiana gulf coast salt marsh. Evaluates restoration methods on replicated plots with crude oil applied. Describes effects on microfauna (nematodes, copepods), sediment, macrophytes, and macrofauna.

241. Demgen, F. C. 1979. Wetlands creation for habitat and treatment—at Mt. View Sanitary District, California. Pages 61–73 *in* R. K. Bastian and S. C. Reed, eds. Aquaculture systems for wastewater treatment: seminar proceedings and engineering assessment. U.S. Environmental Protection Agency, Washington, D.C.

Response: INVERT, WFOWL, NGBIRDS, SHOREB, VEG, CHEM, WQUAL

Genus: *Echinochloa, Lemna, Scirpus, Typha*

Discusses a full-scale pilot wetland creation project at the Mount View Sanitary District, Martinez, Contra Costa County, California. The 8.2-ha wetland system consists of five interconnected areas with tributary edge habitat. A balanced and healthy wetland ecosystem, composed of pond and marsh areas, has been created using secondary-treated wastewater. Four years of monitoring indicated that the wildlife habitat actively supports 72 species of plants and 10 subspecies of mammals, 90 subspecies of birds, and 34 subspecies of aquatic invertebrates. Mosquito breeding has been reduced to a minimum through the introduction of mosquito fish. Nitrate removal has been consistent. Public support for the wetland is strong; educational and recreational use is considerable.

242. Demgen, F. C. 1980. Wetlands creation using secondary treated wastewater. Pages 727–739 *in* Water reuse symposium, Vol. 1. American Water Works Association, Washington, D.C.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, HUSE, CHEM, WQUAL, ECON

Genus: *Echinochloa, Scirpus, Typha*

Describes the use of treated sewage effluent in the creation of wetlands at a treatment plant in the Mt. View Sanitary District, Contra Costa County, California. The wetland plots cover 6.2 ha (15.2 acres) and are designed to form a complex of shallow areas dominated by emergent vegetation and deeper open water areas. "Ecofloats" in open water provided supplemental artificial habitat for aquatic invertebrates. Water quality analysis indicated that the wetlands improved the effluent from the treatment plant, even though the wetlands were created primarily to provide wildlife habitat. Resident animal species are described. Marsh management, emphasizing minimization of maintenance, includes discussions of algae (control), levees, erosion, plot design, mosquito control, control of avian botulism, and costs and benefits.

243. Derrenbaeker, J., and R. R. Lewis. 1982. Seagrass habitat restoration, Lake Surprise, Florida Keys. Pages 132–154 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Halodule, Thalassia*

Several methods were used to establish *Halodule wrightii* and *Thalassia testudinum* on substrates disturbed by construction in Lake Surprise, Key Largo, Florida. Steel staples (15 cm long) were used to anchor *H. wrightii* runner sections in moderately impacted shell hash, severely impacted fine silt, and rocky areas. After 7 months, vegetative coverage of these three areas was 100%, 98%, and 18%, respectively. *Thalassia testudinum* seedlings were hand-broadcast in moderately to severely impacted fine silt; after 7 months the vegetative survival rates were 44–55%. *Thalassia testudinum* rhizomes with attached short shoots were transplanted in moderately to severely impacted silt; 7-month survival rate was 75%.

244. Dial, R. S., and D. R. Deis. 1986. Mitigation options for fish and wildlife resources affected by port and other water-dependent developments in Tampa Bay, Florida. U.S. Fish Wildl. Serv., Biol. Rep. 86(6). 150 pp.

Response: FISH, INVERT, WFOWL, SHOREB, VEG, SUCCESS

Genus: *Avicennia, Halodule, Juncus, Laguncularia, Paspalum, Rhizophora, Ruppia, Salicornia, Spartina, Syringodium, Thalassia, Ulva*

Evaluates development projects that have effected intertidal and subtidal habitats of Tampa Bay, Florida. Field investigations were conducted on 10 past restoration projects in the bay to determine success of plantings of mangroves, needle rush (*Juncus roemerianus*), cordgrass (*Spartina*) on filled subtidal areas. Restoration projeets throughout Florida were reviewed by examining available literature. Discusses the feasibility of restoring various wetland habitats in Tampa Bay, including recommended plant species, planting techniques, and potential problems. Twelve potential sites within Tampa Bay were evaluated for the feasibility of future restoration. Discusses in detail the role of mitigation and legal and policy requirements of implementing mitigation planning.

245. Diaz, R. J., and D. F. Boesch. 1977. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix C: Environmental effects of marsh development with dredged material: acute effects on the macrobenthic community. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-23. 153 pp.

Response: INVERT, SOIL

Genus: None

Describes the effects of dredged material habitat developments on macrobenthic organisms at Windmill Point, James River, Virginia. Sediment grain size greatly influenced community structure. Sand sites generally had a lower diversity of invertebrates and mud sites had the highest diversity. Fauna were surveyed before and after constuction activities. Acute effects were observed within the habitat development site and in the dredge area. Discusses the importance of displaced shallow benthic habitats in comparison to the importance of the artificial marsh.

246. Dicks, B. 1977. Changes in the vegetation of an oiled Southampton water salt marsh. Pages 208–240 *in* J.F. Cairns, K. L. Dickson, and E. E. Herricks, eds. Recovery and restoration of damaged ecosystems. University Press Virginia, Charlottesville.

Response: VEG, SUCCESS

Genus: *Aster, Halimione, Salicornia, Spartina, Suaeda*

Documents a study of the changes in vegetation as a salt marsh recovers from oil pollution damage incurred over a 20-year period. The study site is in Southampton, Hampshire, England. Describes recolonization by original marsh plant species on adjacent healthy areas. Recolonization success depends on effective seeding; although *Spartina anglica* is the natural dominant vegetation, it reproduces primarily vegetatively and spreads slowly, compared to other species. Discusses effects of oil on marsh plants. The revegetation of some previously denuded areas is a result of both climatic factors and water quality improvement.

247. Dickson, R. E., J. F. Hosner, and N. A. Hosley. 1965. The effects of four water regimes upon the growth of four bottomland tree species. For. Sci. 11(3):299–305.

Response: VEG

Genus: *Fraxinus, Nyssa, Platanus, Quercus*

Discusses the growth of seedlings of four bottomland hardwood species collected from southern Illinois and grown under four moisture regimes. On the basis of height growth and total dry weight, tupelo blackgum (*Nyssa sylvatica*) and green ash (*Fraxinus pennsylvanica*) seedlings grew best under continuously saturated conditions (184 days, 16-hour photoperiod). Sycamore (*Platanus*) and pin oak (*Quercus palustris*) grew best when soil was watered to moisture equivalent when 50% or more of the available water was removed. With few exceptions, the smallest seedlings were grown on soil watered to moisture equivalent when wilting point was reached. Discuss the segregation of these species along soil moisture gradients in bottomland areas.

248. Dillon, P. J., N. D. Yan, W. A. Scheider, and N. Conroy. 1979. Acidic lakes in Ontario, Canada: characterization, extent and responses to base and nutrient additions. Ergebnisse der Limnologie 13:317–336.

Response: INVERT, VEG, CHEM, WQUAL

Genus: *Peridinium*

Describes the characteristics of acidic lakes in Ontario, Canada, and diseusses their response to base and nutrient additions for lake restoration. The addition of base to acidic lakes raised the pH and lowered the heavy metal concentrations, but did not affect nutrient levels. The phytoplankton biomass was initially drastically reduced, but increased to pretreatment levels within a few months. Zooplankton standing stocks were substantially reduced and generally did not return to species composition typical of the oligotrophic lakes of the region. Fertilization of two lakes with low levels of phosphorus increased phytoplankton biomass and species composition; zooplankton biomass increased to levels of an unfertilized, neutralized lake, but composition did not improve. After 3 years, zooplankton populations of treated lakes remained atypical compared to the oligotrophic lakes of the region.

249. Disano, J., B. W. Anderson, and R. D. Ohmart. 1984. Irrigation systems for riparian zone revegetation. Pages 471–476 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55, University of California Press, Berkeley.

Response: VEG, ECON, HYDRO, WQUAL

Genus: None

Describes and evaluates two experimental irrigation systems on the Cibola National Wildlife Refuge on the lower Colorado River (California–Arizona border). One system used polyvinyl chloride (PVC) irrigation pipe from a 3-m well, which pumped the water to the revegetation site. The second system entailed pumping water from an on-site pond that received water from the Colorado River. Discusses advantages and disadvantages of the efficiency, installation, cost of pumping, availability of electricity, and availability of free-flowing water. The pvc pipe method costs $34 per tree, with maintenance cost of $3 per tree. The pond irrigation system cost $3 per tree and $16 per tree for maintenance. The recommended system uses a gasoline–diesel pump, pvc pipe, and free-flowing water.

250. Dodd, J. D., and J. W. Webb. 1975. Establishment of vegetation for shoreline stabilization in Galveston Bay. U.S. Army Corps Eng., Fort Belvoir, Va., Misc. Pap. 6–75. 67 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Arundo, Avicennia, Distichlis, Juncus, Phragmites, Scirpus, Spartina, Tamarix*

Determines which resident marsh speeies were adapted to saline conditions, and which of these species were best suited

for revegetation to control shoreline erosion. Soil texture, soil chemistry, and water salinity were measured at low, middle, and upper tide zones. A temporary wave-stilling device was erected to protect plantings; mechanical sloping was not successful because severe natural erosion conditions. The upper zone supported gulf and smooth cordgrass (*Spartina alterniflora*) and giant reed (*Arundo donax*). Valuable species for use in the middle zone were smooth cordgrass, saltgrass (*Distichlis spicata*), and black mangrove (*Avicennia germinans*) for protection and stabilization.

251. Doornbos, G., A. M. Groenendijk, and Y. W. Jo. 1986. Nakdong estuary barrage and reclamation project: preliminary results of the botanical, macrozoobenthic, and ornithological studies. Biol. Conserv. 38(2):115–142.

Response: INVERT, WFOWL, NGBIRDS, SHOREB, VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Ceratophyllum, Hydrilla, Myriophyllum, Najas, Phragmites, Potamogeton, Salsola, Salvinia, Scirpus, Spirodela, Trapa, Vallisneria, Zostera*

Discusses preliminary results from the Nakdong estuary barrage and reelamation project in Korea. The barrage was constructed to prevent saline water from reaching the lower reaches of the river basin and adversely effecting the macrozoobenthos and wintering waterfowl roosting and feeding areas. Upstream of the barrage, a freshwater reservoir was constructed with a fixed mean water level; plant biomass was measured. Includes a table of macrozoobenthos biomass per square meter for 12 sampling stations and a table listing observations of abundance of nonpasserine birds. Discusses predictions on barrage construction effeets to the vegetation of the freshwater basin.

252. Dougherty, S. T., C. A. Berry, and M. A. Deimel. 1987. Hydrology and vegetation in montane and subalpine wetlands of Colorado. Pages 81–84 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: HYDRO, VEG

Genus: *Carex, Juncus, Salix, Scirpus*

Discusses the relation between hydrology and vegetation in montane and subalpine wetlands. The Williams Fork River wetland study (central Colorado Rocky Mountains) and Homestake Project Phase II (Holy Cross Wilderness, Colorado) have provided information about the ecology of montane and subalpine wetlands that will be useful for effect predictions and mitigation efforts. Data gaps include hydrologic limits of dominant wetland species, species tolerance of saturated conditions, and duration and frequency of soil saturation required for exclusion of upland species from wetland areas.

253. Douglas, S. 1985. Save the Everglades. Oceans 18(2):3–9.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, HYDRO, ECON

Genus: None

Describes Florida's "Save the Everglades" program initiated in the early 1980's. This plan calls for the restoration of a large area of the Everglades and its water source, notably the Kissimmee River and Lake Okeechobee. This system, extending from central Florida, south into Florida Bay, would be restored through partial elimination of flood canal C-38 (i.e., the channelized Kissimmee River); restoration of adjacent marshes; restoration of 246 km^2 (95 mi^2) of drained land in Palm Beach County; removal of alligator alley, a major road barrier to sheet flow and animal habitat; and restoration of waterfowl populations and endangered species such as the everglades mink (*Mustela vison evergladensis*), round-tailed muskrat (*Neofiber alleni*), Florida panther (*Felis concolor coryi*), and manatee (*Trichechus*).

254. Dubinski, B. J., C. S. Nordby, S. D. Perry, J. D. Covin, and J. B. Zedler. 1987. Artificial wetlands to enhance estuarine ecosystems in southern California. Pages 170–171 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: WFOWL, SHOREB, VEG, ECON, SUCCESS

Genus: *Anemopsis, Chara, Cotula, Cyperus, Eleocharis, Frankenia, Juncus, Oenothera, Polygonum, Potamogeton, Scirpus, Typha*

Describes the creation of 87 wetlands on 14 ha of abandoned agricultural land in the Tijuana River National Estuarine Research Reserve in southern California. Objectives were to determine if impoundments created in upland habitat would support native wetland plant species (Phase I), construct larger wetlands than those used in Phase I and evaluate plant propagation methods (Phase II), and create wetlands of varying area-to-edge ratios and salinities to determine which types of habitats attract the greatest number and diversity of shorebirds.

255. Duever, M. J., and J. McCollom. 1988. Plant community boundaries and water levels at Lake Hatchineha, Florida. Pages 67–72 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: VEG, HYDRO

Genus: Many

Describes a study to identify the regularly inundated portions of shoreline along Lake Hatchineha in central Flordia. Hydroperiod was recognized as one of the dominant factors influencing freshwater wetland community distribution. Describes major plant communities along the lakeshore as they relate to annual periods of inundation and specific lakeshore elevations. Discusses plant community boundary elevations, hydroperiod, and ordinary high water lines.

256. Duff, D. 1979. Riparian habitat recovery on Big Creek, Rich County, Utah—a summary of 8 years of study. Pages 91–92 *in* O. B. Cope, ed. Proceedings of a forum on grazing and the riparian stream ecosystem. Trout Unlimited, Denver, Colo.

Response: FISH, INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Salix*

Discusses riparian and instream habitat recovery after 8 years of exclosure from livestock and installation of instream improvement structures on Big Creek, Rich County, Utah. After 4 years of exclosure, sedges and grasses had responded significantly from previous severe grazing effects; willow (*Salix*) responded more slowly. Six weeks of trespass livestock within the exclosure completely eliminated willows and reduced grass-sedge habitat to pre-exclosure conditions. Trout increased 570% on the section with the exclosure and instream

devices compared to sections with only instream devices. Discusses the need to consider riparian zones separate from upland zones in grazing management schemes.

257. Dunn, P. V. 1982. Considerations for restoration of an endangered species: salt marsh bird's beak. Page 99 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: VEG

Genus: *Cordylanthus*

Summarizes results of a study of the endangered plant salt marsh bird's beak (*Cordylanthus maritimus maritimus*) at Tijuana Estuary in southern California. This plant is one of three halophytic annuals found in southern California and can tolerate large seasonal variations in soil salinity. Describes germination requirements and basic ecology of this hemiparasitic plant. Discusses preservation of this species in terms of inclusion in restoration plans for salt marshes in southern California.

258. Dunn, W. J., and G. R. Best. 1983. Enhancing ecological succession—survey of seed bank composition in marsh ecosystems and potential of seed bank establishment as an alternative for restoration of native marshes. Pages 100–114 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow, Fla.

Response: VEG

Genus: *Amaranthus, Echinochloa, Eichhornia, Eleocharis, Juncus, Ludwigia, Polygonum, Pontederia, Saururus*

Examines size and species composition of seed banks in natural and postmining marshes of central Florida to evaluate the feasibility of establishing marshes by mimicking natural recovery processes known to occur with seed banks. In natural marsh seed banks, species richness varied from 7 to 38 species and seed bank size varied from 6,000 to 156,000 seeds per square meter. Species richness in samples from phosphate mined lands was low over a 2-month germination period.

259. Dunn, W. J., and G. R. Best. 1983. Enhancing ecological succession: 5. Seed bank survey of some Florida marshes and role of seed banks in marsh reclamation. Pages 365–370 *in* Proceedings of 1983 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, Lexington.

Response: VEG, SUCCESS

Genus: *Amaranthus, Aster, Baccharis, Cyperus, Eclipta, Eichhornia, Eupatorium, Hypericum, Juncus, Ludwigia, Polygonum, Ptilimnium, Sacciolepis, Samolus*, many

Describes and compares seed bank samples from natural, reclaimed, and unreclaimed freshwater wetland systems in Florida and natural systems in Iowa (prairie glacial marsh), New Jersey (freshwater tidal marsh), and Ontario (lakeshore marsh). The restoration of stable, self-sustaining marsh systems in postmining landscapes may depend on seed banks that contain representative species from all successional stages, all types of regeneration, and all life histories. Two problems in reclamation attempts are lack of desirable climax species (late-succession, long-lived perennials), and control of aggressive weeds capable of arresting the process of succession. Discusses the time required for the seed bank of a reclaimed marsh to reach the point of being a "reasonable facsimile" of a natural marsh.

260. Dunst, R. C., S. M. Born, P. D. Uttormark, S. A. Smith, S. A. Nichols, J. O. Peterson, et al. 1974. Survey of lake rehabilitation techniques and experiences. Wisc. Dep. Nat. Resour. Tech. Bull. 75. 179 pp.

Response: FISH, VEG, HUSE, HYDRO, CHEM, WQUAL

Genus: *Ceratophyllum, Chara, Microcystis, Myriophyllum, Nymphaea, Potamogeton, Typha*, many

Presents a synopsis of lake rehabilitation techniques, discusses managing the consequences of lake aging, and describes nearly 600 accounts of lake restoration throughout the world. Topics include curbing nutrient influx, in-lake schemes to accelerate nutrient outflow or prevent recycling (e.g., dredging, dilution, biotic harvesting, lake bottom sealing), aeration and circulation, water level manipulation, vegetation manipulation, chemical controls, and biological controls (e.g., predator-prey relations, pathological reactions). The restoration objective, methodology, results, and references are included in the accounts of lake restoration projects. Lists more than 800 documents in the bibliography.

261. Dunstan, W. M., G. L. McIntire, and H. L. Windom. 1975. *Spartina* revegetation on dredge spoil in southeastern marshes. J. Waterways Harbors Coastal Eng. Div. 101:269–276.

Response: ECON, VEG

Genus: *Spartina*

Describes experimental planting of smooth cordgrass (*Spartina alterniflora*) on a 8-ha (20-acre) dredged spoil site at Hell Gate on Little Don Island, Ossabow Sound, Georgia. Before planting, the silt-clay substrate had dried to a hard, cracked crust. Experimental plots were planted to test seeds, nursery plants, fertilization, and growth of transplants from a vegetated part of the same island and a healthy marsh on another island. Elevation varied from 2 to 2.7 m (7 to 9 feet) above mean low water (mlw). After 1.5 years, the local transplant survival rate was 36.1%, whereas that of the transported plants was 22.5%. Almost 70% of the *Spartina* planted at 2–2.3 m (7–7.5 feet) above mlw survived, whereas the rate for those planted above 2.6 m (8.5 feet) was 8.7%.

262. Durako, M. J., and M. D. Moffler. 1981. Variation in *Thalassia testudium* seedling growth related to geographic origin. Pages 99–117 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEGR

Genus: *Thalassia*

Growth patterns of *Thalassia testudium* seedlings taken from different sites in Florida (Florida Keys, Biscayne Bay, Tampa Bay) were studied under a variety of lab culture conditions. Findings suggested that *T. testudium* populations acclimatize physiologically to specific environments, which affects the success of revegetation efforts using seed stock from other geographic areas. For example, leaf blade and root growth were greatest in seedlings from the Florida Keys and lowest from Tampa Bay populations. The use of peat pellets for anchoring seedlings seems to be effective.

263. Durako. M. J., and M. D. Moffler. 1984. Qualitative assessment of five artificial growth media on growth and survival of *Thalassia testudium* (hydrocharitacae) seedlings. Pages 73–92 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Halodule, Thalassia*

Thalassia testudium seedlings were collected during summer and cultured in several media: Jiffy-7 pellets, rootcubes, horticubes, plant plugs, and a control of Aragonite. Compares plant survival, efficacy (growth times percent survival), and cost. Seedlings were transplanted the following spring and summer. After 7 months, those planted in *Halodule wrightii* beds flurished. No seedlings planted in bare sand survived. Seedling mortality was highest in the first few months. The use of steel staples for anchoring had no effect on survival of transplants.

264. Eagles, P. F. J. 1982. Gravel pit reclamation in Ontario: the Crieff case study. Pages 141–147 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife value of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: WFOWL, NGBIRDS, SHOREB, VEG, SUCCESS

Genus: *Betula, Carex, Habenaria, Juncus, Larix, Liparis, Populus, Salix, Scirpus, Spiranthes, Thuja, Typha*, many

Describes natural succession in the Crieff study area, a 30-ha gravel pit, 20 km south of Guelph, Ontario. The pit has two main habitat types: an old pond surrounded by wetland, and dry gravel deposits. Research needs include plant and wildlife species that naturally move into gravel mined areas, ecological succession, design features to maximize ecological diversity, methods for increasing the rate of succession, and creation of a "natural" ecosystem over time. Concluded that gravel pits do have reclamation potential, they are colonized first by seed dispersal from nearby communities, and topsoil is not always necessary for tree seed germination and growth. Discusses habitat for birds.

265. Earhart, H. G., and E. W. Garbisch, Jr. 1983. Habitat development utilizing dredged material at Barren Island, Dorchester County, Maryland. Wetlands 3:108–119.

Response: SHOREB, VEG, ECON

Genus: *Spartina*

Discusses the use of a dredge material disposal site for wildlife habitat. The site is on the eastern shore of Maryland, just northeast of Barren Island in Tar Bay, Dorchester County. Elevation (maximum of 1.8 m mlw [mean low water]) of the fill material was regulated carefully. Smooth cordgrass (*Spartina alterniflora*) seeds were disseminated and marshhay cordgrass (*S. patens*) was planted at higher elevations. Unvegetated habitat spread with dredged shell was used as a nesting site by least terns (*Sterna antillarum*). The project altered 8.5 ha of shallow water habitat and created 14.9 ha of diversified habitat (including 6.5 ha of shallow water). Costs were $506/ha for seeding and fertilization and $384/ha for transplanting.

266. Eckert, J. W., M. L. Giles, and G. M. Smith. 1978. Design concepts for in-water containment structures for marsh habitat development. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-31. 69 pp.

Response: SOIL

Genus: None

Provides general guidance for selecting and designing in-water containment structures for use in marsh habitat development, with emphasis on retaining dredged material. Discusses site selection, structure and construction considerations, and relative costs. Discusses two examples of containment structure projects; a sand dike (Windmill Point, Virginia) and a bog dike (Bolivar Peninsula, Texas).

267. EDAW, Inc. 1982. Big Canyon marsh restoration, upper Newport Bay. Page 99 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: WFOWL, SHOREB

Genus: None

Describes the initial stages of the restoration of a 2.8-ha (7-acre) freshwater marsh at Big Canyon, adjacent to the upper Newport Bay ecological reserve in Orange County, California. The restored marsh was a former salt and brackish marsh and a dredged spoil deposit site. The primary objective was creation of habitat for the endangered light-footed clapper rail (*Rallus longirostris levipes*). Significant benefits to other wildlife, including migratory waterfowl and shorebirds, were also incurred. Revegetation has occurred naturally and is expected to reach a stage of complete restoration within 3–4 years. Freshwater marshes adjacent to salt marshes are important foraging areas for light-footed clapper rails. Discusses project planning and interagency cooperation.

268. Edwards, H. K. 1982. The chain of lakes project along Interstate 80 in Nebraska. Pages 211–214 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: FISH, HUSE

Genus: *Acer, Cornus, Fraxinus, Populus, Prunus, Salix, Ulmus*, many

Provides a brief overview of the development of many gravel pits along Interstate 80 and the Platte–South Platte River from Grand Island to Big Springs, Nebraska. These pits became the "chain of lakes" system and were diked, stocked with fish, and managed primarily as recreation areas, but also for wildlife habitat.

269. Edwards, R. D., and W. W. Woodhouse. 1982. Brackish marsh development. Pages 1–17 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Juncus, Spartina*

The establishment of a brackish water marsh adjacent to Bond Creek, Beaufort, North Carolina, was initiated by experimental plantings of smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), big cordgrass (*S. cynosuroides*), and needle rush (*Juncus roemerianus*). All cordgrass (*Spartina*) species were fertilized at planting. Elevation varied from 0.06 to 0.36 m msl; *S. alterniflora* was most adaptable to the entire range. Although these plantings do not duplicate the natural high marsh, primary production by the third growing season in the planted marsh was equal to or greater than that of a nearby natural marsh. Natural invasion of marsh species into the unplanted control area was slower than establishment by planting.

270. Ehlers, R. 1956. An evaluation of stream improvement devices constucted eighteen years ago. J. Calif. Fish Game 42(3):203–217.

Response: FISH, HYDRO, SOIL

Genus: None

Provides an overview of the effeetiveness of 41 stream improvement struetures constructed in 1935 on the east fork of the Kaweah River, Sequoia National Forest, Tulare County, California. The work was done to determine which dams were most effective for creating pools (for trout habitat). Dam types included masonry, earth, board, log, log deflectors, and double deflectors. In 1953, only 15 pools remained of 67 that could have been expeeted to develop as a result of the dams and deflectors.

271. Elder, J. F. 1988. Factors affecting wetland retention of nutrients, metals, and organic materials. Pages 178–184 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: Wetland Hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO, WQUAL

Genus: None

Provides a summary of current information on the effects of wetlands on transport of constituents. Discusses characteristics of hydrology, vegetation, sediments and microbiota that affect constituent transport, retention, or transformation. Includes management implications such as long-term changes, introduction of pathogens and biotransformation of non-toxic to toxic forms. Wetlands are likely to have multiple roles as nutrient sources, sinks, and transformers depending on location, season, and environmental factors. Provides an extensive bibliography.

272. Eleuterius, C. K., and L. N. Eleuterius. 1984. Numerical-hydrodynamic model use in evaluation of marsh island creation. Pages 76–93 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, HYDRO

Genus: None

Describes a computer-based hydrodynamic assessment system designed as an aid for locating spoil deposition sites in estuaries. The system provides a means of assessing sites and configurations of potential marsh islands and effects of such islands on water circulation patterns in different estuarine locations. St. Louis Bay, Mississippi, was used as a demonstration site. The simulation graphics system allows for rapid assessment of the consequences of any number of spoil disposal sites—especially in terms of the effects of wave-current action on vegetation establishment.

273. Eleuterius, L. N. 1974. A study of plant establishment on dredge spoil in Mississippi Sound and adjacent waters. U.S. Army Corps Eng., Ocean Springs, Miss., Rep. FR-74. 327 pp.

Response: VEG

Genus: *Cymodocea, Distichlis, Halodule, Ipomoea, Juncus, Panicum, Phragmites, Spartina, Thalassia, Uniola*

Describes plant establishment experiments on dredged spoil substrate in Mississippi Sound and adjacent waters. Part I covers seagrass transplantation studies on both dredge spoil and barren sea bottom. Includes techniques for anchoring. Discusses invertebrate associations with seagrass beds. Part II describes studies on transplanting emergent species in salt marsh and dune areas, including discussion of their biology, ecology, and propagation techniques, with emphasis on types of vegetative reproduction.

274. Eleuterius, L. N. 1975. Submergent vegetation for bottom stabilization. Pages 439–456 *in* L.E. Cronin, ed. Estuarine research. Vol. II. Geology and Engineering. Academic Press, New York.

Response: VEG, SOIL

Genus: *Cymodocea, Diplanthera, Thalassia*

Describes the transplanting of turtlegrass (*Thalassia testudium*), gulf manateegrass (*Cymodocea manatorum*), and Wright shoalgrass (*Diplanthera wrightii*) from natural habitats to submerged spoil areas and to control locations adjacent to seagrass beds. All sites were located in the Mississippi Sound (near Ship Island and Horn Island) and Biloxi Bay. Various anchoring devices were necessary to prevent sprig removal by wave action and currents. Sedimentation produced elevation changes: deposition rates greater than 2.5 cm/month exceeded the growth rates of *Thalassia* and *Cymodocea* and rates over 5 cm/month exceeded the growth rate of *Diplanthera*. Although roots and rhizomes of *Thalassia* and *Cymodocea* were larger, *Diplanthera* had a much greater growth rate and was more effective in binding the substratum. Discusses environmental conditions affecting plant growth and survival.

275. Eleuterius, L.N. 1976. Transplanting maritime plants to dredged material in Mississippi waters. Pages 900–918 *in* P. A. Krenkel, J. Harrison, and J.C. Burdick, III, eds. Proceedings of the specialty conference on dredging and its environmental effects. American Society of Civil Engineering, New York.

Response: VEG, SOIL, CHEM

Genus: *Cymodocea, Distichlis, Halodule, Juncus, Panicum, Phragmites, Spartina, Thalassia, Uniola, Zostera*

Presents results of an extensive study of submergent and emergent plant establishment on dredged material sites in coastal Mississippi. Of the seagrasses, up to 40% of the American shoalweed (*Halodule beaudettei*) transplants survived after 1 year; less than 20% of the turtlegrass (*Thalassia testudium*) survived; and out of 300 transplants of gulf manateegrass (*Cymodocea filiformis*), no plants survived. No appreciable difference in available nutrients (phosphorous, nitrogen, potassium) was noted between spoil seagrass beds and adjacent barren areas. Of marsh and dune emergents, overall survival of transplants rooted in peat pellets was greater than those of sprigs; however, some species survived much better when planted by sprigs. Survival also was highest when transplanting was done from November to February. Provides a guide to transplanting several species.

276. Eleuterius, L. N., and J. D. Caldwell. 1981. Colonizing patterns of tidal marsh plants and vegetational succession on dredge spoil in Mississippi. Pages 58–73 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM, SUCCESS

Genus: *Albizia, Amorpha, Andropogon, Baccharis, Boltonia, Cephalanthus, Cinnamomum, Cladium, Distichlis, Eleocharis, Hibiscus, Hydrocotyle, Ipomoea, Iva, Juncus, Kosteletzkya, Lippia, Lonicera, Ludwigia, Melia, Mikania, Muhlenbergia, Panicum, Paspalum, Phytolacca, Pinus, Rubus, Rumex, Salicornia, Salix, Sambucus, Sapium, Scirpus, Sesbania, Setaria, Solidago, Spartina, Typha, Uniola, Verbena*

Describes plant colonization and succession on dredge spoil islands and shores along the Mississippi coast. The chemical characteristics of the spoil areas lie within the tolerance range of many tidal marsh plants. Elevation, shore slope, and sub-

strate stability are important factors in plant colonization. Spoil areas with elevations up to .9 m (2 feet) above mlw remain marshy; shrubs eventually occupy areas above .8 m (2.5 feet) mlw and trees dominate above 1.4 m (4.5 feet mlw). The primary colonizer is smooth cordgrass (*Spartina alterniflora*), followed by seashore salt-grass (*Distichlis spicata*), bigleaf sumpweed (*Iva frutescens*), and groundsel baccharis (*Baccharis halimifolia*). Needle rush (*Juncus roemerianus*) may require 6–15 years to colonize spoil areas. Transplants are best established at elevations higher than those found in natural marshes, so that plants can adjust themselves downward until they reach the optimum elevations for growth.

277. Eleuterius, L. N., and C. K. Eleuterius. 1979. Tide levels and salt marsh zonation. Bull. Mar. Sci. 29(3):394–400.

Response: VEG

Genus: *Juncus, Spartina*

Examines aspects of tidal inundation, frequency, duration, and exposure related to the distribution zones of smooth cordgrass (*Spartina alterniflora*) and needle rush (*Juncus roemerianus*) in Davis Bay, Mississippi. The marsh zone was divided into 100 intervals and the *Spartina* and *Juncus* zones were then subdivided into four subzones of equal vegetative height. Tidal amplitude was recorded hourly. The study showed that tidal inundation does not account specifically for salt marsh vegetation zonation and that edaphic and biotic interactions were contributing environmental factors.

278. Eleuterius, L. N., and J. I. Gill. 1981. Long-term observations on seagrass beds and salt marsh established from transplants. Pages 74–86 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Andropogon, Baccharis, Batis, Boltonia, Cymodocea, Distichlis, Eleocharis, Halodule, Ilex, Iva, Juncus, Myrica, Panicum, Phragmites, Pinus, Sagittaria, Salicornia, Scirpus, Setaria, Spartina, Thalassia, Zizania*

Tidal marsh plants were transplanted to a spoil area in Jackson County, Mississippi. Preliminary rooting was found to be unnecessary for establishment; 60–80% survival was achieved when shoots were planted between November and February. Transplanting results were tested by two restoration projects in Biloxi Bay. Smooth cordgrass (*Spartina alterniflora*) transplants established at higher elevations eventually spread to low areas on the intertidal plane. Needle rush (*Juncus roemerianus*) remained in separate clumps; areas between clumps were colonized by seashore salt-grass (*Distichlis spicata*) and marshhay cordgrass (*Spartina patens*). Recommended planting elevation for *S. alterniflora* in this region was .5–.9-m (1.8–3 feet) above mean low water. Large areas can be vegetated from one sprig or shoot within a short time. The use of hay bales for containment walls around spoil was recommended. Seagrass transplants had a survival rate of about 30% after 1 year.

279. Elser, M. M., J. J. Elser, and S. R. Carpenter. 1986. Paul and Peter Lakes: a liming experiment revisited. Am. Midl. Nat. 116(2):282–295.

Response: FISH, INVERT, VEG, CHEM, WQUAL

Genus: *Anabaena, Ankistrodesmus, Ankyra, Arthrodesmus, Asterionella, Asterionella, Cerasterias, Chroococcus, Chrysosphaerella, Closteriopsis, Cosmarium, Crucigenia, Cryptomonas, Dactylococcopsis, Dinobryon, Gloeocystis, Gomphosphaeria, Mallomonas, Merismopedia, Oocystis, Peridinium, Phacus, Quadrigula, Rhodomonas, Selenastrum, Sphaerocystis, Staurastrium, Synura, Trachelomonas*

Compares the limnological properties of Peter Lake, which was limed periodically 8 years before the study, to those of the neighboring unlimed lake, Paul Lake, in northwestern Michigan. Physical and chemical changes in limed Peter Lake included increases in pH, alkalinity, dissolved inorganic carbon concentration, transparency, oxygen content, and summer heat content. The changes occurred rapidly the first year of liming and persisted with little variability through the 8 years following liming. Historical data and observations during this study indicated that the planktonic community structure of Peter Lake has been more variable than that of unlimed Paul Lake. Phytoplankton bloomed earlier and zooplanktivores foraged more efficiently in the limed lake.

280. Emerson, F. B., Jr. 1961. Experimental establishment of food and cover plants in marshes created for wildlife in New York State. J. N.Y. Fish Game. 8(2):130–144.

Response: WFOWL, VEG, SUCCESS

Genus: *Butomus, Polygonum, Sagittaria, Scirpus, Sparganium, Zizania*

Describes the results of plant establishment experiments at 32 wildlife marshes in Schuyler, Tompkins, Tioga, and Madison Counties, New York. The purpose of the plantings was to establish food and cover for waterfowl; planting areas were later evaluated in terms of factors that limited the establishment of vegetation such as wild rice (*Zizania aquatica*), hardstem bulrush (*Scirpus acutus*), flowering rush (*Butomus umbellatus*), three-square bulrush (*Scirpus americanus*), softstem bulrush (*Scirpus validus*), river bulrush (*S. fluviatilis*), American burreed (*Sparganium americanum*), arrowhead (*Sagittaria rigida*), and smartweed (*Polygonum* spp.). Describes planting success for each species. Planting recommendations include the statement that "planting cannot remedy errors in site selection and design."

281. Environmental Laboratory. 1978. Wetland habitat development with dredged material: engineering and plant propagation. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. DS-78-16. 158 pp.

Response: VEG, ECON

Genus: *Alisma, Borrichia, Carex, Cyperus, Deschampsia, Distichlis, Fimbristylis, Iris, Iva, Juncus, Panicum, Peltandra, Phragmites, Polygonum, Sagittaria, Salicornia, Scirpus, Spartina, Typha, Zizania*

Synthesizes information regarding marsh habitat development on dredge spoil substrate at six field sites: Windmill Point, James River, Virginia; Buttermilk Sound, Georgia coast; Bolivar Peninsula, Galveston Bay, Texas; Miller Sands, Columbia River, Oregon; Drake Wilson Island, Apalachicola Bay, Florida; and Salt Pond #3, San Francisco Bay, California. Describes guidelines for marsh plant selection (location, climate, tolerance, availability, cost, and maintenance). Discusses site selection and construction. Information on regional occurrence, growth requirements, propagule handling methods, soil, salinity, and inundation tolerance are listed for 115 plant species.

282. Environmental Laboratory. 1986. Field guide for low maintenance vegetation establishment and management. U.S. Army

Eng. Waterways Exp. Stn., Vicksburg, Miss., Instr. Rep. R-86-2. 111 pp.

Response: VEG, SOIL, CHEM

Genus: Many

Serves as a guide for natural resource and project managers dealing with increased costs of establishing and maintaining vegetation. Provides a flow diagram for selecting appropriate programs based on site evaluations. Additional flow charts assist with identifying vegetation problem areas for each site. Discusses soil properties, vegetation relations, climatic stresses, disease, insect stresses, maintenance, and recreational-use-induced stresses. Includes a section dealing with baseline data needs, along with strategies for site preparation, protection, and project implementation.

283. Erickson, P. A., G. Camougis, and E. J. Robbins. 1978. Highways and ecology: effect assessment and mitigation. Fed. Highw. Adm., Rep. FWA-RWE/OEP-78-2. 182 pp.

Response: None

Genus: None

Discusses an ecosystem approach to assessing ecological effects of highway development and presents mitigation and enhancement measures for terrestrial, aquatic, and wetland environments. Summarizes studies of various highway mitigation projects for each type of environment. Measures for enhancing aquatic and wetland habitats include brief discussions of stream relocation, instream structures for fish, fish passage systems, reestablishment of vegetation, sediment trapping pools, excavation of borrow pits, and marsh creation.

284. Ericson, W. A., W. D. Carrier, III, L. G. De Mello, and R. X. Gonzalez. 1984. Stabilization and design planning for reclamation of an abandoned phosphatic clay settling pond. Pages 203–208 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: SOIL

Genus: None

Describes stabilization and design planning for reclamation of an abandoned phosphatic clay settling pond in Polk County, Florida. Abandonment of the pond consisted of draining and strengthening the clays followed breaching of the perimeter dike system at one or more locations. After 4 years of lowered water levels (to 1.5 m [5 feet] below clay surface), near surface solids content of the clay increased from 15 to 31%. During that time, woody vegetation replaced the wetland plants. Presents proposed construction methodology to revegetate the site and further consolidate clays.

285. Erlandson, C. S. 1987. The potential role of seed banks in the restoration of drained prairie wetlands. M.S. thesis, Iowa State University, Ames. 105 pp.

Response: VEG

Genus: *Alisma, Ammannia, Carex, Echinochloa, Elatine, Eleocharis, Erotiola, Juncus, Leersia, Lemna, Limosella, Lindernia, Lycopus, Mentha, Panicum, Penthorum, Polygonum, Ranunculus, Riccia, Ricciocarpus, Rorippa, Rumex, Sagittaria, Scirpus, Sium, Sparganium, Spirodela, Typha*

Examines seed bank trends influenced by geographic location and duration of drainage and cultivation in drained and undrained prairie wetlands in Sheridan and Wells counties, North Dakota; Otter Tail County, Minnesota; and Story County, Iowa. Eighty-two sites were sampled; seeds contained in the samples were germinated under laboratory conditions. The average number of species in the seed bank (per site) was compared to duration of drainage at the site. Presents geographical distribution of selected species and describes seed longevity characteristics.

286. Erwin, K. L. 1984. Fort green reclamation project: second annual report. 1984. Agrico Chemical Co., Mulberry, Fla. 253 pp.

Response: INVERT, VEG, CHEM, WQUAL

Genus: *Acer, Fraxinus, Gordonia, Hydrocotyle, Ilex, Nyssa, Panicum, Pinus, Platanus, Polygonum, Pontederia, Quercus, Taxodium, Typha, Ulmus*

Summarizes findings from a second year of monitoring the reclamation of phosphate mined land adjacent to the Payne Creek floodplain in southwest Polk County, Florida. Emphasis was placed on forest and marsh reclamation sampling techniques and parameter estimation criteria and assessment. A predictive model was developed for comparing reclaimed and natural wetland systems based on the findings from benthic invertebrate data. Water quality data from 20 wells measured temperature, pH, turbidity, alkalinity, BOD, specific conductance, nitrogen, phosphate, ammonia, and 19 additional metals. The marsh vegetation establishment was accelerated through the use of a thin layer of mulch.

287. Erwin, K. L. 1986. A quantitative approach for assessing the character of freshwater marshes and swamps effected by development in Florida. Pages 295–297 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Describes an approach for evaluating the structure and function of an impacted wetland ecosystem. Discusses hydrological functions, water quality, fish and wildlife values, and vegetative composition. Reviews methodologies for characterizing vegetation, with emphasis on line intercept transect and line strip (elongated quadrat) techniques. Discusses limitations to this approach; they include lack of success criteria, time (to evaluate seasonal cycles), and expense (e.g., extensive field work and data analysis).

288. Erwin, K. L. 1983. Fort Green reclamation project: first annual report. 1983. Agrico Chemical Co., Mulberry, Fla. 120 pp.

Response: VEG, CHEM, WQUAL

Genus: *Acer, Baccharis, Cyperus, Digitaria, Gordonia, Hydrocotyle, Lemna, Liquidambar, Nyssa, Platanus*, many

Summarizes the reclamation of phosphate mined land adjacent to the Payne Creek floodplain in southwest Polk County, Florida. The reclamation project was designed specifically for the evaluation and monitoring of a freshwater marsh and hardwood swamp. Emphasis was on sampling and measurement of forest and marsh communities and applying the information to reclamation. The site was prepared with muck using contouring and levee construction to form impoundments and control drainage. A water budget proved useful for predicting groundwater elevations, runoff, evapotranspiration, water storage, and surface evaporation. Water quality parameters were monitored quarterly from a series of 12 m (40-feet) deep wells. Overall vegetation mortality was less than 20%.

289. Erwin, K. L. 1985. Fort Green reclamation projeet, third annual report. Agrico Chem. Co., Mulberry, Fla. 362 pp.

Response: INVERT, WFOWL, NGBIRDS, SHOREB, VEG, HYDRO, WQUAL, SUCCESS

Genus: *Acer, Cyperus, Echinochloa, Fraxinus, Gordonia, Hydrocotyle, Ilex, Liquidambar, Najas, Nyssa, Panicum, Pinus, Platanus, Polygonum, Pontederia, Quercus, Taxodium, Typha, Typha, Ulmus*, many

Describes the results of monitoring the Agrico Swamp project, a phosphate mined site in southwest Polk County, Florida. The project involved reclaiming high quality marsh and forested wetland ecosystems. The goal of the monitoring program is to compare results of reclamation with and without mulching to establish late successional perennials and control aggressive weedy species. In the forested wetland, long-term survival and growth of more than 65,000 trce seedlings on previously mined lands under a variety of environmental conditions will be documented. Monitoring of benthic invertebrates, aquatic macrophytes, hydroperiod, water quality, and bird life is designed to develop a predictive model of long-term trends in the development of a biological community on mined lands.

290. Erwin, K. L. 1986. Fort Green reclamation project, fourth annual report. Agrico Chemical Co., Mulberry, Fla. 296 pp.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, VEG, HYDRO, WQUAL, SUCCESS

Genus: *Acer, Cyperus, Echinochloa, Fraxinus, Gordonia, Hydrocotyle, Ilex, Liquidambar, Najas, Nyssa, Panicum, Pinus, Platanus, Polygonum, Pontederia, Quercus, Taxodium, Typha, Typha, Ulmus*, many

Provides an update of the results of monitoring the Agrico Swamp project from 1982 to 1986 at the Fort Green mine near Payne Creek in southwest Polk County, Florida. The program includes marsh community reclamation, forest wetland community reclamation, analysis of biological integrity within Agrico Swamp and Payne Creek, water quality analyses, and fish and wildlife studies. Provides extensive data.

291. Erwin, K. L., and F. D. Bartleson. 1985. Water quality within a central Florida phosphate surface mined reclaimed wetland. Pages 84–95 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: HYDRO, CHEM, WQUAL

Genus: None

Describes the results of water quality testing at Agrico Swamp, a reclaimed wetland in Polk County, Florida. Formerly a phosphate surface mine, the reclaimed area now includes open water, freshwater marsh, hardwood swamp, and upland habitats. Surface water varied from 7.9 to 9.8 pH, compared to 5.7 to 6.0 pH in a nearby natural lake; amounts of total nitrogen and total phosphorus were relatively low in the swamp. Dissolved solids, specific conductance, and turbidity were higher in the swamp than in the natural area. Describes water quality parameters in adjacent Payne Creek. Groundwater had 6.3 to 7.6 pH inside Agrico Swamp and 6.2 to 7.9 pH outside the project area; includes other groundwater quality parameters.

292. Erwin, K.L., and G.R. Best. 1985. Marsh community development in a central Florida phosphate surface-mined reclaimed wetland. Wetlands 5:155–166.

Response: VEG

Genus: *Hydrocotyle, Najas, Panicum, Polygonum, Pontederia, Typha*

Describes a study of wetland creation at Agrico Swamp near Payne Creek, Polk County, Florida. Compares revegetation of topsoil and overburden to determine effective methods for establishing marshes in late stages of succession (and high diversity) immediately after mining. In general, the mulch topsoiled area had greater species richness than the overburden area. Describes seasonal changes in percent cover of several plant species on both overburden and topsoil areas. Emphasizes the importance of creating wetlands well buffered against disturbances.

293. Erwin, K. L., G. R. Best, W. J. Dunn, and P. M. Wallace. 1985. Marsh and forested wetland reclamation of a central Florida phosphate mine. Wetlands 4:87–104.

Response: VEG, HYDRO

Genus: *Acer, Fraxinus, Gordonia, Ilex, Juncus, Liquidambar, Najas, Nymphaea, Nyssa, Panicum, Pinus, Platanus, Pontederia, Quercus, Taxodium, Typha, Ulmus*

Describes results of the reclamation of Agrico Swamp, a phosphate mine area in southwest Polk County, Florida. The land was contoured, ponds were constructed, and a water budget was developed. About 66,000 trees (12 species) were planted. After 1 year, tree survival was 72–77%. In the marshes, topsoil areas had more species and a higher percent cover than overburden areas. The topsoil areas were dominated by both annuals and perennials, whereas the overburden areas were dominated mostly by annuals. Discusses the establishment of late successional, long-lived perennials and control of aggressive weed species. The use of topsoil from donor marshes was successful in this case.

294. Ettinger, W., and C. Yuill. 1982. Sand and gravel pit reclamation in Louisiana: creation of wetlands habitats and its integration into adjacent undisturbed bayou. Pages 109–114 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn., Misc. Publ. 17-1982.

Response: None

Genus: None

Describes a reclamation plan for Gifford-Hill's Sibley mine site in Webster Parish near Sibley, Louisiana. The postmining landscape consisted of spoil piles and excavated troughs. A major element of the reclamation plan was accommodating lowered land elevation resulting from mining. Habitat development includes planning for a mix of dry areas, periodically flooded areas, and warmwater fisheries habitat. Describes regrading, water level manipulation, and revegetation. Includes revegetation objectives: planting of rapidly growing cover to control erosion, planting of species compatible with adjacent bayou, and providing a mix of vegetation for optimum wildlife habitat potential.

295. Evans, M., and T. Brungardt. 1978. Shoreline analysis of Sarasota County bay systems with regard to revegetation activities. Pages 193–206 *in* D. P. Cole, ed. Proceedings Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Avicennia, Rhizophora*

Describes the development of estuarine resource mapping (including geographical areas of special concern) in Sarasota County, Florida; two pilot projects dealing with shoreline sta-

bilization and nursery cultivation of shoreline vegetation; and a shoreline preference survey to determine public preference of different types of shoreline. Results from the projects indicated that with the addition of mulch and fertilizer, the survival rate of *Rhizophora* was 68–95% and the survival rate of *Avicennia* was 8–70%.

296. Evans, R. K. 1977. Techniques and seasonal growth rate of transplanted white mangroves. Pages 77–104 *in* R. Lewis and D. Cole, eds. Proceedings of the Fourth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: INVERT, VEG

Genus: *Laguncularia*

Describes transplanting experiments with white mangrove (*Laguncularia racemosa*) at the Bayside Club, Inc., Siesta Key, Florida. Transplant survival rate was 97.6%. Highest growth rates were achieved with spring plantings. Distance from the shoreline influenced growth significantly; plants thrived best when roots contacted water, but were not completely inundated. Larger transplants were more likely to survive than seedlings. Survival rates of transplants were increased by watering until plants were established, leaving rootballs intact, and pruning.

297. Exum, J. H., and B. W. Breedlove. 1986. Habitat evaluation and postdevelopment site design on a central Florida site proposed for development. Pages 298–304 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Association of State Wetland Managers, Berne, N.Y.

Response: FISH, WFOWL, NGBIRDS, SHOREB, REPT, VEG

Genus: None

Describes the evaluation of existing habitat, potential habitat, and basin-wide effects for a mitigation project in southern Orange County, Florida. Seven indicator species were selected for the U.S. Fish and Wildlife Service's habitat evaluation procedures (HEP). These species represent wildlife guilds that would be expected to use habitat niches that result from the mitigation project. The information was used to design a wildlife corridor along the floodplain of shingle creek.

298. Faber, P. 1983. Marsh restoration with natural revegetation: a case study in San Francisco Bay. Coastal Zone '83 1:729–734.

Response: VEG, SOIL, CHEM

Genus: *Cotula, Distichlis, Grindelia, Jaumea, Salicornia, Spartina, Spergularia*

Describes the natural revegetation of Muzzi Marsh in San Francisco Bay, California. Tidal activity was restored through dike breaching; a ring of channels was created around the marsh to limit access. Vegetation was monitored, mapped, and inventoried. Soil was analyzed and birds were surveyed. After a lag period of 2–3 years, as soil salinity decreased, rapid colonization by pickelweed (*Salicornia virginica*) and slower colonization by cordgrass (*Spartina foliosa*) occurred.

299. Faber, P. 1982. Muzzi Marsh restoration, a mitigation project. Page 100 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: SHOREB, VEG, SUCCESS

Genus: *Salicornia, Spartina*

Discusses restoration to tidal activity by dike breaching of 55 ha (135 acres) of diked and partially filled marshland on San Francisco Bay, California. After 4 years, 50% of the site was covered by *Salicornia virginica*. Between the third and fourth years, significant increases in *Spartina foliosa* were noted. Increases in fish and invertebrates were reflected in the observation of active feeding of large flocks of shorebirds. The project was developed as mitigation for the loss of 34 ha (85 acres) of mudflats to dredging activities.

300. Falco, P. K., and F. J. Cali. 1977. Pregermination requirements and establishment techniques for salt marsh plants. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Misc. Pap. D-77-1. 40 pp.

Response: VEG, SOIL

Genus: *Ammophila, Aster, Borrichia, Distichlis, Enteromorpha, Fimbristylis, Iva, Juncus, Limonium, Panicum, Phragmites, Plantago, Salicornia, Scirpus, Solidago, Spartina, Spergularia, Suaeda, Typha, Ulva, Uniola*

This is an overview of pregermination requirements and establishment techniques for salt-marsh plants. Seeding and transplanting methods have been used to successfully establish artificial marshes in coastal areas (including dredged spoil deposits). Most frequently the substrate is sand. Physical characteristics of substrate affect growth; elevation and hydrology affect plant distribution and zonation. State-of-the-art reviews cover factors affecting germination and growth of salt marsh grasses, growth requirements (propagation, substrate, fertilization, establishment), and artificial marsh establishment.

301. Farnworth, E. G. 1981. Natural revegetation of tidal freshwater marshes disturbed by natural gas pipeline construction in Savannah, Georgia. Pages 1–29 *in* R. E. Tillman, ed. Proceedings: second symposium on environmental concerns in rights-of-way management. Electric Power Research Institute, Palo Alto, Calif.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Alnus, Cornus, Cyperus, Fraxinus, Iris, Juncus, Myrica, Nyssa, Peltandra, Pinus, Polygonum, Pontederia, Quercus, Sagittaria, Scirpus, Taxodium, Typha, Zizania, Zizaniopsis*, many

Natural rapid revegetation of disturbed tidal and freshwater marshes occurred in soil retained after pipeline construction in the Savannah National Wildlife Refuge, Georgia. Where backfilling occurred, revegetation began before the winter die-back of the marsh. Many colonizing species in the disturbed area were annuals. Nitrogen was measured at 6.0–9.0 mg/L in the disturbed marsh and 1.0–3.0 mg/L in the undisturbed area. Net primary production (dead material and below-ground biomass were not considered) was 550–1,000 g/m^2/year in the disturbed marsh and 470–600 g/m^2/year in the undisturbed marsh.

302. Fauer, S. E., and M. Gritzuk. 1979. An environmental assessment of restored salt marshes in New Jersey. Pages 175–190 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, VEG, SOIL, ECON

Genus: *Baccharis, Distichlis, Iva, Limonium, Phragmites, Pluchea, Salicornia, Spartina*

Describes the restoration of seven salt marshes near Barnegat Bay and Little Egg Harbor, Ocean County, New Jersey. These areas were graded and planted with marshhay cordgrass (*Spartina patens*; upper elevations) and smooth cordgrass (*S. alterniflora*; lower elevations). Prerestoration ecological surveys of areas were not conducted, but such baseline data would have been extremely helpful. Evaluates foliar export, erosion, debris, succession, and wildlife after 2 years. Two problems that hampered the restoration effort were salt toxicity at higher elevations and selection of *S. patens* instead of reeds (*Phragmites*) for planting at one site. Restoration of 2.6 ha cost $76,334.

303. Fehring, W. K., and C. Giovenco. 1979. An analysis of three marsh creation projects in Tampa Bay resulting from regulatory requirements for mitigation. Pages 191–206 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Avicennia, Laguncularia, Rhizophora, Spartina*

Describes 3 wetland creation projects in Tampa Bay, Florida: planting of red mangrove (*Rhizophora mangle*) seedlings along seawalls at Apollo Beach; transplanting of cordgrass (*Spartina*) on spoil islands in Hillsborough Bay; and transplanting of black mangroves (*Avicennia germinas*) and *Spartina*, also on spoil islands in Hillsborough Bay. All three projects were the result of regulatory requirements for mitigation. Technical problems included poor breakwater construction, transplanting at unsuitable elevations, and in one case a poor choice of transplant species. Discusses issues associated with land ownership, organizational authority, long-term commitment to project success, and the reluctance of developers to undertake mitigation projects.

304. Fischel, M. 1988. Wetland restoration/creation and the controversy over its use in mitigation: an introduction. Pages 127–129 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: SUCCESS, ECON

Genus: None

Discusses wetland restoration and creation, the success of these processes, and the controversy over the use of restoration and creation to mitigate for wetland loss from development activities. Most marsh restoration projects have been small, often less than 8 ha (20 acres). Costs vary from $250/.4 ha for simple, small projects to many thousands of dollars per acre for more complex projects (e.g., sewage treatment marsh). Success of the project depends on many factors, including wetland type and location, project scope and size, materials and methods used, careful project planning, and long-term management. Many years are required before the restored or created wetland functions as a "natural" wetland. In some instances it is unacceptable to trade the certain benefits provided by a natural wetland for the uncertain benefits of a newly-created marsh.

305. Flake, L. D. 1978. Wetland diversity and waterfowl. Pages 312–319 *in* P. E. Greeson, J. R. Clark, and J. E. Clark, eds. Wetland functions and values: the state of our understanding. Proceedings of the national symposium on wetlands. American Water Resources Association, Minneapolis, Minn.

Response: WFOWL

Genus: None

Discusses waterfowl use of wetland habitats, primarily in the prairie regions of North and South Dakota, during reproduction, molt, migration, and wintering. Waterfowl use of the numerous stock ponds and dugouts in the prairie region is directly related to the association of these man-made structures to natural wetlands. Stock ponds are seldom used by diving ducks and are often short-lived due to siltation and wash-out problems. Manmade dugouts built in small, shallow natural marshes produce significant amounts of fill material, which can destroy the marsh and simplify the wetland complex.

306. Follansbee, B. 1987. Eelgrass salvage, transplantation. Restor. Manage. Notes 5(2):96–97.

Response: VEG, SOIL

Genus: *Zostera*

Describes the transplantation of a large bed of eelgrass (*Zostera*) as mitigation for a proposed dredging project. Eelgrass was salvaged and planted at Indian Island, Humboldt Bay, California. Transplantation sites met the following criteria: 10–20° C water temperature, mud substrate, 0.6–0.8 kn/s current velocity, and no regular wave shock. An ongoing 2-year monitoring program has been established.

307. Fonseca, M. S. 1987. Habitat development applications: use of seagrass transplanting for habitat development on dredged material. Pages 145–150 *in* M. C. Landin and H. K. Smith, eds. Beneficial use of dredged material. Proceedings of the first interagency workshop. U.S. Army Waterways Exp. Stn., Vicksburg, Miss.

Response: VEG

Genus: *Zostera*

Discusses the National Marine Fisheries Service's program of evaluating seagrass transplanting for habitat development on dredged material. Research at the Beaufort Laboratory, North Carolina, has resulted in the development of cost-effective transplanting techniques, evaluation of erosion control by these plant communities, estimation of operation costs, and standardization of restoration and management protocol for most North American seagrass species. Seagrass population growth and coverage models form the basis for management guidelines. Work was initiated on an common eelgrass (*Zostera marina*) transplanting project adjacent to a dredged material island in North Carolina to determine differences in faunal use of transplanted and natural seagrass meadows.

308. Fonseca, M. S., and J. S. Fisher. 1986. A comparasion of canopy friction and sediment movement between four species of seagrass with reference to their ecology and restoration. Mar. Ecol. Prog. Ser. 29:15–22.

Response: VEG, HYDRO, SOIL

Genus: *Halodule, Syringodium, Thalassia, Zostera*

Compares canopy friction and sediment movement for four seagrass species under 27 combinations of velocity, water depth, and plant density in a flume. The magnitude of frictional development by the plants was ranked: *Thalassia testudinum* > Wright shoalweed (*Halodule wrightii*) = common eelgrass (*Zostera marina*) > slender syringodium (*Syringodium filiforme*). *Syringodium filiforme* exhibited no change in friction across the 5–30 cm/s range of velocities. Canopy friction exhibited a strong positive relation to the percentage of water column occupied by the seagrasses. Significant alteration of estuarine circulation patterns could result from removal of

seagrass meadows or their creation through transplanting. The frictional characteristics also directly influence the deposition and distribution of fauna and detritus in a seagrass bed.

309. Fonseca, M. S., W. J. Kenworthy, K. M. Cheap, C. A. Currin, and G. W. Thayer. 1984. A low-cost transplanting technique for shoalgrass (*Halodule wrightii*) and manatee grass (*Syringodium filiforme*). U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Instr. Rep. EL-84-1. 16 pp.

Response: VEG

Genus: *Halodule, Syringodium*

Presents a simplified, low-cost seagrass transplanting technique for use in high- and low-current regimes. Mature, vegetative shoots, free of sediment, were anchored to the substrate. Includes selection of planting stock, harvesting, storage, preparation of planting units, and labor requirements.

310. Fonseca, M. S., W. J. Kenworthy, J. Homziak, and G. W. Thayer. 1979. Transplanting of eelgrass and shoalgrass as a potential means of economically mitigating a recent loss of habitat. Pages 279–326 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: INVERT, VEG, HYDRO, SOIL, CHEM, WQUAL, ECON

Genus: *Halodule, Zostera*

Describes the experimental revegetation of common eelgrass (*Zostera marina*) in a shallow embayment in back sound, southeast of Cape Lookout, North Carolina. The purpose of this experiment was to evaluate substrate-energy regime; season of planting; and interactions with other marine angiosperms, especially Wright shoalweed (*Halodule wrightii*). Describes a new approach for transplanting. Analyses of scallop populations within the transplanted area indicated a strong relation between tranplant success (grass cover) and number of scallops (density). Fall seemed the best season for planting. The new planting method is more efficient than planting plugs, in terms of transplant growth, survival, and cost ($0.09–0.27/shoot).

311. Fonseca, M. S., W. J. Kenworthy, and R. C. Phillips. 1982. A cost evaluation technique for restoration of seagrass and other plant communities. Environ. Conserv. 9(3):237–241.

Response: ECON

Genus: *Halodule, Thalassia, Zostera*

Presents a seagrass restoration cost analysis, which also can be applied to assess plantings of other vegetation types. Essential factors include planning, planting, monitoring, geographic location, tidal influence, labor, and materials (both expendable and nonexpendable). Cost per (successfully established) shoot or seed or fruit is recommended as the best indicator of cost effectiveness for a given technique. Incorporation and presentation of this information are recommended for future projects to motivate wider application of seagrass and other essential plant-community restoration.

312. Fonseca, M. S., W. J. Kenworthy, K. Rittmaster, and G. W. Thayer. 1987. The use of fertilizer to enhance transplants of the seagrasses *Zostera marina* and *Halodule wrightii*. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. EL-87-12. 45 pp.

Response: VEG, HYDRO, SOIL, CHEM, ECON

Genus: *Halodule, Zostera*

Examines the influence of slow release fertilizers on survival, population growth, and areal coverage of common eelgrass (*Zostera marina*) and Wright shoalweed (*Halodule wrightii*) at three sites near Beaufort, North Carolina, in both spring and fall. Balanced fertilizer additions (14–14–14) of nitrogen-phosphorus-potassium at 10 g per planting unit seemed to increase population growth, coverage, and productivity in a cost-effective manner for fall eelgrass (*Zostera*) transplants.

313. Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1987. Transplanting of the seagrasses *Halodule wrightii, Syringodium filiforme*, and *Thalassia testudinum* for sediment stabilization and habitat development in the southeast region of the United States. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. EL-87-8. 62 pp.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL, ECON

Genus: *Halimeda, Halodule, Laurencia, Syringodium, Thalassia*

Assesses seagrass shoot generation and coverage rates under different environmental conditions at sites near Panama City, Florida, and the Florida Keys. Temperature, sediment fluctuation, sediment depth, and biotic disturbance affected transplants more than salinity, light attenuation, water depth, hydraulic regime, or sediment type. Biotic factors were probably most influential in transplant survival and coverage through shading, temperature increases due to reduced circulation, excavation, and grazing. Shoot generation rates varied as a function of species, planting season, and latitude. On the basis of shoot generation rates, Wright shoalweed (*Halodule wrightii*) and slender syringodium (*Syringodium filiforme*) were recommended as primary transplant species, followed by turtlegrass (*Thalassia testudinum*).

314. Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1982. A low-cost transplanting procedure for sediment stabilization and habitat development using eelgrass. Wetlands 2:138–151.

Response: ECON, SUCCESS

Genus: *Zostera*

Presents a low-cost eelgrass (*Zostera*) transplanting technique used during October in the Beaufort, North Carolina, area. The technique consists of attaching vegetative shoots, rinsed free of sediment, to 25 I-shaped steel rods, which are then inserted into sediment. Whole shoots from high current areas yielded a superior shoot generation rate in comparison to shoots from low current areas. Harvest rate from high current areas equaled 18,000 shoots per man hour (mh). Total labor requirements were 250 and 493 mh/ha in low and high current areas, respectively. Sediment stabilization was dependent on current velocity reduction and wave dampening, which were functions of meadow size and ambient current and wave regimes. Eelgrass was capable of trapping and maintaining at least 90 m^3 of sand per hectare of bottom covered.

315. Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1982. A low-cost planting technique for eelgrass (*Zostera marina* L.) U.S. Army Corps Eng., Fort Belvoir, Va., CETA 82-6. 15 pp.

Respouse: VEG, ECON

Genus: *Zostera*

Describes a low-cost planting method for common eelgrass (*Zostera marina*). Bundles of mature, vegetative shoots were washed free of sediment and anchored in the bottom substrate. Guidelines on harvesting and storing the plants, preparing planting units, the planting method, plant material require-

ments, and labor requirements are presented. Planting units have been successfully established in high (>.5 m/s [>1.6 feet/s]) and low current regimes on grids of .6–.8 m (2–2.6 feet). The production-line efficiency of the technique greatly reduces planting costs.

316. Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1986. Restoration and management of seagrass systems: a review. *in* International symposium on ecology and management of wetlands. College at Charleston, Charleston, S.C.

Response: None

Genus: *Halodule, Ruppia, Syringodium, Thalassia, Zostera*

Discusses restoration and management of seagrass systems throughout the coastal United States. Presents a chronological summary of selected seagrass transplanting efforts with geographic location, species, and a synopsis for each of 35 references. Topics include seagrass restoration as a mitigative tool, indirect and direct effects of seagrass transplanting, site selection, and monitoring (success, planning acreage, permit conditions, and functional equivalency). Recommends restoration of seagrasses, with emphasis on conservation of existing seagrass habitat, appropriate mitigation site selection, continued monitoring of plantings, and encouragement of research and data acquisition on the functional value of transplanted meadows.

317. Fonseca, M. S., W. J. Kenworthy, G. W. Thayer, D. Y. Heller, and K.M. Cheap. 1985. Transplanting of the seagrasses *Zostera marina* and *Halodule wrightii* for sediment stabilization and habitat development on the east coast of the United States. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. EL-85-9. 63 pp.

Response: VEG, SOIL, CHEM

Genus: *Halodule, Zostera*

Discusses results of a study in Back Sound, Carteret County, North Carolina, that evaluated critical environmental factors controlling eelgrass (*Zostera*) and shoalweed (*Halodule*) growth to determine sites most suitable for transplanting these species. Recommended limits and monitoring procedures are included for temperature, salinity, light depth, hydrodynamics, sediment characteristics, and sediment fluctuation. Semi-enclosed embayments protected from prevailing winds are suggested as preferred planting sites. Includes equations for determining amount of transplant stock and spacing required to cover sites in a specified number of days and recommendations for selecting stock.

318. Fonseca, M. S., G. W. Thayer, and W. J. Kenworthy. 1986. The use of ecological data in the implementation and management of seagrass restorations. Pages 175–187 *in* M. J. Durako, R. C. Phillips, and R. R. Lewis, III, eds. Proceedings of a symposium on subtropical-tropical seagrasses of the southeastern United States. Fla. Dep. Nat. Resour. Mar. Res. Publ. 42.

Response: VEG

Genus: *Halodule, Syringodium, Thalassia*

Discusses the use of ecological data to select seagrass restoration sites and compares seagrass population growth models developed from study sites near Panama City, Florida, and in the Florida Keys. Environmental factors such as light, temperature, salinity, tidal range, and sediment stability may be used to determine whether seagrass growth could be supported at a given site. Data suggested that unvegetated patches among natural meadows should not be planted (as mitigation for destruction of existing meadows) due to unfavorable environmental conditions. The use of seagrass population growth models can be an effective tool for planning, monitoring, and predicting responses of seagrass restoration projects.

319. Foote, A. L., and J. A. Kadlec. 1988. Effects of wave energy on plant establishment in shallow lacustrine wetlands. J. Freshwater Ecol. 4(4):523–532.

Response: VEG, SOIL

Genus: *Distichlis, Scirpus*

Discusses the effects of wave energy on plant establishment from June to September on exposed mud flats in the Bear River Bay, Great Salt Lake, Utah. Waves resuspended a minimum of 18 and maximum of 511 t of sediment per hectare. Sediment traps also captured seeds removed from the seed bank when sediments were resuspended. Survival of alkali bulrush (*Scirpus maritimus*) buds on protected and exposed sites was described. Wave break exclosures were used to produce protected site conditions. The survival rate of protected buds was almost twice that of exposed buds.

320. Ford, K. V. 1983. Wetland restoration at Four Corners Mine. Pages 134–147 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow, Fla.

Response: VEG

Genus: None

Discusses wetland restoration at the Four Corners Mine, a 5 million ton per year phosphate mine and beneficiation plant at the juncture of Hillsborough, Polk, Hardee, and Manatee Counties, Florida. Four wetland depressions (ponds) were constructed and used to determine the best method for revegetating marshes. Pond treatments consisted of hand planting of plants from nearby natural marshes, transplanting the upper 15-cm (6-inch) layer of muck from a nearby marsh, hand planting of trees, and no treatment (control pond). Ponds and natural marshes were monitored for 4 years. Transplanting muck was the most successful technique in terms of accelerated development of a dense and diverse marsh vegetation cover.

321. Forney, J. L. 1968. Production of young northern pike in a regulated marsh. J. N.Y. Fish Game. 15(2):143–154.

Response: FISH

Genus: *Alisma, Carex, Eleocharis, Juncus, Phalaris, Spartina, Typha*

Discusses production and survival of young northern pike (*Esox lucius*) from 1964 to 1967 in an experimental marsh created by impounding a temporary stream .4 km (.25 mile) from Oneida Lake in New York. Flooded vegetation consisted of winter wheat (*Triticum*) and natural vegetation, primarily sedges (*Carex*), grasses (*Spartina*), and water plantain (*Alisma*). Mortality between spawning and hatching was 81–84%; loss of young between hatching and emigration was 83%. Recoveries of fin-clipped fish suggested that few northern pike less than 65 mm long survived after they left the marsh. Suggests that maintenance of northern pike populations in many lakes may depend primarily on producing large juvenile fish in nursery areas before they emigrate to the lake.

322. Fowler, B. K., C. S. Hardaway, G. R. Thomas, C. L. Hill, J. E. Frye, and N. A. Ibison. 1985. Vegetative growth patterns in planted marshes of the vegetative erosion control project. Pages 110–120 *in* F. J. Webb., ed. Proceedings of the Twelfth

Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Spartina*

Documents the planting of 24 marshes for erosion control on the shores of the lower Chesapeake Bay and its tributaries. Planting locations exhibited diverse environmental conditions. Observations based on the results of 3 years of monitoring and maintenance planting include marshes established on lower energy shorelines are more productive; smooth cordgrass (*Spartina alterniflora*) should be planted between mean sea level and mean high water-spring high water; marshhay cordgrass (*S. patens*) areas accumulate wind-blown sediment, raising the elevation of the backshore; and marshes should be fertilized twice each summer. Presents measurements of stem density and culm diameter.

323. Fowler, D. K., and D. A. Hammer. 1976. Techniques for establishing vegetation on reservoir inundation zones. J. Soil Water Conserv. 31(3):116–118.

Response: VEG, ECON

Genus: *Lolium*

Describes three methods for seeding reservoir inundation zones (either steep shoreline or extensive mudflats) at several sites in Tennessee. Hydroseeding was used on sloping inundation zones; an aquaseeder was developed for this purpose. Production costs (seed, fertilizer, labor, vehicle operation) was $18.00/.4 ha. Air cushion vehicles were used to seed mudflats. Equipment modifications cost $2,500; areas inaccessible to other equipment were successfully seeded at a cost of $5.89/0.4 ha. Helicopters were used to seed extensive mudflats; total costs were $5.59/acre. Vegetation was successfully established by all three techniques; time and extent of mudflat exposure were critical factors in technique selection.

324. Fowler, D. K., D. M. Hill, and L. J. Fowler. 1985. Colonization of coal surface mine sediment ponds in southern Appalachia by aquatic organisms and breeding amphibians. Pages 261–285 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: FISH, INVERT, AMPHIB, VEG, CHEM, WQUAL

Genus: *Carex, Eleocharis, Juncus, Lindernia, Ludwigia, Typha*

Describes an experiment to determine the colonization rates of aquatic organisms and breeding amphibians in nine newly constructed coal surface mine sediment ponds in Campbell County, Tennessee. The disturbed areas were regraded, revegetated, and stabilized before stocking with game and forage fish. Describes breeding amphibians and aquatic insects. Benthic samples were taken using an Ekman dredge and pipe sampler. Includes water quality measurements.

325. Fowler, D. K., and J. B. Maddox. 1974. Habitat improvement along reservoir inundation zones by barge hydroseeding. J. Soil Water Conserv. 29(6):263–265.

Response: VEG, ECON

Genus: *Echinochloa, Fagopyrum, Lolium*

Describes the planting of Japanese millet (*Echinochloa crusgalli*), common buckwheat (*Fagopyrum esculentum*), and Italian ryegrass (*Lolium multiflorum*) along reservoir inundation zones. The study site was Cherokee Reservoir near Mooresburg, Tennessee; the feasibility of barge hydroseeding along the drawdown zone was examined. Potential benefits of vegetating this area included aesthetics, provision of food for wildlife (waterfowl), and erosion control. Costs for seed, fertilizer, and labor were about $30/.4 ha ($30/acre). Japanese millet seemed to be best adapted to site conditions. Timing of planting is important (seeding should not occur after early August) for minimization of potential frost damage. Both Japanese millet and common buckwheat were frost damaged during this study; Italian ryegrass grew vigorously until the temperature got cold and remained green during winter. Discusses habitat improvement implications.

326. Fowler, D. K., and L. J. Turner. 1981. Surface mine reclamation for wildlife: a model reclamation plan for southeast Appalachia. U.S. Fish Wildl. Serv., FWS/OBS-81/09. 27 pp.

Response: ECON

Genus: *Typha*, many

Presents a reclamation plan for surface coal mines in southern Appalachia. Includes suggestions for establishing groundcover and trees and retaining sediment ponds to provide wetland habitat. The costs of reclaiming the site for forestry and wildlife are compared to the costs for a more traditional forestry (monoculture) option. Costs of reclaiming land for wildlife, which involved retaining sediment ponds, were less than costs of the forestry option, which included removing sediment ponds.

327. Francis, G. R., J. J. Magnuson, H. A. Regier, and D. R. Talhelm. 1979. Rehabilitating Great Lakes ecosystems. Gt. Lakes Fish. Comm. Tech. Rep. 37. 99 pp.

Response: ECON

Genus: *Cladophora*

Reviews the state of the art for ecological rehabilitation of aquatic ecosystems and assesses the feasibility of applying it to the Great Lakes. Presents 16 man-induced stresses and some useful rehabilitative techniques (and a measure of current feasibility of implementing these techniques from technical, economic, and institutional viewpoints). Stresses included fishing and other harvesting, introduction of exotics, various contaminants, stream modifications, dredging and filling, and acid precipitation. This document serves as a framework for developing effective strategies for rehabilitation of Great Lakes ecosystems.

328. Fraser, J. E., and D. L. Britt. 1982. Liming of acidified waters: a review of methods and effects on aquatic ecosystems. U.S. Fish Wildl. Serv., FWS/OBS-80/40.13. 189 pp.

Response: FISH, INVERT, VEG, HYDRO, CHEM, WQUAL, ECON

Genus: None

Summarizes current information on liming and how it relates to aquatic habitats potentially effected by the acidification process. Primary emphasis is on the fishery resource. Discusses acid-sensitive regions and the effects of acidification on fisheries of each region. Address preventative and mitigative liming, liming techniques, aquatic ecosystems, and information needs. Appendixes provide a summary of liming projects in the northeast and midwest; a listing of State, Federal, and private sector contacts to aid liming projects; and a review and evaluation of models and predictive techniques for establishing liming requirements.

329. Fredette, T. J., M. S. Fonseca, W. J. Kenworthy, and G. W. Thayer. 1985. Seagrass transplanting: 10 years of U.S. Army Corps of Engineers research. Pages 121–134 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Halodule, Syringodium, Thalassia, Zostera*

Summarizes 10 years of research on seagrass transplanting by the U.S. Army Corps of Engineers. Discusses site suitability, recommended environmental measurements (light-depth penetration, salinity, temperature, sediment flux, current, fetch-waves, and sediment depth), planting methods, and species selection. The recommended planting method is the bare-root technique using 5–15 shoots attached to anchors. In some areas, multispecies transplanting is recommended due to slow growth rate of *Thalassia*. Vegetative reproduction of shoalweed (*Halodule*) is rapid, whereas *Syringodium* grows at an intermediate rate. Discusses continuing research needs.

330. Fredrickson, L. H., and F. A. Reid. 1986. Wetland and riparian habitats: a nongame management overview. Pages 59–96 *in* J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the midwest; a developing art. Proceedings 47th midwest fish and wildlife conference, north central sect. Wildlife Society, Grand Rapids, Mich.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT

Genus: None

Presents an overview of nongame habitat use and management of wetland and riparian habitats throughout the United States. Discusses case histories of management in Missouri. Topics include current status and trends of wetland and riparian habitats, characteristics of wetland and riparian habitats, habitat complexes, conceptual approaches to management, and specific management practices (marsh, moist-soil, and riparian habitat). Presents an integrated management scheme for five wetland basins in Missouri and concludes that habitats should be manipulated as complexes with dynamic water regimes.

331. Fredrickson, L. H., and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish Wildl. Serv., Resour. Publ. 148. 29 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG

Genus: *Bidens, Cyperus, Digitaria, Echinochloa, Leptochloa, Panicum, Polygonum, Xanthium*, many

Discusses moist soil management to attract wildlife on man-made impoundments. Low sites where row crops are often lost to flooding are particularly well suited for moist soil management. Optimum success requires good levees, control structures for precise water manipulations, and a pumping system to remove or add water. A group of small impoundments provides more management flexibility than a single large impoundment. Presents guidelines for developing moist soil impoundments (construction, costs, benefits), vegetation management of seasonally flooded impoundments, manipulations of water levels for wildlife, and developing integrated management plans.

332. Funk, W. H., and H. L. Gibbons. 1978. Lake restoration by nutrient inactivation. Pages 141–151 *in* Lake restoration: proceedings of a national conference. U.S. Environ. Prot. Agency, Minneapolis, Minn. EPA 440/5-79-001.

Response: FISH, INVERT, WQUAL

Genus: None

Describes the techniques, methodology, equipment, and costs of treatment used to improve water quality of several eutrophic lakes: Horseshoe Lake, Manitowoc County, Wisconsin; Twin and Dollar lakes, near Kent, Ohio; Medical Lake, Washington; Clines' Pond, Corvallis, Oregon; and Liberty Lake, Washington. Aluminum compounds were commonly used to inactivate (excess) lake nutrients, primarily phosphorus. This treatment was successful in reducing algal blooms by removing phosphorus at ice-out and neutralizing the release of phosphorus from aquatic plant matter and from lake sediment. Most treatments were effective for 2–3 years.

333. Funk, W. H., H. L. Gibbons, and G. C. Bailey. 1981. Lake assessment in preparation for a multiphase restoration treatment. Pages 226–237 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, Portland, Maine, EPA 440/5-81-010.

Response: INVERT, VEG, HYDRO, CHEM, WQUAL

Genus: *Anabaena, Aphanizomenon, Asterionella, Ceratium, Ceratophyllum, Coelosphaeridium, Elodea, Fragilaria, Gloeotrichia, Melosira, Microcystis, Potamogeton, Tabellaria*

Discusses efforts to restore Liberty Lake in eastern Washington, a heavily used recreational lake plagued by massive blue-green algal blooms during summer. In 1974, alum treatment of the 288-ha lake aimed at late summer and fall release of phosphorus successfully demonstrated the need to control internal cycling of nutrients as well as surface and subsurface input. Macrophytes growing in rich sediments acted as nutrient pumps releasing phosphorus above the floc layer. The alum treatment kept blue-green algal problems under control for 3 years. Further restorative efforts began in 1978 with sewering of the lake periphery and marsh runoff diversion the following year. Suction dredging followed by alum treatment is scheduled for fall 1980. Presents water quality, phytoplankton, macrophyte, and aquatic invertebrate data for 1978–79.

334. Fuss, C. M., Jr., and J. A. Kelly, Jr. 1969. Survival and growth of sea grasses transplanted under artificial conditions. Bull. Mar. Sci. 19(2):351–365.

Response: VEG

Genus: *Diplanthera, Thalassia*

Describes procedures of transplanting seagrasses in aquaria and sea water tanks. Sprigs of turtlegrass (*Thalassia testudium*) and Wright shoalgrass (*Diplanthera wrightii*) were removed from natural sites near St. Petersburg, Florida, and transplanted in aquariums and flow-through seawater tanks. The tanks were filled to approximately 40 cm at 25° C. *Thalassia* sprigs survived 7 months in an aquarium; *Diplanthera* sprigs died after 3.5 months. Records rhizomic and short-shoot growth of *Thalassia* in the tanks.

335. Fuxing, J., and L. Baoshu. 1985. Salt tolerance of several species of *Spartina*. Pages 340–341 *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing Univ., China.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Spartina*

Reviews salt tolerance of (*Spartina anglica*), smooth cordgrass (*S. alterniflora*), marshhay cordgrass (*S. patens*), and big cordgrass (*S. cynosuroides*) grown in anaerobic, high-salinity environments, and the effects of salt on seed germination and growth. Substrate salinity of intertidal zones where *S. alterniflora* and *S. anglica* occur is higher than that of supratidal zones where *S. patens* and *S. cynosuroides* are found. However, all four species will grow in fresh water. Maximum rate of germination occurs in fresh water and rates decrease with increase of salt content. Salt glands on leaves of *Spartina* are the main paths of salt excretion. *Spartina* roots possess high salt resistance.

336. Gallagher, J. L. 1980. Marsh creation: effects of pesticides on the flora. Pages 136–139 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG

Genus: *Spartina*

Describes effects of pesticides on marsh vegetation. Various examples of herbicide-insecticide application, sometimes as part of marsh management, are described. In other instances, wetlands are nontarget recipients of pesticides. Describes several examples of pesticide loss from soils.

337. Gallagher, J. L. 1980. Salt marsh soil development. Pages 28–34 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: SOIL, CHEM

Genus: *Distichlis, Juncus, Phragmites, Salicornia, Spartina, Sporobolus*

Provides an overview of salt marsh soil and its development, characteristics of original marsh sediment (i.e., dredged material), and plant selection to aid desired substrate changes. Whereas natural marsh soils are tidally deposited with fairly uniform grain size fractionation, dredged materials are variable and may be more difficult to vegetate. Discusses salt marsh soil stability, acidity, moisture, salinity, and nutrients. Describes plants tolerant of special soil conditions or useful in aiding desired changes in substrate.

338. Gallagher, J. L., F. G. Plumley, and P. L. Wolf. 1977. Underground biomass dynamics and substrate selective properties of Atlantic coastal salt marsh plants. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-28. 167 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Borrichia, Carex, Distichlis, Eleocharis, Juncus, Phragmites, Salicornia, Spartina, Sporobolus*

Summarizes studies of underground biomass dynamics and substrate selection of salt marsh plants in 18 stands along the Atlantic coast of Georgia, Delaware, and Maine. Study sites included natural marshes and those composed of various types of dredged material. Findings indicated that in developing a salt marsh on dredged materials, substrate problems should be considered: stability (dredged material texture and exposure to wave action); pH; salinity; soil characteristics; and nutrients, of which nitrogen seems to be the key element. Provides recommendations on the use of dredged material and plant species for marsh development and advises the use of a field bioassay before dredging.

339. Gallagher T. J. 1982. Eugene's urban wildlife area: delta ponds. Pages 122–126 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn., Agric. Exp. Stn., Misc. Publ. 17-1982.

Response: None

Genus: *Populus, Potamogeton, Rubus, Salix, Typha*, many

Describes the delta ponds of Eugene, Oregon. The ponds are located on former pasture that was mined for gravel before 1980. The City of Eugene acquired the delta ponds. Lists recommendations for a management plan. Considerations include environment (reshaping ponds and managing for wildlife), recreation (fishing, canoeing, hiking, wildlife observation), education, visual quality, safety, and economics (additional mining of the site could fund many improvements).

340. Gambrell, R. P., R. A. Khalid, and W. H. Patrick, Jr. 1978. Disposal alternatives for contaminated dredged material as a management tool to minimize adverse environmental effects. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. DS-78-8. 163 pp.

Response: SOIL, CHEM, WQUAL

Genus: None

Provides guidelines for selecting alternative methods for dredged material disposal to minimize adverse environmental effects. The focus is on manipulation of spoil and disposal techniques for contaminated sediments. Potentially toxic soils should be placed in low-energy regimes to minimize resuspension and transport of contaminated solids into adjacent aquatic systems. Unconfined subaqueous disposal represents a high environmental risk due to transformation of the contaminants to more mobile, available forms. Short- and long-term considerations for subaqueous intertidal and upland disposal alternatives are discussed. Describes initial considerations and soil conditions necessary for disposal.

341. Garbisch, E. W., Jr. 1977. Revegetation and development of tidal marshlands. Pages 179–184 *in* Proceedings 32nd annual meeting of the soil conservation society of America. New directions in century three: strategies for land and water use. Soil Conservation Society of America, Ankeny, Iowa.

Response: VEG, SOIL, CHEM

Genus: None

Presents guidelines, techniques, and mitigation opportunities for restoring marshlands lost as a result of construction-development activities. Tidal marsh establishment to reduce shoreline erosion and improve wildlife habitat was successful in Chesapeake Bay and southern New Jersey. Filling and resurfacing with marsh materials was best accomplished in winter when production was low and plants were dormant. Peat was the least desirable substrate material. Surface slopes were as low as possible (without impounding water). Proper surface elevation was important for successful vegetative establishment. Toxic salt concentrations in the soil can become a major limiting factor, inhibiting growth of marsh plants. Includes guidelines for establishing wildlife habitat on dredge material.

342. Garbisch, E. W., Jr. 1977. Marsh development for shore erosion control. Pages 77–94 *in* Proceedings of the workshop on the role of vegetation in stabilization of the Great Lakes shoreline. Great Lakes Basin Commission, Ann Arbor, Mich.

Response: VEG, SOIL

Genus: None

Discusses bank sloping in relation to marsh development for shore erosion control on the Great Lakes. Presents brief examples of marsh creation on existing and on physically altered shores, with diagrams and photos. Stresses conducting preliminary research on marsh creation technology in the Great Lakes region and emphasizes that most marsh development would have to take place within low-profile protective enclosures or behind breakwaters due to the extensive wave exposure of the Great Lakes shoreline.

343. Garbisch, E. W., Jr. 1973. "Green grow the rushes": tidal marsh synthesis in the Chesapeake Bay. Potomac Appalachian Mag. (1):17–27.

Response: MAMMALS, WFOWL, VEG

Genus: *Ammophila, Distichlis, Panicum, Spartina, Typha*

Presents an overview of efforts to create, restore, and maintain Chesapeake Bay tidal marshes. A case study of a created intertidal sand flat at Hambleton Island is discussed in greater detail. Approximately 2,294 m^3 (3,000 cubic yards) of biologically sterile sand was placed in the bay and planted with 60,000 seedlings of cordgrass (*Spartina*), saltgrass (*Distichlis spicatum*), cattails (*Typha*), common reed (*Phragmites australis*), switchgrass (*Panicum virgatum*), and American beachgrass (*Ammophila breviligulata*). Within 8 months after planting, benthic invertebrate species diversity was identical to that found in an undisturbed intertidal control area. Consumption of submerged rhizomes by geese, swans, muskrats (*Ondatra zibethica*), and raccoons (*Procyon lotor*) reduced vegetative establishment.

344. Garbisch, E. W., Jr., P. B. Woller, and R. J. McCallum. 1975. Salt marsh establishment and development. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Memo. 52. 110 pp.

Response: INVERT, VEG, SOIL, CHEM

Genus: *Ammophila, Distichlis, Spartina*

Intertidal and subtidal zones of several sites in mid-Chesapeake Bay were planted with experimental seagrass seedlings. No limitations for vegetation establishment above mean high water were found. Net production of seagrasses increased 135–860% in the moderate to low-energy sandy areas after application of fertilizer. Macrobenthic invertebrate response was monitored; the subtidal zone had the larger population, which decreased with increasing elevation. Seedlings were protected from grazing Canada geese (*Branta canadensis*) by covering the site with netting. Transplant mortalities were reduced in the high-energy zone by delaying planting until mid-June.

345. Garbisch, E. W. 1978. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix B: propagation of vascular plants. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-23. 157 pp.

Response: VEG

Genus: *Peltandra, Scirpus, Spartina*, many

Describes marsh planting results on off-dike, unconfined dredged materials at the James River habitat development site, Windmill Point, Prince George County, Virginia. Plants were monitored to determine optimum elevations and fertilization needs for successful propagation. Compares results of seeding and sprigging. Discusses laboratory tests conducted on seed germination.

346. Garbisch, E. W. 1977. Wetland rehabilitation. Pages 217–219 *in* Proceedings of the national wetland protection symposium. U.S. Fish Wildl. Serv., FWS/OBS-78/97.

Response: VEG, ECON, SUCCESS

Genus: None

Includes discussion of marsh rehabilitation, planting techniques and costs, and functions of rehabilitated marshes. The technology for rehabilitation of tidal marshes has been developed well enough to play a significant role in the development of guidelines for site preparation and vegetative establishment. Depending on marsh establishment design, important marsh functions (including vegetative productivity), wildlife use, erosion control, and water quality improvement, maximize operationally within 1–3 years of initial establishment.

347. Garbisch, E. W. 1977. Recent and planned marsh establishment work throughout the contiguous United States—a survey and basic guidelines. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Contract Rep. D-77-3. 48 pp.

Response: VEG

Genus: *Distichlis, Juncus, Peltandra, Pontederia, Rhizophora, Salicornia, Scirpus, Spartina, Typha*

Reports on 105 marsh establishment projects throughout the United States. Surface slope and elevation are the two most important factors in marsh site preparation. Marsh plant selection guidelines include consideration of native species, project objectives, growth rates and sediment stabilizing characteristics, site elevation, and time of planting. For plantings in high stress areas, properly developed nursery stock is most successful. Discusses transplant spacing and fertilization requirements. Three major requirements for marsh establishment are removal of debris and litter, protection against waterfowl depredation, and fertilization.

348. Garbisch, E. W. 1986. Highways and wetlands: compensating wetland losses. Fed. Highway Adm., Off. Implementation, Mclean, Va., FHWA-IP-86-22. 60 pp.

Response: VEG, ECON

Genus: *Acorus, Avicennia, Carex, Cephalanthus, Deschampsia, Distichlis, Festuca, Halodule, Laguncularia, Leersia, Panicum, Peltandra, Polygonum, Pontederia, Potamogeton, Rhizophora, Ruppia, Sagittaria, Saururus, Scirpus, Spartina, Thalassia, Typha, Vallisneria, Zostera*

This illustrated handbook contains information on wetland restoration, enhancement, and establishment procedures. Describes specifications for wetland establishment, from final grading to maintenance requirements and costs. Factors that limit the success of wetland establishment projects include improper final grade, poor choice of plant species, inadequate water level control, errors in the timing of plantings, erosion, vandalism, low quality materials, degradation by wildlife or livestock, development of salt stress-zone, and litter deposition-accumulation. A guide to perennial wetland plants includes information on range, habitat, seed harvest and storage, recommended propagules, and site seeding potential for more than 25 species.

349. Garbisch, E. W., and L. B. Coleman. 1978. Tidal freshwater marsh establishment in upper Chesapeake Bay: *Pontederia cordata* and *Peltandra virginica*. Pages 285–298 *in* R. E. Good, D. F. Whigham, R. L. Simpson, eds. Freshwater wetlands: ecological processes and management potential. Academic Press, New York.

Response: VEG

Genus: *Peltandra, Pontederia*

Describes the effects of tidal elevation, substrate type, and fertilization on Virginia arrowarum (*Peltandra virginica*) and common pickerelweed (*Pontederia cordata*). The study area is in a small cove on the Northeast River in upper Chesapeake Bay, Maryland. Seeds (for seedling stock) were harvested in the James River, stored in cold water, germinated, and transplanted at the study site. *Peltandra virginica* establishment at elevations above mean high water was about 93%; at mean low water, germination was only 5%. Seedlings had a low rate of productivity and did not flower during the first year's growth. Establishment by 1-year-old bulbs or 2-year-old seedling stock may be more successful. Germination of *P. cordata* seed was 20% or less at all elevations and on all substrate types; 3-month-old seedling transplants were more successful.

350. Garbisch, E. W., and P. B. Woller. 1975. Marsh development on dredged materials at Slaughter Creek, Maryland. U.S. Army Corps Eng., Baltimore, Md. 110 pp.

Response: INVERT, VEG

Genus: *Ammophila, Distichlis, Spartina*

Discusses creation of a 1.2-ha (2.9-acre) salt marsh on dredged material at the entrance canal to Slaughter Creek, Dorchester County, Maryland. This area is subject to severe wave stress during winter from Little Choptank River on the eastern edge of Chesapeake Bay. Establishment of cordgrass (*Spartina*) and salt-grass (*Distichlis*) plantings was more successful on unfertilized soft mud dredged material than unfertilized coarser grained material. Fertilization of the latter material greatly accelerated plant development. Loss of early established vegetation due to erosion and burial was estimated to be 20–30%. This area is expected to stabilize within 2 years of plant establishment. Erosion of mainland directly behind the new marsh has been abated entirely.

351. Garbisch, E. W., P. B. Woller, W. J. Bostian, and R. J. McCallum. 1975. Biotic techniques for shore stabilization. Pages 405–426 *in* L. E. Cronin, ed. Estuarine research. Vol. II. Geology and engineering. Academic Press, New York.

Response: VEG, SOIL

Genus: *Ammophila, Distichlis, Panicum, Phragmites, Scirpus, Spartina, Typha*

Describes planting techniques for estuarine shore stabilization. Seven project sites are described: six along the Chesapeake Bay shoreline and one at Ocean City, New Jersey. These projects have been initiated to establish salt, brackish, and freshwater marshes on a variety of coastal substrates and shorelines. Describes each site in detail; summarizes planting results. Discusses substrate limitations, fertilizer requirements, effects of stress, recovery of benthos (artificial tide flats), and methods of vegetative establishment.

352. Gardner, W. S. 1980. Salt marsh creation: effect of heavy metals. Pages 126–131 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: SOIL, CHEM, WQUAL

Genus: *Spartina*

Examines the factors that affect the impact of toxic heavy metals (mercury, cadmium, lead, arsenic) on salt marsh systems. Sources of these metals include input from rivers and river drainages, local pollution, and dredging. Redox and pH changes incurred by dredging may release metals already present in sediments into the water. Discusses physical, chemical, and biological processes that affect distribution or concentration of heavy metals. Plants, for example, may remove metals from solution, transfer them from sediment into the water, or store them in plant tissue. Estuarine sediments retain about 10–20% of the cadmium, copper, and mercury; 100% of the iron; and 60% of the manganese they receive.

353. Gates, S. 1982. An inventory of California coastal wetlands with a potential for restoration and enhancement. Pages 11–21 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: ECON

Genus: None

Identifies coastal wetlands in California in terms of potential for preservation and restoration. Criteria used to select these wetlands are based on the type and degree of artificial alteration of wetland habitat. Lists 44 wetland enhancement projects in the San Francisco Bay and other coastal areas. Includes project description, agency, project status, and future actions. Lists wetlands with potential for future restoration.

354. Gatewood, S. E. 1980. Marshland reflooding in the Kissimmee River valley, Florida. Pages 1–17 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: FISH, VEG, HYDRO, WQUAL, CHEM

Genus: None

Describes the reflooding of a previously channelized marsh (Armstrong Slough) adjacent to the Kissimmee River floodplain in Florida. Evaluates methods for improving water quality and pollution control for Lake Okeechobee; results will also be applied to the restoration of the Kissimmee River. Control structures were used to restore natural water fluctuation patterns in the marsh; channel blocking has caused sheet-flow throughout the area, initiating prechannelization flow conditions. This aids pollutant assimilation by marsh vegetation. Project evaluation will include an assessment of fish and wildlife response to reflooding, and effects on watershed hydrology and chemical loading.

355. Gaudet, J. J. 1977. Natural drawdown in Lake Naivasha, Kenya, and the formation of papyrus swamps. Aquat. Bot. 3(1):1–47.

Response: VEG, HYDRO, SOIL

Genus: *Conyza, Cyperus, Sphaeranthus*, many

Discusses plant succession on wet mud at the edge of Lake Naivasha, Kenya, after a natural lake drawdown. Three zones developed, a *Sphaeranthus* zone (closest to the lake water), a sedge zone, and a composite zone (closest to dry land). Succession continued after reflooding and resulted in a papyrus fringe swamp. Production of papyrus swamp along the lake edge was correlated with longer cycles (1–3 years) of drying and flooding. Papyrus (*Cyperus papyrus*) was the most adaptable species present. Includes an appendix of 108 plant species known to occur on the lake's edge.

356. Gay, B. L., and J. T. Tanacredi. 1982. Shoreline stabilization through marsh restoration. Parks 7:19–20.

Response: SOIL, WQUAL

Genus: *Spartina*

Describes beach restoration at Gateway National Recreation Area, New Jersey and New York. To address severe beach erosion problems, Phase I of this project involves the construction of a tire mattress parallel to the beach and several tire bundles (finger projections) perpendicular to the beach. Phase II is the establishment of a smooth cordgrass (*Spartina alterniflora*) marsh system along the shore.

357. Gebhardt, K. A., J. Gebhardt, G. Koonce, B. O'Brien, S. Sweet, and R. B. Tiedmann. 1988. Created wildlife and wetland amenities in an urban environment. Pages 157–161 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American West. Society of Wetland Scientists, Rocky Mountain Chapter, Denver, Colo.

Response: FISH, MAMMALS, WFOWL, HUSE

Genus: None

Summarizes wetland creation work at Spring Meadow on the Boise River, Boise, Idaho. This project involved relocation and improvement of a side-channel stream adjacent to the Boise River, and construction of an emergent wetland. Describes flow design and hydrological functioning. Wildlife habitat creation and enhancement is based on consideration of several key design species: bald eagle (*Haliaeetus leucocephalus*), red fox (*Vulpes vulpes*), great blue heron (*Ardea herodias*), wood duck (*Aix sponsa*), and several species of fish.

358. Geis, J. W. 1979. Shoreline processes affecting the distribution of wetland habitat. Trans. N. Am. Wildl. Nat. Resour. Conf. 44:529–542.

Response: VEG

Genus: *Acer, Calamagrostis, Carex, Ceratophyllum, Chara, Cladophora, Cornus, Elodea, Ilex, Lemna, Myriophyllum, Najas, Nuphar, Nymphaea, Polygonum, Potamogeton, Ranunculus, Typha, Utricularia, Vallisneria*

Discusses results of a wetland inventory along the shoreline of Lake Ontario and the St. Lawrence River in Jefferson County, New York, during higher than normal water levels (1972–74). Panachromatic black and white transparencies were used for cover mapping. Data from other studies of wetland distribution, plant composition, primary production, and environmental control of wetland dynamics were reviewed to provide an understanding of shoreline processes affecting wetlands. The higher water levels resulted in a widespread dieback in shoreline vegetation, primarily emergents.

359. Gelin, C. 1978. The restoration of freshwater ecosystems in Sweden. Pages 323–338 *in* M. W. Holdgate and M. J. Woodman, eds. The breakdown and restoration of ecosystems. Plenum Press, New York.

Response: INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Juncus, Microcystis, Nitella, Phragmites, Potamogeton*

Discusses restoration of three lakes in Sweden. Two of the lakes received wastewater for up to 22 years and were eutrophic with excessive blue-green algae during summer and oxygen deficiency and fish kills during winter. On one lake, a suction dredging technique was used to remove the nutrient-rich sediment layer. Organic nitrogen and total phosphorus of surface water was greatly reduced. The other lake was denitrified by injecting iron chloride, slaked lime, and calcium nitrate into the sediments. Biological oxygen demand greatly decreased and transparency increased. The third lake was overgrown with emergents and a series of burning, cutting, and disking was used to replace emergent vegetation with submergents to increase waterfowl use.

360. Geller, M. S. 1972. *Phragmites*: life preserver of the salt marsh. Underwater Nat. 7(3):4–11.

Response: VEG

Genus: *Phragmites, Spartina*

Discusses the general ecology of the common reed (*Phragmites australis*) in salt marshes. Undisturbed salt marshes contain little or no *Phragmites*; however, the plant is commonly found on disturbed sites. *Phragmites* has been found to purify water degraded by contaminants such as phosphates and oil. The plant can tolerate higher levels of effluents than the classic marsh grasses.

361. George, D. H. 1982. Lagoon restoration at Cape Canaveral Air Force Station, Florida. Pages 84–101 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, FISH, HYDRO, WQUAL, CHEM

Genus: *Juncus, Rhizophora, Spartina*

A lagoon along the north Banana River, Florida, was the site of a pilot project to assess effects of estuarine tidal flushing on impounded areas. The objective was to restore mangrove lagoon and tidal marsh characteristics. Existing culverts were opened. Subsequent tidal flushing resulted in the return of several resident species of fish and wildlife. Various water quality chemical parameters were recorded before and after flushing. Although this mangrove-salt marsh ecosystem cannot be restored to its full natural state, it can be restored to the point of being ecologically productive. Discusses the importance of lagoon productivity to the estuarine and riverine food chains.

362. Gersberg, R. M., R. Brenner, S. R. Lyon, and B. V. Elkins. 1987. Survival of bacteria and viruses in municipal wastewaters applied to artificial wetlands. Pages 237–245 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: CHEM, WQUAL

Genus: *Scirpus*

Discusses survival of indigenous total coliform bacteria and seeded MS-2 bacteriophage in artificial wetlands receiving primary municipal wastewaters from Santee, California. At the hydraulic application rate of 5 cm/day, the mean effluent total coliform level was reduced 99.1% in the effluent of a 18.5-m by 3.5-m (0.76-m deep) bulrush (*Scirpus*) bed and 95.7% in the effluent of an unvegetated bed. Concentrations of ms-2 bacteriophage was reduced 98.3% in the vegetated bed. Results indicated that artificial wetlands may serve as low-cost alternatives to conventional treatment systems for reducing the load of disease-causing bacteria and viruses in the aquatic environment.

363. Gersberg, R. M., B. V. Elkins, and C. R. Goldman. 1985. Wastewater treatment by artificial wetlands. Water Sci. Technol. 17(4/5):443–450.

Response: CHEM, WQUAL, ECON

Genus: *Scirpus, Typha*

Provides an overview of the use of four artificial wetland beds at the Santee water reclamation facility, Santee, California, for treament of municipal wastewaters. Both secondary and advanced treatment were accomplished. At an application rate of 6 cm/day, 6.5 ha (16 acres) of constructed wetlands were required to treat 3,785 m^3 of primary wastewater to secondary treatment levels. Detailed information on BOD, suspended solids removal, and nutrient removal is provided. Cost data indicated that artificial wetlands are competitive with other treatment technologies used by small or medium communities.

364. Gersberg, R. M., B. V. Elkins, and C. R. Goldman. 1983. Nitrogen removal in artificial wetlands. Water Res. 17(9):1009–1014.

Response: VEG, CHEM, WQUAL, SUCCESS

Genus: *Phragmites, Scirpus, Typha*

Describes the use of artificial wetlands for removal of nitrate from secondary wastewater effluent at high application rates. The nitrified effluent was provided by an existing treatment plant—the Santee water reclamation facility of the Padre Dam municipal water district, Santee, California. Describes the removal of nitrogen, BOD, suspended solids, orthophosphates, and total phosphorus, and compares among mulched and nonmulched vegetated beds, and nonmulched, nonvegetated beds.

365. Gersberg, R. M., B. V. Elkins, S. R. Lyon, and C. R. Goldman. 1986. Role of aquatic plants in wastewater treatment by artificial wetlands. Water Res. 20(3):363–368.

Response: VEG, CHEM, WQUAL, ECON

Genus: *Phragmites, Scirpus, Typha*

Describes the results of studies at the Santee water reclamation facility, Santee, California, to assess the roles of softstem bulrush (*Scirpus validus*), common reed (*Phragmites australis*), and common cattail (*Typha latifolia*; in artificial wetland systems) in the removal of nitrogen, BOD, and total suspended solids from primary wastewaters. Bulrush and reed beds exhibited high efficiency in removal of ammonia-n and BOD. Based on study results, an estimated 8 ha (20 acres) of artificial wetlands would be required to effectively treat 3.8 million L (1 million gal) of effluent per day at a significantly lower cost than conventional secondary treatment processes. Describes the role of wetland plants in performing integrated secondary and advanced municipal wastewater treatment.

366. Getter, C. D., G. Cintron, B. Dicks, R. R. Lewis, III, and E. D. Seneca. 1984. The recovery and restoration of salt marshes and mangroves following an oil spill. Pages 65–113 in J. Cairns, Jr., and A. Buikema, Jr., eds. Restoration of habitats effected by oil spills. Butterworth Publishing, Boston, Mass.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Avicennia, Juncus, Laguncularia, Rhizophora, Salicornia, Spartina*

Provides an overview of effects of oil on marine wetlands and an evaluation of restoration attempts. *Salicornia* and related species were less resistant to oil spills, whereas rush (*Juncus*) and cordgrass (*Spartina*) were more resistant. In general, perennial plants with large root systems, which enabled them to grow back following oil spills, were the most resistant. Studies showed that natural revegetation was limited and restoration was necessary. Planting should be delayed until the spring after the spill. Discusses methods and techniques (with specific quantitative information on plant growth responses) relating to creating and restoring areas affected by oil spills.

367. Gifford, C. A. 1978. Use of floating tire breakwater to induce growth of high marsh and foredune plants along a shoreline. Pages 136–148 *in* D. P. Cole, ed. Proceedings of the Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Distichlis, Iva, Juncus, Panicum, Ruppia, Spartina, Thalassia*, many

A floating tire breakwater was put in place on the north shore of Santa Rosa Island, Pensacola Beach, Escambia County, Florida, to control shoreline erosion. Consequently, unexpected volunteer plant growth occurred along the shoreline. The breakwater created conditions where active movement allowed the deposition of sand and organic detritus. Sumpweed (*Iva*) and cordgrass (*Spartina*) were successful colonizers in this area. Describes salinity, conductivity, and groundwater temperature. Sorrel (*Rumex*), *Panicum*, saltgrass (*Distichlis*), *Sesuvium*, goldenrod (*Solidago*), sunflower (*Helianthus*), and other plants were found along the crest of the berm. In the high beach area, only *Distichlis* was successful.

368. Gilbert, T., T. King, and B. Barnett. 1981. An assessment of wetland habitat establishment at a central Florida phosphate mine site. U.S. Fish Wildl. Serv., FWS/OBS-81/38. 96 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, SOIL, CHEM, WQUAL

Genus: *Aeschynomene, Alternanthera, Ambrosia, Ampelopsis, Andropogon, Aristida, Aster, Baccharis, Bacopa, Commelina, Cynodon, Cyperus, Desmodium, Digitaria, Echinochloa, Eclipta, Eleocharis, Eleusine, Eupatorium, Imperata, Indigofera, Juncus, Ludwigia, Panicum, Paspalum, Pistia, Pluchea, Polygonum, Pontederia, Rubus, Sagittaria, Salix, Salvinia, Sesbania, Sida, Stillingia, Typha, Urena*

Examines wetland restoration efforts over a 3-year period on a phosphate mine adjacent to Peace River, westcentral Florida. Provide analysis results of soil chemical data, inundation values, rainfall, water quality parameters, and relative abundance of plants, reptiles, amphibians, birds, mammals, and benthic macroinvertebrates. Test plantings were made using various marsh and upland plant species. Reports survival rates in the lower emergent, upper emergent, and lower transition zones. The optimum conditions for reclamation occurred in the lower emergent areas. Includes restoration considerations and wetland habitat planning objectives.

369. Gilbert, T., T. King, B. Barnett, J. N. Allen, and R. S. Hearon. 1979. Wetlands reclamation technology development and demonstration for Florida phosphate mining. Pages 87–101 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, VEG, HYDRO, WQUAL

Genus: *Acer, Catalpa, Fraxinus, Juncus, Juniperus, Liquidambar, Nyssa, Panicum, Pinus, Platanus, Pontederia, Populus, Quercus, Sagittaria, Taxodium*

Discusses the restoration of wetland habitat for fish and wildlife on phosphate mined lands in Polk and Hillsborough Counties, Florida. Discusses techniques for establishing freshwater wetland habitat. Planting techniques include transplanting

local trees and freshwater marsh plants, planting bare-root nursery seedlings, and direct seeding. Vegetation survival and growth, plant succession trends, hydrology, aquatic community development, effects of aquatic communities on water quality, and wildlife use trends are included in the test site monitoring program.

370. Gilbert, T., T. King, and L. Hord. 1980. An assessment of wetlands establishment techniques at a Florida phosphate mine site. Pages 245–263 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: CHEM, WQUAL, SOIL, HYDRO, VEG, MAMMALS, INVERT, FISH, REPT, AMPHIB, SHOREB, NGBIRDS, WFOWL

Genus: *Acer, Alternanthera, Catalpa, Cephalanthus, Cyperus, Eichhornia, Fimbristylis, Fraxinus, Hydrocotyle, Juncus, Lemna, Lindernia, Liquidambar, Ludwigia, Najas, Nyssa, Panicum, Paspalum, Pinus, Pistia, Platanus, Polygonum, Pontederia, Populus, Quercus, Sacciolepis, Sagittaria, Salix, Scirpus, Taxodium, Thalia, Typha*

Presents the first year monitoring results for a 3-year project evaluating wetland creation techniques on a phosphate-mined site near Bartow in central Florida. Plantings of herbaceous freshwater marsh plant species and tree seedlings, especially baldcypress (*Taxodium distichlum*), red maple (*Acer rubrum*), and sweet gum (*Liquidambar styraciflua*) had high survival rates. Plant invasion was rapid. Discusses soil data, water quality, and hydrology. Aquatic systems developed rapidly and included abundant fish, amphibians, and aquatic insects and other invertebrates. Wildlife use of the site was high—observations included 8 species of fish, 15 species of reptiles and amphibians, 73 species of birds, and 12 species of mammals.

371. Gilio, J. L. 1984. Conversion of an affected freshwater wet prairie into a functional aesthetic marshland. Pages 94–111 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, VEG, SOIL, WQUAL, CHEM, SUCCESS

Genus: *Acer, Azolla, Bacopa, Cladium, Eleocharis, Fimbristylis, Habenaria, Juncus, Lemna, Myrica, Nymphaea, Pontederia, Sagittaria, Spartina, Spirogyra, Xyris*

Describes the process of converting a drowned wet prairie into a biologically diverse, aesthetically pleasing marsh. The site is in Palm City, Martin County, Florida. Removal of undesirable plants was followed by extensively transplanting a variety of marsh plants. Several mallard (*Anas platyrhynchos*) were introduced for biological control of duckweed (*Lemna* and *Spirogyra*). After marsh restoration, aquatic bird use increased, including use by species of special concern in Florida (little blue heron, snowy egret [*Egretta thula*]) and the federally endangered wood stork. Discusses estimates of man-hours required for marsh maintenance.

372. Gilio, J. L. 1984. Design and attainment of water quality and chemical free maintenance through ecological balance in a man-made condominium lake in south Florida. Pages 93–107 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: CHEM, FISH, INVERT, WQUAL, VEG, SHOREB, NGBIRDS, WFOWL, SUCCESS

Genus: *Alternanthera, Bacopa, Cladium, Cyperus, Hydrocotyle, Hydrodictyon, Ludwigia, Najas, Nuphar, Nymphaea, Panicum, Pithophora, Sagittaria, Spartina, Spirogyra, Typha, Vallisneria*, many

A man-made retention lake in a residential community was planted with native vegetation. Tapegrass grew rapidly throughout the littoral zone, stabilizing and trapping sediment, and was positively correlated with increased water clarity. A number of fish species were established through stocking and natural flooding. Maintenance has been reduced and no chemical control has been needed for 2 years due to establishment of biocontrols in the lake system. The lake has shifted from eutrophic to oligo-mesotrophic.

373. Gilmore, R. G., D. W. Cooke, and C. J. Donohoe. 1982. A comparison of the fish populations and habitat in open and closed salt marsh impoundments in east-central Florida. Northeast Gulf Sci. 5(2):25–37.

Response: FISH, VEG, CHEM, WQUAL

Genus: *Avicennia, Batis, Ruppia, Salicornia*

Describes a study comparing vegetation and fish populations associated with two salt marsh impoundments along the Indian River Lagoon, Florida. The marsh impoundment closed to tidal influence contained 12 fish species. Water temperature varied from 14 to 34° C, salinity from 2.0 to 200 ppt, and dissolved oxygen from 1.2 to 14.2 ppm. The impoundment reopened to tidal influence (using an 80-cm diameter culvert) contained 41 fish species. Temperatures varied from 13.5 to 30° C, salinity from 25 to 38 ppt, and dissolved oxygen from 2.2 to 7.5 ppm. Extensive regrowth of vegetation occurred on the reopened impoundment.

374. Girts, M. A., and R. L. P. Kleinmann. 1986. Constructing wetlands for treatment of mine water. Society of Mining Engineers, St. Louis, Mo., Unpubl. Pap. 23 pp.

Response: None

Genus: *Equisetum, Scirpus, Sphagnum, Typha*

Presents an overview of constructing wetlands for treating mine water in the eastern United States. Full-scale field tests initiated at 25 mine sites during 1984–85 indicated that water quality can be upgraded to meet discharge standards with relatively minor maintenance requirements for constructed wetlands treating small flows of acidic mine water. Metals are removed by wetland vegetation (primarily *Sphagnum* moss) and indigenous bacteria. Iron concentrations of 25–85 mg/L in influent water was <2 mg/L during flow through small wetlands. Manganese is removed less efficiently. Flow over limestone at the discharge raises pH.

375. Glass, S. 1987. Rebirth of a river. Restor. Manage. Notes 5(1):6–14.

Response: VEG

Genus: *Acer, Eichhornia, Juncus, Myrica, Pistia, Pontederia*

Discusses the history of the Kissimmee River flood control project in Florida and efforts to restore the river. Between 1964 and 1971, the Corps of Engineers reduced the 160-km river channel to a 78-km canal. The result was a reduction of flood damage in the lower basin and replacement of marshes and wetlands with dry plains. Consequently, populations of bald eagles (*Haliaeetus leucocephalus*), alligators, waterfowl, and other wetland species declined drastically.

376. Glazier, R. C., R. W. Nelson, and W. J. Logan. 1981. Planning for mine cut lakes. Pages 533–540 *in* D. H. Graves, ed. Proceedings 1981 symposium on surface mining hydrology, sedimentology, and reclamation. University of Kentucky, OES Publication, Lexington.

Response: ECON

Genus: None

Discusses some concepts and principles useful in developing mine cuts into valuable permanent water impoundments. The costs of providing lake and surrounding watershed features as a feasible postmining land use are a fraction of the backfilling costs necessary to restore premining topography and land use.

377. Gleason, M. L., D. A. Elmer, N. C. Pien, and J. S. Fisher. 1979. Effects of stem density upon sediment retention by salt marsh cordgrass, *Spartina alterniflora loisel*. Estuaries 2(4):271–273.

Response: VEG

Genus: *Spartina*

Discusses a laboratory experiment conducted to determine whether retention of waterborne sand by salt marsh smooth cordgrass (*Spartina alterniflora*) is directly related to the number of stems per unit area. Plant densities of 27, 54, and 108 stems per square meter were tested on 3% and 6% slopes subjected to 60 waves (6–10 cm high). The amount of accretion seemed to be a positive nonlinear function of stem density. With increasing stem density, the peak of the berm became more pronounced and located further downslope.

378. Glue, D. E. 1970. Changes in the bird community of a Hampshire gravel pit 1963–68. Bird Stud. 17:15–27.

Response: WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Anthemis, Carex, Fumaria, Hedera, Juncus, Papaver, Phragmites, Polygonum, Populus, Rubus, Salix, Scirpus, Sinapsis, Trifolium, Typha, Ulmus*

Presents results of annual breeding bird surveys at the Hampshire gravel pit, Great Britain, and discusses the probable factors influencing population changes during 1963–68. The 40.5-ha (100-acre) gravel pit was bulldozed and plant succession progressed from bare ground with shallow pools in 1962, to wet and dry grassland, to willow (*Salix*) dominance with little standing water, to a mixed immature willow woodland at the end of the study. The bare gravel habitat is a transient stage and requires regular willow clearing to maintain bare ground nesting birds (e.g., plovers, lapwings). Dry and wet grasslands support a comparatively sparse bird community, but this can be increased by raising the water level and, consequently, the spread of *Salix*, *Juncus*, and *Carex*.

379. Goforth, H. W., and T. J. Peeling. 1979. Intertidal and subtidal eelgrass (*Zostera marina* L.) transplant studies in San Diego Bay, California. Pages 327–356 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, ECON

Genus: *Zostera*

Describes several common eelgrass (*Zostera marina*) planting projects in San Diego Bay, California. The first study (1976) satisfied a mitigation requirement. The subtidal transplant operation used the plug method and biodegradable fiber pots. The second transplant project (1978), also a mitigation project, established 1.6 ha (4 acres) of *Zostera* on dredged material in subtidal and intertidal areas. Estimates of manpower requirements and material costs are provided. Transplant survival was affected by plug size, site selection (water depth and sediment characteristics), and the use of biodegradable fiber pots (which effectively doubled transplant survival).

380. Goforth, H. W., and J. R. Thomas. 1979. Plantings of red mangroves (*Rhizophora mangle* L.) for stabilization of marl shorelines in the Florida Keys. Pages 207–230 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: SOIL, VEG, ECON

Genus: *Rhizophora*

Explores the planting of mangroves as a superior alternative to traditional construction for shoreline stabilization. Red mangroves (*Rhizophora mangle*) were planted along marl shoreline at Key West, Florida. After 23 months, survival rates were 45% for propagules, 48% for seedlings, and 98% for small trees (2–3 years old). Degree of exposure to erosion or burial was a significant determinant for seedling survival. The use of a power auger to bore holes and the application of seagrass wrack as mulch was an effective and economical combination. The total cost of tranplanting 142 mangroves was $470 (which was cost effective compared to nonbiological alternatives, riprap and seawalls). Peat offered little advantage over seagrass wrack in terms of tranplant survival and growth.

381. Goforth, H. W., and M. Williams. 1983. Survival and growth of red mangroves (*Rhizophora mangle* L.) planted upon marl shorelines in the Florida Keys. Pages 130–148 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Rhizophora*

Tests the effects of tidal height, degree of exposure to erosion, and organic additions (sphagnum peat and seagrass detritus) to marl substrate on the growth of red mangrove (*Rhizophora mangle*) transplants. Planting sites (including controls) were located on Stock Island in the Florida Keys; 126 red mangroves were planted in three developmental stages. After 5 years, plant survival rates on exposed shores, protected shores, and partially protected shores were 0%, 64%, and 43% for propagules; 0%, 43%, and 64% for seedlings; and 79%, 75%, and 94% for small trees, respectively. Success of mangrove establishment on marl shorelines was attributed to the use of a power auger to loosen substrate, addition of organic materials to augment nutrient supply, and the use of stakes for anchoring transplants.

382. Goldley, J. S., and R. J. Callahan. 1984. Creation of wetlands in a xeric community. Pages 112–129 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: AMPHIB, VEG, HYDRO

Genus: *Acer, Baccharis, Berlandiera, Callicarpa, Ceratiola, Cladium, Elephantopus, Erythrina, Garberia, Hamelia, Helianthus, Ilex, Iris, Juncus, Juniperus, Lantana, Lyonia, Magnolia, Myrica, Nuphar, Nymphaea, Opuntia, Parkinsonia, Passiflora, Phoebanthus, Piloblephis, Pinus, Pontederia, Prunus, Quercus, Rubus, Sabal, Sagittaria, Salix, Serenoa, Spartina, Taxodium, Tephrosia, Tradescantia, Vaccinium, Viburnum, Yucca, Zamia*

Describes the creation of wetlands for stormwater retention near Hudson in Pasco County, Florida. The site consisted of well-drained sandhills; a clay liner was spread over the bottom of wetland depressions for water retention. The clay was covered with organic soils and planted with native wetland and upland species. More than 8,000 plants of 48 species were planted. Most were transplants from nearby areas. Survival of the 15 wetland species varied from 71 to 100%. High survival was attributed to adequate water-retention of the clay layer, addition of the organic (peat-much) soil layer, planting of herbaceous plants on the same day they were dug up, transplanting of entire plants rather than plugs, and starting trees in containers before transplanting. One major problem was stabilization of water levels at the center of the marsh areas.

383. Goldner, B. H. 1984. Riparian restoration efforts associated with structurally modified flood control channels. Pages 445–451 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55, University of California Press, Berkeley.

Response: VEG, SUCCESS

Genus: *Alnus, Carex, Cotula, Platanus, Populus, Quercus, Rhus, Rubus, Salicornia, Scirpus*, many

Reviews revegetation projects along streams and rivers in the semiarid Santa Clara Valley, north of Monterey Bay, California. Plant selection was based on drought tolerance and compatibility with flood control channel environment. Nursery plants in peat-pots and a mixture of annual and perennial flowers were planted and hydroseeded. Discusses projects evaluated by the percent of seed germination and growth of weeds. Discusses planting site preparation, irrigation system, and maintenance requirements. Recommendations include the installation a fixed irrigation system, the use of root cuttings for plant establishment, the implementation of a weed management program, and the protection of sites from vandalism.

384. Goldstein, A. L. 1982. Utilization of a recreated freshwater marsh for detention and reduction of nutrients in rural nonpoint source runoff. Pages 194–211 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: WQUAL, CHEM

Genus: None

A previously drained and channelized backwater marsh in the Kissimmee River Basin, Florida, was reconstructed. The recreated marsh was used as a demonstration of the effectiveness of such a system in the reduction of nitrogen and phosphorus from agricultural runoff. The marsh had low to moderate flows during the 9-month study. A net reduction in nutrient load to receiving waters was measured. Net uptake (removal) efficiency of the marsh was 54% for nitrogen and 69% for phosphorus.

385. Golet, F. C. 1986. Critical issues in wetland mitigation: a scientific perspective. Natl. Wetlands Newsl. 8(5):3–6.

Response: SUCCESS

Genus: None

Discusses critical wetland mitigation concepts and issues as they relate to regulatory agency decision making. Important points include mitigation should be limited to reducing or compensating for unavoidable wetland effects or losses; criteria for selecting the best mitigation plan should address restoration of wetland functions and values; both short- and long-term results of mitigation efforts are uncertain—therefore success is uncertain; mitigation should serve to restore specific wetland functions and values, not to substitute alternative functions and values; and wetland evaluation methods should be used with caution. Proposes a regulatory agency philosophy for mitigation.

386. Gonor, J. J. 1979. An evaluation of the ecological basis of mitigation requirements in Oregon statewide estuarine resources planning. Pages 93–102 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: SUCCESS

Genus: None

Describes mitigation requirements for protecting estuarine resources in Oregon. Priorities in these guidelines include restoration of replacement sites in close proximity to the altered site, restoration of sites elsewhere in the estuary, and restoration of areas or resources made scarce by past removals and not necessarily having the same ecological qualities as those lost at the site being developed. Describes a set of ecological specifications and standards for mitigation site identification and assessment. Includes an area-submergence time method for equalizing unlike areas in tideland mitigation and methods for predicting the outcome and evaluating the adequacy of mitigation restoration actions.

387. Gordon, T. U. 1981. Local commitment to lake restoration: the Cobbossee watershed example. Pages 4–9 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, Portland, Maine, EPA 440/5-81-010.

Response: VEG, CHEM, WQUAL, ECON

Genus: *Anabaena, Aphanizomenon*

Discusses the Cobbossee Watershed District's program for lake restoration and protection within their 622-km^2 watershed of the Kennebec River basin, 80 km north of Portland, Maine. The district has integrated Federal, State, local, and private resources to restore eutrophic lakes. The primary objective was the restoration of the 575-ha Annabessacook Lake effected by agricultural, municipal, industrial, and residential wastes. A cost-sharing program was established to construct agricultural waste management facilities; a hypolimnetic application of aluminum sulfate and sodium aluminate was used on the lake for nutrient inactivation. Follow-up monitoring of the lake has found significant reductions in phosphorus and chlorophyll and improvements in visibility.

388. Gore, J. A. 1979. Patterns of initial benthic recolonization of a reclaimed coal strip-mined river channel. Can. J. Zool. 57:2429–2439.

Response: INVERT

Genus: None

Describes a study of benthic macroinvertebrates in a reclaimed channel of the Tongue River at the Big Horn mine, Sheridan, Wyoming. The new channel was cut and graded; new topsoil was spread on embankments, hydromulched with grasses and legumes, and planted with riparian trees and shrubs. Tested several theories of macroinvertebrate recolonization. Six sampling stations were established upstream, downstream, and within the new channel. Results indicated that the develop-

ment of a typical macroinvertebrate community (i.e., similar to that of an undisturbed area) is predictable, based on time and distance from upstream source areas.

389. Gore, J. A. 1985. Mechanisms of colonization and habitat enhancement for benthic macroinvertebrates in restored river channels. Pages 81–101 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: INVERT, SUCCESS

Genus: None

Describes techniques for restoration of river channel habitat for benthic macroinvertebrates. Background information includes benthic macroinvertebrate dispersal through drift, upstream migration, movement within the substrate, and colonization by ovipositing aquatic insects; measurement of invertebrate habitat requirements; and prediction of rates and trends of stable community formation. Describes several procedures for habitat enhancement: placement of substrate similar to that of an undisturbed area, placement of structures to control sediment load and maintain productive riffles, monitoring of benthic recolonization, and comparisons between undisturbed source communities and restored areas to determine restoration success.

390. Gore, J. A., and L. S. Johnson. 1981. Strip-mined river restoration. Water Spectrum 13:31–38.

Response: FISH, INVERT, VEG

Genus: None

Describes the restoration of a portion of the Tongue River channel at Big Horn mine near Sheridan, Wyoming. Discusses meander pattern restoration, bank stabilization, substrate, and revegetation. The establishment of cover for fish included placement of rock wings and snags (trees) and pool construction. Drift from established upstream communities made up 95% of the initial colonization of new habitat by aquatic macroinvertebrates. Maintenance of undisturbed upstream communities is an integral part of the restoration effort. Construction of a deep pool downstream of the reclaimed channel is recommended to control increased suspended particulate load and serve as a high-productivity fishery area.

391. Gore, J. A., and L. S. Johnson. 1979. Observations on the initial biotic recolonization of a reclaimed channel of the Tongue River in Wyoming. Univ. Wyo. Water Resour. Res. Inst. Ser. 74. 55 pp.

Response: FISH, INVERT, VEG

Genus: *Agropyron, Astragalus, Bromus, Fraxinus, Populus, Prunus, Salix*

Discusses recolonization of a reclaimed channel of the Tongue River in the coal mining region of northeastern Wyoming. The channel was cut and graded to its approximate premining configuration and gradient. Grasses, trees, and shrubs were planted. Riprap was used to further stabilize banks. Boulders and snags were placed in the stream to provide pooling and cover for potential fish colonizers. Trout, bass, and forage fish were transplanted from nearby pits. Aquatic macroinvertebrate densities reached maximums in about 40 days and were similar to adjacent undisturbed areas.

392. Gore, J. A., and L. S. Johnson. 1979. Biotic recovery of a reclaimed river channel after coal strip mining. Pages 239–244 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: FISH, INVERT

Genus: None

Discusses biotic recovery of a newly constructed channel of the Tongue River in the coal mine region of northcentral Wyoming. The channel had been reclaimed with layers of gravel and cobble, pine snags, bouldered riprap, and rubble piles. Banks were hydromulched and planted with various grasses, trees, and shrubs. Gamefish were transplanted from a previously mined pit. Stream invertebrates recolonized within 70 days. Fish community stability is expected to be attained within 1–2 years. The snag areas provided the best cover for fish colonizers during initial flow in the new channel. Stocking of game fish was not successful. Recommends establishment of a game fishery only after a resident forage fish community has been established.

393. Gore, J. A., and L. S. Johnson. 1980. Establishment of biotic and hydrologic stability in a reclaimed coal strip mined river channel. University of Wyoming, Industrial Fund, Laramie. 134 pp.

Response: FISH, INVERT, HYDRO, SOIL, SUCCESS

Genus: None

Describes the analysis of a coal strip mine-reclaimed channel of the Tongue River, Big Horn mine, Sheridan, Wyoming, in terms of recovery of benthic invertebrates, fish communities, substrate characteristics, and erosion and suspended sediment load. Snags and habitat created by placement of large boulders in the channel were used by fish, although stable fish communities were not present. A stable macroinvertebrate community, mainly established by drift, was formed after 300 days. A pool area at the downstream end of the reclaimed channel is expected to control increased sediment loads until the planted embankment vegetation matures.

394. Gosselink, J. G., R. J. Reimold, J. L. Gallagher, H. L. Windom, and E. P. Odum. 1972. Spoil disposal problems for highway construction through marshes. University of Georgia, Institute of Ecology, Athens. 57 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Distichlis, Fimbristylis, Juncus, Myrica, Rumex, Scirpus, Spartina*

Covers ecological and economic considerations for spoil disposal techniques in coastal marshes of Georgia. Turbidity, BOD, acidity, and heavy metal concentrations are considered in short-term disposal and construction actions. Side-casting was the preferred method resulting in little runoff. Revegetation recommendations are the use of side-casting, level and secure dikes to prevent runoff, and add limestone in areas of high salinity. Includes specific costs and potential annual values of Georgia marshes in an appendix.

395. Gottfried, P. K. 1985. Environmental design guidelines for manmade lakes in Florida. Pages 135–143 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Acer, Aster, Canna, Carya, Celtis, Dichromena, Fraxinus, Gordonia, Hymenocallis, Ilex, Iris, Juncus, Liquidambar, Lyonia, Magnolia, Myrica, Nuphar, Nymphaea, Nyssa, Orontium, Panicum, Pontederia, Quercus, Sabal, Sagittaria, Scirpus, Spartina, Taxodium*

Includes techniques for creating man-made lakes in Florida, and includes guidelines for measuring physical parameters, design and construction, and revegetation. The goals were to create multipurpose lakes for stormwater retention, fish and wildlife habitat, water quality improvement, aesthetics, and recreation; and to mitigate the loss of natural habitat in other areas. Recommendations include maximum water depth of 3–6 m (10–20 feet), side slopes of 6:1 horizontal to vertical, shoreline development index > 1.2, application of hydric soils around the lake, and use of native species for plantings.

396. Grabowicz, G. J. 1985. Regulatory requirements for construction and use of wetlands on mined lands in Pennsylvania. Pages 185–190 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: None

Genus: None

Reviews regulatory requirements for construction of wetlands on mining sites in Pennsylvania. Applicants must provide reclamation and revegetation details in three general categories: informational requirements, engineering and design standards, and performance standards for ponds and impoundments. Information must be provided on minimum and maximum critical flows, water quality, minimum revegetation needs, postmining wildlife habitat, and timetable and cost estimates for each major step of the reclamation process. A plan must be presented to demonstrate the treatment and recharge capacity of the wetland. Discusses specific regulatory requirements.

397. Grace, J. B., and R. G. Wetzel. 1981. Habitat partitioning and competitive displacement in cattails (*Typha*): experimental field studies. Am. Nat. 118(4):463–474.

Response: VEG

Genus: *Typha*

Discusses habitat partitioning of two cattail species in an experimental pond in Kalamazoo County, Michigan. Transplantation of both species along the gradient in the absence of competitors showed that common cattail (*Typha latifolia*) was little affected by the presence of narrowleaf cattail (*T. angustifolia*), but *T. angustifolia* was capable of growing over the entire gradient. The basis for habitat partitioning seems to be a difference in morphology; *T. latifolia* was prevented from growing in deep water because of the higher cost of producing broader leaves, but was better able to compete for light in shallow water because of its greater leaf surface area.

398. Greer, R. B. 1979. A tree planting trial at Loch Garry (Tayside region) aimed at habitat improvement for fish. Scottish For. 33(1):37–44.

Response: FISH, VEG

Genus: *Acer, Alnus, Betula, Crataegus, Fraxinus, Pinus, Populus, Prunus, Quercus, Salix, Sorbus, Ulmus*

Presents preliminary results of tree plantings to reestablish deciduous woodland on the shore of Loch Garry, Scotland, to provide a source of leaves for aquatic invertebrates and thus improve fish habitat. A spaced group-planting method was used to provide a more natural appearance. Damage by deer and wind burn affected some trees, but most trees survived. Discusses general approaches to tree planting for aquatic habitat improvement.

399. Gregory, R. W., A. A. Elser, and T. Lenhart. 1984. Utilization of coal mine wastewater for construction of a northern pike spawning/rearing marsh. U.S. Fish Wildl. Serv., FWS/OBS-84/03. 44 pp.

Response: FISH, MAMMALS, WFOWL, HUSE, CHEM, WQUAL, ECON

Genus: *Agropyron, Eleocharis, Onobrychis*

Describes a project conducted from 1977 to 1981, to examine the use of coal mine wastewater for fish and wildlife habitat enhancement. The project site was in the Tongue River watershed, adjacent to the Tongue River Reservoir, Big Horn County, southeastern Montana. Specific components of the study included providing suitable habitat for rearing northern pike (*Esox lucius*), evaluating use of that habitat by wildlife (e.g., waterfowl), and assessing water quality parameters of mine wastewater. Despite several difficulties encountered during the study, results indicated that marsh habitat creation using coal mine wastewater can provide suitable habitat for fish and wildlife.

400. Groenendijk, A. M. 1986. Establishment of a *Spartina anglica* population on a tidal mudflat: a field experiment. J. Environ. Manage. 22(1):1–12.

Response: VEG, SUCCESS

Genus: *Salicornia, Spartina*

Discusses the potential of *Spartina anglica* to expand into upper tidal mudflats to control erosion after the completion of a storm-surge barrier in the southwest Netherlands. *Spartina anglica* seeds were planted at five sites at depths of 0.5, 1.5, and 3 cm at elevations of 42, 75, 86, 97, and 110 cm in May, July, September, and November. Seed loss was 98% at 0.5 cm, 38% at 1.5 cm, and 43% at 3 cm. In two plots (97 and 110 cm) where *Spartina* became established, *Salicornia procumbens* also became established. Previous *S. anglica* reclamations were made in the 1920's in clay-silt-sand substrate and these stands are the most vigorous. *S. anglica* planted 10–15 years ago on sandbars and mudflats now cover 18 ha of the original site.

401. Gross, F. E., and M. T. Brown. 1987. Guidelines for creation of small stream floodplain ecosystems in north and central Florida. Pages 114–132 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: VEG, HYDRO, SOIL

Genus: *Acer, Cephalanthus, Fraxinus, Gordonia, Ilex, Liquidambar, Lyonia, Magnolia, Myrica, Nyssa, Pinus, Quercus, Taxodium*

Characterizes 12 first-order streams in north and central Florida. Two basic stream types with different cross sectional relief were studied: deeply incised streams with narrow floodplains and wide streams with broad, flat floodplains. Measures basin parameters of slope, stream length, percent hydric soils, and watershed area. Vegetation types were distributed with respect to stream type and stream reach. Results indicate that general stream morphology, basin characteristics, and vegetation types can be used as guidelines for restoration and creation of small streams.

402. Gucinski, H. 1978. A note on the relation of size to ecological value of some wetlands. Estuaries 1(3):151–156.

Response: VEG, SUCCESS

Genus: None

Evaluates the relation between wetland size and ecological value on the Mayo Peninsula, western shore of Chesapeake Bay, where geologic-hydrologic characteristics and land-use effects were relatively homogeneous. Of 59 marshes in this area, 53 are less than 2 ha (5 acres) and comprise 54% of the total area; 68% of the total upland edge length of the marshes is accounted for by marshes less than 5 acres and 73% of the seaward edge length is associated with these smaller marshes. Lists several recommendations with respect to the potentially large significance of small marshes, including reasons why they should be afforded greater protection. Caution should be used in applying these data to other geographic areas.

403. Gunn, J. M., and W. Keller. 1984. *In situ* manipulation of water chemistry using crushed limestone and observed effects on fish. Fisheries 9(1):19–24.

Response: FISH, CHEM, WQUAL

Genus: None

Discusses the effects of limestone additions on the water chemistry and early life stages of salmonids in acidic lakes and streams near Sudbury, Ontario. Under acutely toxic conditions (pH 4.6, total aluminum 400 ug/L), substrate baskets of crushed limestone (as little as 15 kg) neutralized interstitial water, permitting high survial of incubating eggs and fry. Flow-through filter tanks and stream bed additions neutralized flowing water with similar increases in fish survival. Neutralization was poorest during periods of high flows and ice cover, when stream water had limited contact with limestone. The detrimental effects of aluminum precipitation during neutralization treatment needs further study because of its potential toxicity to fish.

404. Haines, E. 1980. Salt marsh creation: impact of sewage. Pages 148–153 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: INVERT, VEG

Genus: *Spartina*

Describes the effects of sewage on salt marshes. Effects include: accumulation of substances, stimulation of biological processes, and inhibition of microbial processes. Salt marshes are not effective as secondary sewage treatment areas, but high monetary value may be attached to their tertiary treatment properties. Marsh plants and benthic algae have high rates of production and can assimilate some nutrients. Some marsh sediments transform nitrogen through denitrification; however, they also accumulate toxic materials.

405. Hale, J. G. 1969. An evaluation of trout stream habitat improvement in a north shore tributary of Lake Superior. Minn. Fish. Invest. 5:37–50.

Response: FISH, HYDRO, SOIL, ECON

Genus: None

Describes the results of an evaluation of trout stream habitat improvement measures in a 1,586-m (5,200-feet) stretch of the west branch of the Split Rock River, Minnesota. Fish present and changes in stream bottom substrate were recorded for 3 years before the construction of habitat improvement structures, 4 years during construction, and 3 years after construction. Habitat alterations improved the carrying (and reproductive) capacity of the stream for wild brook trout (*Salvelinus fontinalis*). Cost comparisons indicated that stream improvement was less costly than stocking.

406. Hall, J. D., and C. O. Baker. 1982. Influence of forest and rangeland management on anadromous fish habitat in western North America: rehabilitating and enhancing stream habitat: 1. Review and evaluation. U.S. For. Serv. Gen. Tech. Rep. PNW-138. 29 pp.

Response: FISH

Genus: None

Reviews the literature on rehabilitating and enhancing stream habitat for salmonid fish and briefly evaluates the use of various management techniques for improving anadromous fish habitat in western North America. Discusses methods to restore, replace, and catch gravel and improve fish access (e.g., fishways, culverts) of spawning habitat. Rearing habitat improvements include boulder placement, rearing pools, winter habitat flow augmentation, and stream fertilization. Discusses the importance of riparian habitat to anadromous fishes . Stress the importance of protecting watershed and stream resources, while continuing to improve methods used to rehabilitate degraded habitats.

407. Hall, V. L., and J. D. Ludwig. 1975. Evaluation of potential use of vegetation for erosion abatement along the Great Lakes shoreline. U.S. Army Corps Eng., Fort Belvoir, Va., Misc. Pap. 7–75. 35 pp.

408. Haltiner, J., and P. B. Williams. 1988. Hydraulic design in salt marsh restoration. Pages 293–299 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium:wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: None

Describes an analysis of design criteria needs for tidal slough channels, marsh plains, and hydraulic structures. Describes the relations between maximum depth, top width, cross-sectional area, and tidal prisms for eight California marshes.

409. Haltiner, J., and P. B. Williams. 1987. Slough channel design in salt marsh restoration. Pages 125–130 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: None

Genus: None

Provides some specific guidelines for tidal slough channel design. Describes the relations between maximum depth, top width, cross-sectional area, and potential tidal prism in four central and four southern California marshes. Hydraulic geometry relations can be developed based on information from natural tidal slough channels. These relations can be used to determine slough channel dimensions for artificial wetlands.

410. Hamilton, D. B., F. T. Auble, R. A. Ellison, and J. E. Roelle. 1986. Effects of flood control alternatives on the hydrology, vegetation, and wildlife resources of the Malheur-Harney lakes basin. U.S. Fish Wildl. Serv. NEC-86120. 85 pp.

Response: WFOWL, VEG, HYDRO, SHOREB

Genus: *Potamogeton, Scirpus, Sparganium, Typha*

Discusses a computer model used to simulate the effects of various water level management alternatives on the hydrology,

vegetation, and wildlife of the Malheur-Harney lakes basin in eastern Oregon. The simulation model is composed of three connected submodels. The hydrology submodel calculates changes in lake volume, elevation, and surface area, as well as changes in water quality that result from proposed water management projects (upstream storage, upstream diversions, drainage canals) and the no-action alternative. The vegetation submodel determines changes in areal extent of wetland and upland vegetation communities. The wildlife submodel calculates indices of abundance or habitat suitability for colonial nesting birds, sandhill cranes (*Grus canadensis*), Canada geese (*Branta canadensis*), diving ducks, and dabbling ducks.

411. Hammer, D. E., and R. H. Kadlec. 1983. Design principles for wetland treatment systems: project summary. U.S. Environ. Prot. Agency EPA-600-S2-83-026. 7 pp.

Response: WQUAL, ECON

Genus: None

Summarizes design principles for the use of wetlands in treating wastewater and presents a simplified model for evaluating wetland treatment designs. Discusses wetland hydrology, correlation of operating data, the mass transfer zone, the loaded zone, synthesis of wetland system design, and economics of wetland treatment. The reliable design of a wetland treatment facility requires the development of performance equations that describe both the response of the ecosystem to wastewater additions and the alteration of water quality.

412. Hammer, D. P., and E. D. Blackburn. 1977. Design and construction of retaining dikes for containment of dredged material. U.S. Army Corps Eng. Savannah, Ga. Tech. Rep. D-77-9. 200 pp.

Response: HYDRO, SOIL

Genus: None

Focuses on considerations necessary to confine dredged material disposal in waterways and harbors. Dike failures in the past were due to foundation conditions, construction material and methods, and disposal practices. Field investigations should be carried out at the site before design and construction. Emphasizes subsurface exploration and field testing. Additional laboratory testing is essential for classifying engineering properties of soils. Materials unacceptable for construction of retaining dikes include highly plastic clays, very wet fine-grained soils, and soils with a high percentage of organic matter. Discusses equipment and materials useful for dike construction. Presents equations for analyzing slope stability.

413. Hampson, G. R., and E. T. Moul. 1978. No. 2 Fuel oil spill in Bourne, Massachusetts: immediate assessment of the effects on marine invertebrates and a 3-year study of growth and recovery of a salt marsh. J. Fish. Res. Board Can. 35:731–744.

Response: INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Cladophora, Distichlis, Enteromorpha, Fucus, Limnobium, Lyngbya, Melosira, Microcoleus, Rhizoclonium, Rivularia, Salicornia, Spartina, Suaeda, Ulva, Vaucheria*

Presents results of a 3-year study on the effects of an oil spill in the Cape Cod Canal, Buzzards Bay, Massachusetts, on various components of a salt-marsh community at Windsor Cove, 5 km from the spill. Within 2 weeks after the spill, massive fatalities of marine invertebrates were observed at the cove. During the following 3 years, marsh grass was unable to reestablish itself by either reseeding or rhizome growth. Sediments continued to show a high concentration of petroleum hydrocarbons. Erosion rates were 24 times greater than that on nearby control sites. Microscopic algal species of the cove were considered less sensitive to environmental changes compared to those collected at the control site. Interstitial fauna showed an extreme reduction in number of individuals and species over the study period.

414. Hao, C., and Z. Rongzong. 1985. A study of synecology and productivity of *Spartina* plantation in Qidong County, Jiangsu. Pages 83–115 *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing University, China. (English abstract)

Response: VEG, SOIL

Genus: *Spartina*

Discusses planting trials of *Spartina anglica* in Qidong County, China. Summarizes climatic and growth form data. Culm and leaf weight ratios were generally above 1:3.5 in higher elevation marshes and below 1:1.5 in lower elevation marshes. Depths of rhizome penetration were 20–25 cm after 1 year of planting and 60–70 cm after 3 years. A dense plantation comprising 2,400–2,500 culms per square meter with 90% coverage achieved in 1–2 years by planting 7–8 culms, 1 m apart. Accretion varied from 9.5 to 13.7 cm within 500 m of a seawall, to 2.6 cm at 900 m from the seawall after 14 months. Shoot biomass was influenced by rate of accretion and temperature.

415. Hardaway, C. S. 1966. Marsh grass reestablishment in the Virginia Chesapeake Bay system. Restor. Manage. Notes 4(2):77–78.

Response: VEG, SOIL

Genus: *Spartina*

Compares the establishment of a marsh grass fringe for estuarine shoreline erosion control at 24 sites under various degrees of wave action in the Virginia Chesapeake Bay. Results after 4 years of monitoring indicated that marsh grass fringe could be established with little or no maintenance planting on low-wave energy shores. Medium-wave energy shorelines required a combination of smooth cordgrass (*Spartina alterniflora*) and marshhay cordgrass (*S. patens*) plantings, with annual maintenance plantings. Marsh fringes were impractical to establish on straight shorelines of 6.5–10.2 km of fetch unless permanent offshore wave-stilling devices were used.

416. Hardaway, C. S., G. R. Thomas, B. K. Fowler, C. L. Hill, J. E. Frye, and N. A. Ibison. 1985. Results of the vegetative erosion control project in the Virginia Chesapeake Bay system. Pages 144–158 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Spartina*

Summarizes the results of a vegetative erosion control project along the Virginia shores of Chesapeake Bay. The reestablishment of cordgrass *Spartina* for estuarine shoreline erosion control is a viable alternative to the construction of bulkheads, revetments, or groins. Physical limitations to revegetation may be imposed by average fetch exposure, shore geometry, and shore orientation. On low-wave energy shores a marsh grass fringe (combination of saltmeadow hay and smooth cordgrass [*Spartina alterniflora*]) can be established with little or no maintenance. In high energy areas, the addition of a permanent offshore wave-stilling device is necessary for marsh fringe

establishment. Marsh grass plantings are not recommended for areas exposed to an average fetch 10.2 km.

417. Hardisky, M. A. 1979. Marsh restoration on dredged material, buttermilk sound, Georgia. Pages 143–174 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: INVERT, MAMMALS, VEG, SOIL, SUCCESS

Genus: *Borrichia, Distichlis, Iva, Juncus, Spartina*

Describes a study of the Buttermilk Sound habitat development site at the mouth of the Altamaha River, Glynn County, Georgia, as part of the U.S. Army Corps of Engineers program to examine alternatives for dredged material disposal. The 15-ha disposal site was graded and divided into plots representing three intertidal zones. Sprigs and seeds of seven wetland plant species were planted; unplanted plots were controls. Marshhay cordgrass (*Spartina patens*) and bigleaf sumpweed (*Iva frutescens*) had greater aerial biomass than other species in the upper third of the intertidal zones. Crab burrow density decreased with lower elevation. A lag in biomass production for most plant species indicated that more time was required for the development of a mature marsh ecosystem.

418. Hardisky, M. A., and R. J. Reimold. 1979. Buttermilk Sound marsh habitat development site, Glynn County, Georgia, 1978. Ga. Dep. Nat. Resour. Final Rep. DACW39-78-M-3016. 74 pp.

Response: SHELLF, VEG

Genus: *Acnida, Borrichia, Distichlis, Iva, Juncus, Panicum, Pluchea, Polygonum, Scirpus, Spartina*

Compares vegetation growth and succession on dredge material experimental plots at the Buttermilk Sound marsh habitat development site, Glynn County, Georgia. Sprigs and seeds of seven species were planted in three tidal zones and exposed to various levels of fertilization during 1975–76. Increased aerial and belowground biomass for most species were recorded. Cover values were highest for the upper third of the intertidal zone. Volunteer plant species proliferated over most sites, but maintained less aerial and root biomass than planted areas. Saltgrass (*Distichlis*) initially spread rapidly, but may be affected by an influx of taller marsh plants. Saltmarsh cordgrass (*Spartina*) dominates the lower intertidal zone with extensive belowground root mat development.

419. Harlin, M. M., B. Thorne-Miller, and J. C. Boothroyd. 1982. Seagrass-sediment dynamics of a flood-tidal delta in Rhode Island. Aquat. Bot. 14:127–138.

Response: VEG, SOIL

Genus: *Ruppia, Zostera*

Examines the interactions between seagrasses and sediment on a flood-tidal delta of a coastal lagoon in southern Rhode Island. The population of an annual form of common eelgrass (*Zostera marina*) increased rapidly from June (100 plants per square meter) to late July and early August (1,000 plants per square meter), after which it rapidly decreased. On vegetated plots, current measurements fell to zero near the substrate, whereas on experimentally denuded plots they reached 8–14 cm/s. At the margin of the delta lobe, sediment accreted 2.5 cm in vegetated plots and eroded 1.5 cm in denuded plats. Results indicated that even as an ephemeral, *Z. marina* can encourage sediment accumulation by slowing water current on a moderate-energy tidal delta, but the degree of this depends on the density of the plant bed.

420. Harrington, R. A. 1986. Environmental controls on clonal willow growth (Wisconsin). Restor. Manage. News 4(1):30.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Salix*

Describes the elonal spreading rates of willow (*Salix*) in Wisconsin wetlands. Stem cutting just above ground level produced more resprouting on stumps where belowground connections to the rest of the elone had been eut than on stumps with intact connections to the clone. New stem emergence was affected by water level fluctuations and was greatest at constant water levels of approximately 20 em below soil surface. Includes redox measurements.

421. Harris, R. W., A. T. Leiser, and A. T. Fissell. 1975. Plant tolerance to flooding. Summary Report: 1971–1975. University of California, Department of Environmental Horticulture, Davis. 30 pp.

Response: VEG

Genus: *Acacia, Acer, Agropyron, Carya, Cephalanthus, Cynodon, Diospyros, Eucalyptus, Fraxinus, Gleditsia, Platanus, Populus, Quercus, Salix, Taxodium, Washingtonia*, many

Discusses plant tolerance to flooding in central California, based on planting experiments at the flood reservoir at the University of California, Davis, and at Folsom Lake State Recreation Area east of Sacramento, and on assessments of existing plant communities at Andrus, Brannon, and Sherman Islands in the San Joaquin delta. Approximately 30 species of plants (primarily shrubs and trees) were transplanted or seeded (grasses). Nearly 70 species were included in the assessment of the delta islands. Includes summary data on percent survival and tolerance levels under various water regimes for all species.

422. Harris, S. W., and W. H. Marshall. 1963. Ecology of water-level manipulations on a northern marsh. Ecology 44(2):331–343.

Response: VEG, HYDRO, SUCCESS

Genus: *Carex, Chenopodium, Cirsium, Lemna, Phragmites, Polygonum, Potamogeton, Rumex, Salix, Scirpus, Senecio, Typha*, many

Describes an experiment to establish emergent vegetation in drawdown areas on the Agassiz National Wildlife Refuge in northwestern Minnesota. The primary objective was to revegetate open water after planned drawdowns. Various pool conditions were available to study drawndown effects. Conditions varied complete drawdowns for 4–5 years to partial reflooding over several years. Results are presented in a table depicting marsh type, species composition, density, exposure time, soil type, rate of superficial drainage, and amount of algal debris. Maintenance of emergent marshes depends on water depths and cover types on 1- or 2-year drawdowns in 5- to 10-year intervals. Discusses effects of flooding on species survival.

423. Harris, S. W., and W. H. Marshall. 1960. Germination and planting experiments on soft-stem and hard-stem bulrush. J. Wildl. Manage. 24:134–139.

Response: VEG

Genus: *Scirpus*

Presents results of five storage and three germination tests on seeds of softstem bulrush (*Scirpus validus*) and hardstem bulrush (*S. acutus*) conducted at the Mud Lake National

Wildlife Refuge, northwestern Minnesota. Seeds stored in water during winter and germinated under natural conditions had a higher rate of germination than seeds stored at room temperature or outside in either wet or dry containers. Seed planted in spring failed to germinate. All plantings in fall, after the growing season, developed into heavy stands of seedlings the following spring and summer. Suggests two methods of coordinating timing of drawdowns and bulrush seeding.

424. Harter, R. D. 1966. The effect of water levels on soil chemistry and plant growth of the Magee Marsh Wildlife Area. Ohio Game Monogr. 2. 36 pp.

Response: VEG, SOIL, CHEM

Genus: *Oryza, Polygonum*

Discusses studies on the Magee Marsh Wildlife Area, Ottawa County, Ohio, that determined chemical equilibria of organic wet soils and the effect of waterlogging on cultivated rice (*Oryza sativa*) and smartweed (*Polygonum*). Results indicated that as the amount of water in the soil pores increased, the soil environment changed from oxidizing to reducing conditions (within about 5 days after flooding). Reduced conditions may be more toxic to higher plants. Inundation caused a decreased uptake of calcium, magnesium, manganese, and potassium and an increased uptake of phosphorus by both rice and smartweed. Smartweed seemed to be more tolerant of high manganese content than rice and was unable to grow under waterlogged conditions.

425. Harvey, H. T., M. N. Josselyn, and M. S. Race. 1986. Forum: wetlands restoration and mitigation policies: comment and reply. Environ. Manage. 10(5):567–572.

Response: SUCCESS

Genus: None

Consists of two parts, each representing a different view of the issues associated with the determination of the success of restoration projects. The "comment" section (Harvey and Josselyn) is a critique of a previous article by Race—whose reply follows. Specific examples are taken from the San Francisco Bay area; however, information generated by the debate is useful for many types of wetlands. Includes discussions on planting survival, monitoring, mitigation, and evaluation of the site over time.

426. Harvey, H. T., P. Williams, J. Haltiner, Madrone Associates, et al. 1983. Guidelines for enhancement and restoration of diked historic baylands. San Francisco Bay Conserv. Dev. Comm. Tech. Rep. 38 pp.

Response: VEG, HYDRO, SOIL, WQUAL

Genus: *Atriplex, Baccharis, Cordylanthus, Distichlis, Frankenia, Grindelia, Jaumea, Salicornia, Scirpus, Spartina*

Discusses wetland habitats of the San Francisco Bay area and presents techniques useful for restoring diked historic baylands. Guidelines were based on nine salt marsh projects that range in size from 1 to 213 ha (3 to 525 acres). Includes the following hydraulic design criteria: tidal elevation and marsh topography; tidal range, levee breach, topographic modifications, outlet structure, drainage and circulation, and sedimentation and erosion. Presents designs for marshes used for stormwater and wastewater treatment and for flood protection. Includes aspects of vegetation establishment: climate, substrate, topography, species requirements, and upland and transition zone enhancement. Discusses management of restoration projects.

427. Harvey, J. W., R. M. Chambers, and W. E. Odum. 1988. Groundwater transport between hillslopes and tidal marshes. Pages 270–276 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO, SOIL

Genus: *Peltandra*

Describes the results of the first season of a study of groundwater relation at a tidal freshwater marsh on the Chickahominy River, a James River sub-estuary of the lower chesapeake Bay. Reports the results from 36 piezometers installed at the base of the hillslope (adjacent to the marsh) and in the marsh. Describes hydraulic head distribution and subsurface flow pathways. Discusses physical and chemical roles of tidal marshes in modifying groundwater discharge to estuaries.

428. Hasfurther, V. R. 1985. The use of meander parameters in restoring hydrologic balance to reclaimed stream beds. Pages 21–40 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: HYDRO, SOIL

Genus: None

Describes the use of meander parameters in the process of stream bed reclamation. Discusses methods and techniques for channel restoration in terms of the importance of meander parameters to stream channel stability. Discusses geologic, hydraulic, and geometric stream system parameters. Describes relations and equations incorporating stream bankfull width, sediment load index, stream gradient, and channel depth. Discusses meander design and analysis in terms of creating a hydrologically stable channel with controlled sediment deposition and transport and establishing an enhanced habitat for aquatic life.

429. Hasselrot, B., and H. Hultberg. 1984. Liming of acidified swedish lakes and streams and its consequences for aquatic ecosystems. Fisheries 9(1):4–9.

Response: FISH, INVERT, VEG, WQUAL

Genus: None

Describes biological responses to the liming of acidic lakes and streams in Sweden. To treat streams, high doses of lime are spread in headwater wetlands on upstream reaches. In lakes, limestone is spread on rocky or sandy bottoms in shallow zones. Number of plankton species and decomposition rates increase with liming. Describes the effects on phytoplankton, macrophytes, zooplankton, benthic fauna, and fish. Liming is described as creating a new and temporary stage in the history of a lake.

430. Hasted, S. S. 1980. Growth, sedimentation/erosion, water quality in two marsh restoration projects in Clinton and Stratford, Connecticut. Pages 81–115 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, HYDRO, WQUAL, CHEM

Genus: *Distichlis, Juncus, Salicornia, Spartina*

Restoration studies were conducted on two marshes near Long Island Sound in Clinton and Stratford, Connecticut. Growth responses of several plant species (and stock forms) were studied in terms of elevation, substrate composition, erosion, fertilization, and water quality (salinity, carbon diox-

ide, alkalinity, pH, hardness). Drainage (determined by elevation and substrate texture) was the most significant influence on plant growth; well-drained, sandy, high-shore areas revegetated more successfully than mudflats. Water quality fluctuations in estuarine marshes were correlated with the influences of river water at neap tide and salt water at moon tide.

431. Havens, P. W., and M. E. Lehman. 1987. Wetlands by design: examination of two case studies of wetland creation by the U.S. Navy at Naval Submarine Base, Kings Bay, Georgia. Pages 133–146 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: ECON

Genus: *Baccharis, Ilex, Iva, Myrica, Paspalum, Persea, Ruppia, Scirpus, Spartina*

Describes the U.S. Navy's approach for designing and building low maintenance functional wetland systems with maximum value as wildlife habitat. Explains two studies from the Naval Submarine Base at Kings Bay, Georgia: a tidal saltwater wetland and a freshwater wetland. The Navy has developed a process that creates the potential for savings by incorporating wetland design criteria and site configurations into borrow area construction contracts. Presents cost estimates for planting emergent macrophytes and tree seedlings. Emphasizes an engineering-construetion approach.

432. Haynes, R. J. 1984. Summary of wetlands reestablishment on surface-mined lands in Florida. Pages 357–362 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, Lexington.

Response: WFOWL, VEG, CHEM, WQUAL, SUCCESS

Genus: None

Summarizes information on freshwater wetland reestablishment in lands affected by surface mining of phosphate and limestone in southern Florida. Compares an earthern dam site, which promotes the elimination of settling impoundments and their associated aboveground dams; no management effort, resulting in use of the impoundment by wildlife; and managing for waterfowl and hunting only. Stresses the importance of creating littoral zones, replacing organic matter in lake sediments, and ereating bermless lakes with adjacent periodically inundated wetland areas.

433. Haynes, R. J., and F. Crabill. 1984. Reestablishment of a forested wetland on phosphate-mined land in central Florida. Pages 51–63 *in* P. E. Pope, Comp. Proceedings of the fourth annual better reclamation with trees conference. Purdue University, West Lafayette, Ind.

Response: ECON, SUCCESS

Genus: *Acer, Gordonia, Magnolia, Myrica, Nyssa, Persea, Quercus*

Discusses the concepts and implementation of a revegetation plan for reestablishing a 6.5-ha forested wetland on a phosphate-mined site in Hillsborough County, Florida. Topics include site preparation, mining activities, grading, topsoil storage, soil amendments, revegetation methods, experimental design, and monitoring strategy. Several uncommon reclamation approaches will be used, including establishment of vegetation islands and tree spading. Other site factors include: topsoiling, mulching, use of potted plants and bare-root seedlings, natural invasion, control of plant competition, erosion control, and short- and long-term evaluation of reclamation success and wildlife use. Summarizes categorical project costs.

434. Haynes, R. J., and L. Moore. 1987. Reestablishment of bottomland hardwoods within national wildlife refuges in the southeast. Pages 95–103 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, ECON, SUCCESS

Genus: *Acer, Carya, Liquidambar, Liriodendron, Platanus, Populus, Quercus, Ulmus*

Provides an overview of attempts to reestablish bottomland hardwoods in 12 national wildlife refuges in the southeastern United States. Planting methods, success of refuge plantings (site age varied from 1 to 19 years after planting), reasons for planting failures, competition, and natural regeneration (for species diversity) are described with examples from the literature. The effective supression of the natural reestablishment of tree species may occur when the establishment and growth of competing groundcover is not controlled. Natural regeneration processes alone probably cannot achieve a bottomland forest community (with the desired species) within a 40- to 60-year period.

435. Hedman, E. R., and U.S. R. Osterkamp. 1982. Streamflow characteristics related to channel geometry of streams in western United States. U.S. Geol. Surv. Water-Supply Pap. 2193. 17 pp.

Response: HYDRO

Genus: None

Presents a method of using empirically developed equations to yield a discharge value from ehannel-geometry and channel-material data for streams of the western United States. The equations were developed by collecting data at numerous streamflow-gaging sites and statistically relating those data to selected discharge characteristics. Mean annual runoff and flood discharges with selected recurrence intervals can be estimated for perennial, intermittent, and ephemeral streams. Channel-geometry measurements offer an alternative method of quickly and inexpensively estimating stream-flow characteristics for ungaged streams. The hydrologic data are particularly useful for assessing activities in areas where instrumented gaging stations are unavailable.

436. Heede, B. H. 1979. Predicting impact of a restoration project on river dynamics: a case history. U.S. For. Serv. Gen. Tech. Rep. RM-62. 8 pp.

Response: SOIL, WQUAL

Genus: None

Discusses a project intended to reduce erosion and sediment load of Dump Creek at its junction with the Salmon River in Idaho. The degree of influence of a proposed restoration project can be predicted by taking into account the apparent mechanics and dynamics of the entire river system. The project at Dump Creek-Salmon River is an example of a case where essential data were not available, but where the project would proceed anyway. Describes an approach using theory and experience in combination with available data (to evaluate restoration effects).

437. Heede, B. H. 1979. Deteriorated watersheds can be restored: a case study. Environ. Manage. 3(3):271–281.

Response: VEG, HYDRO, SOIL

Genus: *Agropyron, Artemisia, Bromus, Lolium, Melilotus*

Discusses rehabilitation of a dense gully network in the Alkali Creek watershed, westcentral Colorado. Check dam systems and improved vegetative cover stabilized not only structurally treated gullies, but also untreated network gullies. Check dams decreased gully depth by accumulating sediment deposits, resulting in hastened bank stabilization and increased alluvial aquifer volumes. This increase, plus higher filtration rates as a result of denser vegetation, led to renewed perennial streamflow after 7 treatment years. Sediment loads in flows were reduced more than 90% within 11 years after treatment. Results indicate that the mainstem gully, and those tributaries controlling local base levels of other gullies, are the critical segments that should be structurally treated.

438. Heede, B. H. 1977. Case study of a watershed rehabilitation project: Alkali Creek, Colorado. U.S. For. Serv. Res. Pap. RM-189. 18 pp.

Response: VEG, HYDRO, SOIL, SUCCESS

Genus: None

Describes the restoration of headwaters in the Alkali Creek watershed, White River National Forest, near Silt, Colorado (elevation 2,320–2,560 m [7,600–8,400 feet]). The area was fenced (excluding cattle); vegetation was planted and check dams were constructed. After 7 years, the ephemeral flow became perennial. Erosion was decreased by about two-thirds. Analysis included development of an empirical equation to express relations between original gully gradient and deposit gradient above the check dams.

439. Hefner, J. M. 1982. The National Wetlands Inventory: tools for wetland creation and restoration. Pages 265–275 *in* F. J. Webb, Jr., ed. Proceedings of the Ninth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: None

The U.S. Fish and Wildlife Service's National Wetlands Inventory provides products relating to wetland creation and restoration, including a wetland map series, a hydric soils list, a wetland plant list and data base, and statistical analyses of wetland gains and losses since the mid-1950's. Maps have been prepared using photointerpretation of high altitude aerial photography. The hydric soils list was prepared by the Soil Conservation Service for use in delineating wetlands. The wetland plant list and data base provides habitat requirement information for each species. Statistical analyses provide information on wetland loss trends in the United States.

440. Heilman, P. E., D. M. Greer, S. E. Brauen, and A. S. Baker. 1978. Habitat development field investigations, Miller Sands marsh and upland habitat development site, Columbia River, Oregon; Appendix E: postpropagation assessment of botanical and soil resources on dredged material. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-38. 393 pp.

Response: VEG, SOIL, CHEM

Genus: *Agropyron, Carex, Deschampsia, Festuca, Hordeum, Trifolium, Vicia*

Reports quantitative results of a habitat development experiment at Miller Sands, Columbia River, Oregon. Emphasis is placed on methods, experimental investigations, soil analysis, and soil fertility. *Carex* and *Deschampsia* were used to establish vegetative cover. Soils in lower elevation plots (.64 m [2.13 feet] above mlw) had a high content of silt, clay, and fine sand. Subsequently, sedge (*Carex*) and hairgrass (*Deschampsia*) did not survive well. Aerial biomass at the end of the second growing season was 1,356 kg/ha for *Deschampsia* and 547 kg/ha for *Carex*. These results are compared to biomass in undisturbed areas (6,157 kg/ha) and an unvegetated area (379 kg/ha). Fertilization greatly increased production during the first growing season, but did not contribute significantly to biomass production during the second season.

441. Henderson, S., A. B. Allen, B. Abbruzzese, M. E. Kentula, and R. M. Hughes. 1987. A method for the selection of reference wetlands. Pages 289–291 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: SUCCESS

Genus: None

Describes the development of a method to select natural wetlands in a given ecoregion and compare them to restored or created wetlands in the same ecoregion. The purpose of this procedure is to aid in determining the effectiveness of wetland restoration or creation in replacing the ecological functions of wetlands that were destroyed. The method consists of defining the study area, characterizing the parent population of reference sites, drawing a sample from a list frame, and verifying appropriateness of the reference sites.

442. Herricks, E. E. 1977. Recovery of streams from chronic pollutional stress—acid mine drainage. Pages 43–71 *in* J. Cairns, Jr., K. L. Dickson, and E. E. Herricks, eds. Recovery and restoration of damaged ecosystems. University Press Virginia, Charlottesville.

Response: SUCCESS

Genus: None

Discusses the recovery of streams from ehronic pollution stress and assesses a case study of Indian Creek in Fayette County, Pennsylvania. Topics include: damage caused by acid mine drainage, effects of acid mine drainage on aquatic ecosystems, and recovery-restoration mechanisms affecting streams damaged by long duration stress. Factors that determine recovery are: reduction of stress and restoration of damaged habitat, availability of organisms for recolonization, and seasonal stability of stream conditions (discharge, water quality) for regular maintenance of stream communities. Restoration can be accomplished by natural conditions (as illustrated by the Indian Creek study) as long as the diseharge of pollutants docs not exceed the total stream system's assimilative capacity.

443. Herricks, E. E.. 1982. Development of aquatic habitat potential of gravel pits. Pages 196–206 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. University Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: FISH

Genus: None

Provides information on developing sand-gravel mine pits for aquatic habitat. To minimize maintenance costs, management for any one species requires the development of a complex, supporting ecosystem, which takes time. This time can be shortened (thus increasing site value) by careful management and implementation of procedures relating to site topographic development (using a morphocdaphie index), including provision of littoral areas (.6–1.8-ha [2–6 feet] deep) more than

20% or more of the lake surface area, edge sculpturing to maximize shoreline length, construction of islands, and a variable bottom configuration. During mining, water quality control and early development of fish and wildlife resources can be implemented.

444. Herricks, E. E., and J. Cairns, Jr. 1972. The recovery of stream macrobenthic communities from the effects of acid mine drainage. Pages 370–398 *in* Fourth symposium on coal mine drainage research. Carnegie-Mellon University, Monroeville, Penn.

Response: INVERT, CHEM, WQUAL

Genus: None

Discusses the effects of acid mine drainage on macroinvertebrates of indian Creek, Fayette County, Pennsylvania. The creek was sampled upstream and downstream of an acid source and at various flows during May, July, and October. The effect of lower stream discharge was a decrease in the dilution of acid mine drainage and an increase in the stesss on the macroinvertebrate communities, which were dominated by tolerant organisms. Tributaries to the creek improved water quality by dilution and supplied organisms to reinvade the damaged regions of the stream from which they had been eliminated during low flow (higher sulfate levels and lower pH).

445. Herricks, E. E., and J. Cairns, Jr. 1974. Rehabilitation of streams receiving acid mine drainage. Water Resour. Res. Cent. Bull. 66. 284 pp.

Response: INVERT, HYDRO, WQUAL, CHEM

Genus: None

Presents results of three studies on the effects of acid mine drainage on streams of Montgomery County, Virginia, and Fayette and Venango Counties, Pennsylvania. Acid was experimentally added to a healthy productive stream, reducing pH from 8.0 to 4.0 for 15 min. Diversity and density of aquatie macrobenthos were reduced by 29 and 42% and full recovery occurred within 19–28 days. Recolonization was related to drift of recolonizing organisms. In other studies, source areas of recolonizing organisms were unpolluted tributaries, which also improved the acid mine-impacted streams by diluting the discharge and improving water quality. The use of lime neutralization can rapidly restore water quality, but hydroxide floc, a byproduct of the neutralization, limits the recolonization of some bottom fauna.

446. Herricks, E. E., and J. Cairns, Jr. 1974. The recovery of streams stressed by acid coal mine drainage. Pages 11–24 *in* Fifth symposium on coal mine drainage research. National Coal Assocciation, Washington, D.C.

Response: INVERT, HYDRO, CHEM, WQUAL

Genus: None

Discusses the interactions between physical, chemical, and biological systems of an acidic coal mine drainage area in the Indian Creek watershed, Fayette and Westmoreland Counties, Pennsylvania. Recovery to near normal environmental conditions occurred within 12.9 km (8 miles) of the acidic discharge source area. This rapid recovery was due in part to unpolluted tributaries that aided in dilution and neutralization of the acidic discharge. In portions of the stream, conditions varied seasonally with changing discharge. During low discharge, stress levels were increased and the biological community was altered. Biological communities became temporarily reestablished when acid drainage concentrations were low due to high discharge volumes.

447. Herricks, E. E., and L. L. Osborne. 1985. Water quality restoration and protection in streams and rivers. Pages 1–20 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: CHEM, WQUAL

Genus: None

Provides an overview of water quality restoration and protection in streams and rivers. Discusses risk or hazard assessment and tolerance of various species to toxic substances. Describes restoration techniques in terms of water quality criteria and designated stream use. Describes effects of several chemical substances on specifie organisms. The primary elements of restoration are the isolation, removal, transfer, or dilution of substances that degrade water quality. Discusses protection of rivers and streams from point and nonpoint source contamination.

448. Herskowitz, J., S. Black, and W. Lewandowski. 1987. Listowel artificial marsh treatment project. Pages 247–254 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: CHEM, WQUAL

Genus: *Typha*

Discusses five separate cattail (*Typha*) marsh treatment systems, oceupying 8,670 m^2, used to treat 4% of the sewage from Listowel, Ontario. Two pretreatment types, complete mix aeration cell effluent and lagoon effluent, were also tested. The marsh effluent quality achieved was at levels between conventional and tertiary treatment. The systems demonstrated large reductions in BOD, suspended solids, and bacteria on a year-round basis. Effluent quality was highest when oxygen supply was adequate to support aerobic metabolism in the marshes. The data from the experimental treatments were used to refine the design for a full-scale marshland sewage treatment facility at Port Perry, Ontario. The major modification was the installation of an upgraded pretreatment unit.

449. Hey, D. L. 1987. The Des Plaines River wetlands demonstration project: developing and implementing goals and objectives. Pages 89–91 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL, ECON, SUCCESS

Genus: None

Describes the Wetlands Research, Inc., planning and development of the Des Plaines River wetlands demonstration project near Wadsworth, Illinois. Objectives of the project are to develop and test design principles, construction methods, and management programs for the various functions of reconstructed wetlands. Research will be conducted on eight experimental wetland areas as well as on the river system. Discusses performance criteria and funding sources.

450. Hey, D. L., and N. S. Philippi. 1985. The Des Plaines River wetlands demonstration project: Vol. III. Design, construction specifications, and site management. Wetlands Research, Inc., Chicago, Ill.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, HUSE, HYDRO, CHEM, WQUAL, ECON

Genus: *Andropogon, Calamagrostis, Carex, Ceratophyllum, Elymus, Lemna, Myriophyllum, Nelumbo, Nuphar, Nymphaea, Panicum, Potamogeton, Sorghastrum, Spartina,* many

Describes in detail the design and construction of the Des Plaines River wetlands demonstration project, a restoration effort on 182 ha (450 acres) along 3.2 km (2.8 miles) of the upper Des Plaines River, Lake County, Illinois. Describes habitat design and management conditions, followed by grading and drainage plans, irrigation system plans, vegetation, public use, construction plans, and costs. Discusses potential plant communities at the site: aquatic, islands and lowlands, extended shoreline, wet prairie and sedge meadow, prairie, riparian marsh, inundated riparian marsh, sedge meadow-low prairie, cattail marsh, lawn mix, and mud flat-marsh.

451. Hey, D. L., and N. S. Philippi. 1985. The Des Plaines River wetlands demonstration project; Vol. II. Baseline survey. Wetlands Research, Inc., Chicago, Ill.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, HUSE, HYDRO, CHEM, WQUAL, SUCCESS

Genus: Many

Describes existing conditions at the 450-acre site of the Des Plaines River wetlands demonstration project, Lake County, Illinois, during spring/summer 1985. The project involves the restoration of riverine wetlands bordering a 2.8-mile stretch of the upper Des Plaines River. The following are described in detail: topography, hydrology, water quality, geology, soils, vegetation, microorganisms, aquatic macroinvertebrates, terrestrial insects, amphibians and reptiles, fish, birds, mammals, habitat evaluation procedures, public use, and historic use. Chapters on these topics were prepared by experts in the various fields.

452. Hey, D. L., J. M. Stockdale, D. Kropp, and G. Wilhelm. 1982. Creation of wetlands in northeastern Illinois. Ill. Dep. Energy Nat. Resour. Doc. 82109. 117 pp.

Response: None

Genus: *Salix*, many

Presents a conceptual plan for wetland restoration at a 450-acre site along the Des Plaines River, Lake County, Illinois. The role of reestablished wetlands is discussed in terms of providing potential solutions to urban problems of (1) loss of wetland and aquatic habitats; (2) reduced flood water storage capacity; (3) treatment of nonpoint source pollution; (4) the cost of high technology, including advanced wastewater treatment; and (5) limited enjoyment and recreation due to water quality. The conceptual plan for the Des Plaines River site includes producing marsh areas, preserving a willow community, and encouraging greater public use of the area. The wetland restoration will be used as a demonstration site for the Lake County Forest Preserve District.

453. Hill, D. M. 1974. Reclamation of damaged streams as a tool in resource management. Pages 96–101 *in* Proceedings on a symposium on trout habitat, research and management. U.S. Forest Service, Southeastern Experiment Station, Asheville, N.C.

Response: None

Genus: None

Discusses factors that affect stream recovery. Although a complex of factors influence the potential of a stream to undergo biological recovery, two of the most important criteria are (1) the absence of limiting residual effects or the continued input of detrimental substances and (2) the availability of recolonizing populations of organisms adequate for the reestablishment of diverse, functional biotic communities. Agencies concerned with reclamation of damaged streams to improve the fishery resources should examine each situation carefully with regard to residual effects or incomplete pollution abatement. Consideration should be given to the possibility of influencing faunal community structures through appropriate faunal transplants.

454. Hillen, J. P. 1976. Dune stabilization and beautification using native vegetation. Pages 105–112 *in* R. R. Lewis and D. P. Cole, eds. Proceedings of the Third Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Coccoloba, Helianthus, Ipomoea, Tournefortia, Uniola, Yucca*

Describes transplanting efforts on the sandy beaches of Florida. Six species of native plants were selected for transplantation on the basis of (1) tolerance to salt in the soil; (2) tolerance to salt spray and salt water; (3) ability to withstand periodic "sandblasting"; (4) provision of cover (protection) from wind, salt, and sand; (5) erosion prevention; and (6) aesthetic appeal. Planting methods are described in detail; survival rates for the six species varied from 55–100%. Causes of plant death in other projects are discussed. Guidelines for successful planting are presented.

455. Hinkle, R. L. 1988. Wetland mitigation plan development for the Manasquan Reservoir system project. Pages 355–361 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG

Genus: *Alnus, Carex, Cephalanthus, Cornus, Salix, Scirpus, Sparganium, Typha, Viburnum, Zizania*

Discusses development of the wetland mitigation plan for the Manasquan Reservoir system project, Monmouth County, New Jersey. The plan was developed using the Pennsylvania modified habitat evaluation procedure (PAM HEP) and involved combined efforts of representatives of Federal and State agencies. PAM HEP is based on the Habitat Suitability Index (HSI) and Related Habitat Units (HU). Infrared aerial photography was used to establish baseline cover types. HSI values for 3–4 wildlife or fish species were used to determine HSI's for each of 12 habitat types. Habitat gains and losses due to the project are presented. The mitigation plan would account for 88% of the wetland values to be lost as a result of reservoir construction. Brief summaries of plans for various components of the project mitigation plan are included.

456. Hobbs, A. J., and L. Shennan. 1986. Remote sensing of salt marsh reclamation in the Wash, England. J. Coastal Res. 2(2):181–198.

Response: VEG, SOIL

Genus: *Aster, Halimione, Puccinellia, Salicornia, Spartina, Spergularia, Suaeda, Zostera*

Describes ground-based radiometry used at a study site on the Wash Estuary, England, to quantify the spectral reflectance properties of surfaces within the salt marsh environment. The objective of the study was to determine the spectral separability of the vegetation and sediment zones and thereby evaluate the potential of remote sensing techniques for monitoring the effects of reclamation of salt marshes for agriculture. Measurements were made in four wave bands that approximated bands 1–4 of the Landsat satellite thematic mapper. Some overlap within vegetation type occurred, but three species groups were distinguishable. Dry sand, wet sand, mud, and water and mud also were distinguishable. Presents guidelines for best use of the technique.

457. Hoffman, G. R. 1978. Shore vegetation of lakes Oahe and Sakakawea, mainstream Missouri River reservoirs. Univ. South Dakota, Dep. Biol., Vermillion. 204 pp.

Response: FISH, VEG, SOIL, CHEM, SUCCESS

Genus: *Agropyron, Alopecurus, Bromus, Chenopodium, Convolvulus, Conyza, Helianthus, Hordeum, Kochia, Lactuca, Melilotus, Panicum, Phalaris, Poa, Polygonum, Populus, Rumex, Salix, Sonchus*

Describes the shoreline vegetation of two artificial lakes (Oahe and Sakakawea) along the upper Missouri River in North and South Dakota. Goals were to determine the feasibility of experimentally establishing species on reservoir shores and to record vegetative responses to cattle grazing, inundation, and soil nutrients. In the inundation zone, successful herbaceous vegetation consisted of *Phalaris arundinacea, Phragmites australis, Scirpus validus, Typha latifolia*, and *Agropyron smithii*. Shrubs were intolerant of flooding. Among trees, *Salix amygdaloides* was most tolerant; *Celtis occidentalis* and *Ulmus* spp. were least tolerant. Cattle grazing significantly reduced plant coverage and biomass. Describes management recommendations.

458. Hoffman, G. R. 1977. Artificial establishment of vegetation and effects of fertilizer along shorelines of lakes Oahe and Sakakawea, mainstem Missouri River reservoirs. Pages 95–113 *in* Proceedings of the workshop on the role of vegetation in stabilization of the Great Lakes shoreline. Great Lakes Basin Commission, Ann Arbor, Mich.

Response: VEG, SOIL, CHEM

Genus: *Agropyron, Alopecurus, Chenopodium, Hordeum, Iva, Kochia, Melilotus, Phalaris, Phragmites, Poa, Polygonum, Rumex, Salsola, Scirpus, Thlaspi, Typha*, many

Discusses establishment of plantings along shorelines of lakes Oahe and Sakakawea on the Missouri River in North and South Dakota. Annual water level fluctuations for the reservoirs averages 3.45–3.58 m and the zone of shoreline flooded annually does not support permanent vegetation. Fifteen species of grasses, emergent hydrophytes, and trees were seeded or transplanted at various sites. Species that seem to be most adapted to the shoreline environment were *Phalaris arundinacea, Alopecures arundinaceus, Phragmites australis, Typha latifolia*, and *Scirpus validus*. Discusses the effects of fertilizer on naturally occurring vegetation.

459. Hoffman, G. R., S. G. Shetron, C. V. Klimas, and H. H. Allen. 1986. Lakeshore revegetation studies at Lake Oahe, South Dakota. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. E-86-3. 18 pp.

Response: VEG, HYDRO

Genus: *Acer, Acorus, Agropyron, Alnus, Alopecurus, Andropogon, Buchloe, Cornus, Elymus, Festuca, Fraxinus, Glycerrhiza, Iris, Lolium, Nasturtium, Panicum, Peltandra, Phalaris, Phleum, Phragmites, Poa, Polygonum, Pontederia, Populus, Quercus, Sagittaria, Salix, Scirpus, Shepherdia, Sorghastrum, Sorghum, Sparganium, Spartina, Stipa, Symphoricarpos, Typha, Zizania*

Discusses survival and growth of 55 plant species transplanted in a subimpoundment adjacent to Lake Oahe, South Dakota, and exposed to various inundation schemes. *Phalaris arundinacea* was the best candidate for transplanting over a wide range of shoreline site conditions in the northern prairie region. Other species demonstrating sufficiently consistent responses to merit recommendation for shoreline planting include *Buchloe dactyloides, Phragmites australis, Poa pratensis, Scirpus americanus, Spartina pectinata, Fraxinus pennsylvanica*, and *Populus deltoides*. Fourteen additional species were recommended for trial planting in particular circumstances. Discusses other aspects besides species selection that need to be considered in shoreline revegetation planning.

460. Hoffman, R. D. 1988. Ducks Unlimited's United States construction program for enhancing waterfowl production. Pages 109–113 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: MAMMALS, WFOWL

Genus: *Typha*

Discusses Ducks Unlimited's program for enhancing waterfowl production in the Great Plains region of the U.S. Over 100 cooperative projects have been completed and over 70,000 acres (28,350 ha)of wetlands have been created or enhanced on public wildlife management areas totalling over 15,000 acres. Projects are evaluated and contructed to improve four factors that may limit waterfowl production: pair territory sites, secure nesting habitat, adequate brood-rearing habitat, and water level management. Techniques employed include predator control, water level manipulation, creation of nesting islands, level ditching, and creation of water level-controlled impoundments. Brief descriptions of these techniques include response of waterfowl to the management practices.

461. Hoffman, W. E., M. J. Durako, and R. R. Lewis, III. 1982. Habitat restoration in Tampa Bay. Pages 636–656 *in* S. F. Treat, J. L. Simon, and R. R. Lewis, eds. Tampa Bay area scientific information symposium proceedings. Bellweather Press, Edina, Minn., Florida Sea Grant Coll. Rep. 65.

Response: VEG, ECON

Genus: *Avicennia, Halodule, Juncus, Laguncularia, Rhizophora, Spartina, Syringodium, Thalassia*

Reviews 19 vegetation establishment projects in Tampa Bay, Florida. The projects were undertaken to improve commercial fishery and colonial waterbird habitat. Transplanted species included *Spartina alterniflora, Thalassia testudinum, Rhizophora mangle, Avicennia germinans, Laguncularia racemosa*, and *Juncus roemerianus*. Plugs, propagules, and seedling transplants were used. A table documents techniques, percent survival, and specific comments on fertilizers, stabilization techniques, and spacing. *S. alterniflora* was the least expensive to reestablish ($4,971/ha) and mangroves were the most expensive ($12,479–62, 943/ha).

462. Hoffman, W. E., and J. A. Rodgers. 1980. A cost/benefit analysis of two large coastal plantings in Tampa Bay, Florida. Pages 265–278 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON, SHOREB

Genus: *Avicennia, Laguncularia, Spartina*

Describes the results of two plantings of coastal vegetation in Hillsborough Bay, Hillsborough County, Florida. *Spartina alterniflora* plugs were planted on a dredge material island; after 14 months, the survival rate was 93.4%. After 13 months, the survival rate of *Avicennia germinans* and *Laguncularia racemosa* seedlings was 73.3%. Compares economic and ecological advantages and disadvantages of plantings. Mangrove transplants (planted on 2-m centers) cost $10,960/ha; smooth cordgrass transplants (at 1.5-m centers) cost $4,218/ha.

463. Hollands, G. G. 1988. Assessing the relationship of groundwater and wetlands. Pages 240–242 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. Sept. 16–18 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: WQUAL

Genus: None

Provides a brief overview of data requirements for understanding groundwater functions of specific wetlands, groundwater recharge and discharge relations, and wetland soils and groundwater relations. Identifies research needs.

464. Hollands, G. G., G. E. Hollis, and J. S. Larson. 1986. Science base for freshwater wetland mitigation in the glaciated northeastern United States: hydrology. Pages 131–143 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass., Environ. Inst., Amherst, Publ. 87–1.

Response: HYDRO, SUCCESS

Genus: None

Describes relations between wetland functions and hydrological data requirements. Describes hydrology and wetland functions, flood storage, desynchronization, nutrient retention, food chain support, habitat, and recreation. Data requirements for assessment of wetland hydrologic functions include land use history, macrotopography, surficial geology, streamflow, lake hydraulics, groundwater level, water quality, microtopography, bedrock geology, stream flow velocity, soil pore water storage, precipitation, water balance analysis, groundwater storage and flow rate, and soil pore water level and flow.

465. Holmes, W. C., and D. T. Stalling. 1987. Four natives evaluated for shoreline erosion control. Restor. Manage. Notes 5(2):91–92.

Response: VEG, SOIL

Genus: *Eleocharis, Juncus, Panicum, Zizaniopsis*

Describes the initial stages of a 5-year erosion control study at Toledo Bend Reservoir, Louisiana. Water millet, maidencane, spikerush and soft rush were planted and evaluated to determine their survival and growth under various moisture and temperature conditions. A regular watering program is suggested for best results during noninundation periods. Water millet was most successful in terms of wave protection and erosion control. Use of wave-stilling devices is recommended.

466. Holtz, S. 1986. Bringing back a beautiful landscape. Restor. Manage. Notes 4(2):56–61.

Response: ECON, SUCCESS

Genus: *Aster, Carex, Solidago, Spartina, Typha*

Discusses the Des Plaines River wetlands demonstration project in northeastern Illinois. The project represents a commitment to reconstruct a wetland of 450 acres (182 ha) of land along a 2.8-mile (4.5-km) stretch of the Des Plaines River to provide a more cost-effective way of controlling flooding and improving water quality. A nonprofit organization, Wetlands Research, Inc., was formed to carry out the project. A disturbed site will be almost completely regraded to create eight experimental wetlands and the river will be widened and in one area divided into two branches, creating a 1-ha island. Two quarries on the site will be graded and used to handle high-water overflow from the river. Other project design plans and costs are discussed, as well as plans to monitor the experimental units.

467. Holtz, S. 1986. Tropical seagrass restoration. Restor. Manage. Notes 4(1):5–11.

Response: VEG, SOIL, ECON, SUCCESS

Genus: *Halodule, Syringodium, Thalassia*

Summarizes past and current techniques of tropical seagrass restoration in southern Florida. Restoration projects in the 1960's and 1970's used plugs, sod, shoots, and anchored turions with varying results. Restoration methods in the 1980's included mechanical and seeding techniques in conjunction with previous methods. Costs of restoration varied from $2,000 to $182,000/ha. Discusses advantages and disadvantages of Federal and State policies dealing with seagrass restoration and mitigation.

468. Homblette, D. J. 1983. Wetland restoration: a model characterization approach using aerial photography and field analysis. Pages 149–163 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, HYDRO, ECON

Genus: *Typha*, many

A 5-year restoration plan was developed for a degraded marsh near Madison, Wisconsin. The plan used a model characterization approach and was based on background data from five natural wetlands. Transition zone slopes of the degraded wetland averaged 12%, whereas those of the natural areas varied from 0.1 to 5%. Steep edge slopes and high water levels with little or no fluctuation (or periods of exposed substrate) were the major limiting factors to the functioning of the degraded marsh. Describes characteristics of the natural marshes and compares in detail to those of the degraded marsh; describes actions and methods to subsequently alter the degraded area. The use of aerial photography was a significant aid to the project and was cost-effective as well.

469. Homziak, J., M. S. Fonseca, and W. J. Kenworthy. 1982. Macrobenthic community structure in a transplanted eelgrass (*Zostera marina*) meadow. Mar. Ecol. Prog. Ser. 9:211–221.

Response: INVERT, VEG

Genus: *Halodule, Zostera*

Describes a study of eelgrass (*Zostera*) transplant success in both low- and high-energy environments at Middle Marsh,

Back Sound, Cartaret County, North Carolina. Changes in physical, chemical, biological, and ecological factors during the development of the seagrass meadow were monitored. The role of seagrasses in structuring maerobenthie communities is discussed; macrofaunal diversity and density are described over time (203 days) and aeross the different seagrass plot conditions (high-energy stock, low-energy stock, eelgrass alone, eelgrass plus shoal grass (*Halodule*), and undisturbed controls).

470. Hook, D. D. 1987. Criteria for creating and restoring forested wetlands in the southern United States. Pages 51–60 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, HYDRO, SUCCESS

Genus: *Carya, Forestiera, Fraxinus, Liquidambar, Nyssa, Pinus, Quercus, Sassafras, Taxodium, Ulmus*

Describes the process of planning and implementing forested wetland creation or restoration activities. Recommendations include determining exactly what type of wetland is desired, selecting the site, designing the hydraulic system to maintain the hydroperiod with minimum energy input, selecting regeneration methods, screening seedlings before planting, removing all competing vegetation, and managing water regime to favor the desired tree species. These points are discussed in some detail, in light of rescarch results and literature review.

471. Hootsmans, M. J. M., J. E. Vermaat, and W. Van Vierssen. 1985. Seed-bank development, germination and early seedling survival of two seagrass species from the Netherlands: *Zostera marina L.* and *Zostera noltii hornem*. Aquat. Bot. 28:275–285.

Response: VEG, CHEM, WQUAL

Genus: *Zostera*

Discusses flowering and seedbank development of annual *Zostera marina* and perennial *Z. noltii* in the Zandkreek, southwest Netherlands, and germination of the plants in the laboratory. Flowering of *Z. noltii* started at the end of June and continued through September. *Z. marina* began and ended flowering a month later than *Z. noltii*. Both species showed a maximum germination at 30° C and 1% salinity; germination decreased with higher salinities and lower temperatures. Stratification stimulated germination only at salinities of at least 20%. Desiccation and anaerobiosis were lethal to *Z. marina* seeds. Seedlings of *Z. marina* survived best at 10° C and 10–20% salinity; those of *Z. noltii* survived best at 10° C and 1% salinity.

472. Hopple, W. H. 1982. Environmental characteristics and the Chironomidae (Diptera) composition of gravel pit ponds. M. S. thesis, University of Cincinnati, Cincinnati, Oh.

Response: INVERT, CHEM, WQUAL

Genus: None

Describes chironomidae species and physical, chemical, and biological characteristics of 46 gravel pit ponds along 30 miles of the Little Miami River, Hamilton County, Ohio. The ponds varied in age from 1 to 72 years and in depth from 0.2 to 9.0 m. Macroinvertebrates were sampled in 38 of the ponds; dominant species were identified. Distribution, species richness, and species diversity of Chironomidae are described and correlated with different pond characteristics.

473. Hosner, J. F. 1960. Relative tolerance to complete inundation of fourteen bottomland tree speeies. For. Sei. 6(3):246–251.

Response: VEG

Genus: *Acer, Celtis, Cephalanthus, Fraxinus, Liquidambar, Platanus, Populus, Quercus, Salix, Ulmus*

Presents results of exposing seedlings of 14 tree speeies in southern Illinois to 5, 10, 20, and 30 days of complete inundation. Relative tolerances to inundation indicated a range from most to least tolerant. However, many species exhibit a greater or lesser tolerance to flooding than species–site relations indicate; thus, other factors also must play an important part in determining the regeneration and succession of tree species in bottomland hardwoods.

474. Hosner, J. F., and S. G. Boyce. 1962. Tolerance to water saturated soil of various bottomland hardwoods. For. Sci. 8(2):180–186.

Response: VEG

Genus: *Acer, Celtis, Fraxinus, Liquidambar, Platanus, Populus, Quercus, Salix, Ulmus*

Describes a laboratory study of 16 species of bottomland hardwoods and the effects of saturated conditions on the growth of seedlings. The results enabled the author to classify species according to their tolerance to water saturated soil conditions. Describes mechanisms of tolerance to saterated soil conditions.

475. Hosner, J. F., and L. S. Minckler. 1963. Bottomland hardwood forests of southern Illinois—regeneration and succession. Ecology 44(1):29–41.

Response: SOIL, VEG

Genus: *Acer, Carya, Celtis, Fraxinus, Platanus, Populus, Quercus, Salix*

Documents the sampling of 62 bottomland hardwood areas in southern Illinois to determine the frequency of regeneration of various hardwoods. The relationship between tree species and moisture holding capacities of associated soils was examined. Tree succession on better drained areas was compared to succession in poorly drained swamps and sloughs. Both mixed soft-hardwoods and mixed hard-hardwoods are apparently subclimaxes; further progression takes place slowly.

476. Hosner, J. F., and L. S. Minckler. 1960. Hardwood reproduction in the river bottoms of southern Ilinois. For. Sci. 6(1):67–77.

Response: VEG

Genus: *Acer, Carya, Celtis, Fraxinus, Liquidambar, Platanus, Populus, Quercus, Salix, Ulmus,* many

Discusses results of a field study conducted to determine the status of tree reproduction in hardwood bottomlands of southern Illinois, and to relate the reproduction of species and species groups to certain stand and site factors. Data are presented on seedlings per acre by species groups, forest site types, basal area of overstory, diameter of canopy openings, groundcover conditions, available water holding capacity in surface soil and subsoil, and depth of litter. Discusses twenty species. American elm, boxelder, green ash, and silver maple were the most strongly represented timber species reproducing in bottomlands, except on newly formed land where cottonwood and willow were the most numerous.

477. Howard, K. Bell Consulting Engineers, Inc. 1986. Preliminary engineering study for artificial wetlands wastewater treatment

facility, City of Pembroke, Kentucky. Howard K. Bell Consulting Eng., Inc., Lexington, Ky. 18 pp.

Response: WQUAL, ECON

Genus: *Lemna, Phalaris, Scirpus, Typha*

Evaluates the proposed artificial wetlands wastewater treatment facility as a cost-effective alternative for upgrading the facilities at Pembroke, Kentueky, to meet the national pollutant discharge elimination systems' permit requirements and provide additional capacity for future wastewater treatment needs. Raw wastewater will be pumped by the existing plant lift station through the existing preliminary treatment system to the reaeration zone for mixing and aeration prior to discharge to the wetlands. At the wetlands, wastewater will enter an emergent marsh, flow to a pond, then to a wetland meadow prior to discharge through a new chlorinator and cascade reaeration system. Detailed plans and costs are provided for the recommended, revised design.

478. Hubbard, D. E., J. L. Richardson, and D. D. Malo. 1988. Glaciated prairie wetlands: soils, hydrology, and land-use implications. Pages 137–143 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. Sept. 16–18 1987, Chicago, Ill. Assoc. of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: None

Describes wetlands of the prairie pothole region in terms of water budgets, groundwater relationships (recharge and discharge, and flowthrough wetlands), pothole wetland soils, and the land use and hydrologic implications of artificial drainage (soil salination, groundwater, and surface drainage patterns). The importance of prairie pothole wetlands in the prairie hydrologic regime is emphasized.

479. Huichun, O., F. Tingzhi, Z. Aitang, Y. Bi, Z. Chongxin, and Q. Rusheng. 1985. Physiological basis of longtime establishment of *Spartina anglica* in alkaline soil. Page 179–184 (English abstract) *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing Univ., China.

Response: VEG, CHEM, WQUAL

Genus: *Spartina*

Discusses trial plantings of *Spartina anglica* in alkaline soil from Dawa County, Liaoning Province, China. Results demonstrated no unfavorable effects on formation of chlorophyll or protein metabolism in plants grown in alkaline soil. Plants appeared to adapt to alkalinity by absorbing and accumulating large quantities of K^+, Na^+, Cl^-, and other ions to guarantee absorbtion of water and nutrients and to lower water potential. Plants also excreted excess quantities of ions to maintain an ionic balance and remain in a proper state of hydration and metabolic activity. *Spartina* was capable of lowering ph in alkaline solutions.

480. Hummon, W. D., W. A. Evans, M. R. Hummon, F. G. Doherty, R. H. Wainberg, and W. S. Stanley. 1978. Meiofaunal abundance in sandbars of acid mine polluted, reclaimed, and unpolluted streams in southeastern Ohio. Pages 188–203 *in* J. H. Thorp and J. W. Gibbons, eds. Energy and environmental stress in aquatic systems. U.S. Dep. Energy, Tech. Inf. Cent., Washington, D.C.

Response: INVERT, HYDRO, SOIL, CHEM, WQUAL

Genus: None

Compares diversity and abundance of meiofauna in natural and acid mine streams of southeastern Ohio and develops preliminary criteria for assessing the state of acid mine stream pollution and recovery based on meiobenthic fauna. Physical-chemical parameters measured for stream and sediment included temperature, pH, conductivity, carbonate alkalinity, sulfates, calcium and total hardness, manganese, iron, dissolved oxygen, bod, and stream flow. Total numbers of taxa, geometrie means of total meiofauna, and Diptera (one of 16 taxa observed) were negatively correlated with values for compensated noncarbonate conductivity from the 14 sampled sites. A dendrogram of similarity analysis is presented. Some mined sites appear to be approaching recovery.

481. Hunt, L. J. 1979. Principles of marsh establishment. Pages 127–142 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, MAMMALS, VEG, SOIL, WQUAL

Genus: *Acnida, Borrichia, Carex, Deschampsia, Distichlis, Iva, Juncus, Panicum, Peltandra, Pluchea, Salicornia, Scirpus, Spartina,* many

Summarizes results from a 5-year U.S. Army Corps of Engineers study of six habitat development field sites: (1) Miller Sands, Columbia River, Oregon; (2) Salt Pond #3, San Francisco Bay, California; (3) Bolivar Peninsula, Galveston Bay, Texas; (4) Drake Wilson Island, Apalachicola Bay, Florida; (5) Buttermilk Sound, Georgia; and (6) Windmill Point, James River, Virginia. Dredged material disposal operations and alternatives are discussed. Information is presented on elevation; plant invasion; site protection; fertilization; and plant species and propagule seleetion, spacing, and time of planting. Elevation, inundation periods, and tolerance of vegetation to flooding determine marsh composition. The study concluded that desirable plant species can be established on dredged material substrates.

482. Hunt. L. J., A. W. Ford, M. C. Landin, and B. R. Wells. 1978. Habitat development with dredged material: engineering and plant propagation. U.S. Army Eng. Waterways Exp. Stn., Environ. Lab., Vicksburg, Miss., Tech. Rep. DS-78-17. 160 pp.

Response: VEG, SOIL, CHEM, ECON

Genus: Many

The use of dredged material as substrate for upland habitat development proved to be a feasible alternative to standard dredged material operations. Three sites were selected to report research results and development guidelines: Miller Sands in the Columbia River, Oregon; Bolivar Peninsula in Galveston Bay, Texas; and Nott Island in the Conneeticut River, Connecticut. Detailed information on substrate structure and project feasibility is included. Tables listing 360 plant species provide information (by region) on their suitability and requirements for planting, including soil pH, soil salinity, wildlife value, storage requirements, and growth. Costs, contaminants, fertilizers, pests, diseases, and other potential problems also are discussed.

483. Hunt, R. L. 1976. A long-term evaluation of trout habitat development and its relation to improving management-related research. Trans. Am. Fish. Soc. 105(3):361–369.

Response: FISH

Genus: None

Discusses responses of a wild brook trout population to instream habitat development on a 0.7-km reach of Lawrence Creek in Wisconsin. Habitat development consisted of a series of 86 paired bank covers and current deflectors. Mean annual biomass of trout, mean annual number of trout over 15 cm (legal size), and annual production increased during the first 3 years following development; an even greater increase was observed during the second 3 years. Peak numbers and biomass were reached during the fifth year after project completion.

484. Hunt, W. A., and R. J. Graham. 1972. Preliminary evaluation of channel changes designed to restore fish habitat. Montana State Univ., Dep. Civil Eng. and Eng. Mechanics, Bozeman, Unpubl. Rep. 72 pp.

Response: FISH, HYDRO, SOIL, WQUAL

Genus: None

Evaluates the hydraulic characteristics of two constructed meander channels and the acceptability of the channels as habitat for species of fish found in the original channel of the Clark Fork River near Drummond, Montana. Comparisons with natural meanders revealed that the constructed meanders provided similar hydraulic, topographic, and fish habitat characteristics. Fish size, species, and quantities in the constructed meanders, 3 years after construction, were similar to natural meanders. Recommendations for determining design criteria, placement of riprap, and acquisition of right-of-way for meander channels are presented. The authors suggest that it may be better to recover the stream length in short sections close to the alterations caused by highway locations, rather than one long section.

485. Huntsman, B. E., R. L. P. Kleinmann, and T. O. Tiernan. 1985. Hydrologic and geochemical considerations in maintaining man-made wetlands constructed for acid mine drainage abatement. Page 375 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State Univ., School For. Resour., Univ. Park.

Response: CHEM, WQUAL

Genus: *Sphagnum*

Describes the feasibility of using artificial wetlands for reducing acid concentrations in surface mines. Maintenance of hydrologic balance involves proper hydraulic retention time, precipitation, runoff, infiltration, and evapotranspiration to maintain proper retention time in zones of biological activity and, consequently, for efficient reduction of contaminants. *Sphagnum* moss survival under various concentrations of acidity, iron, sulfate, and pH were observed. Design changes to accommodate the "flushing" phenomena found in some wetlands are mentioned.

486. Hutchins, M. L. 1981. Simplified ecosystem modeling for assessing alternative biomanipulation strategies. Pages 102–107 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, Portland, Maine, EPA 440/5-81-010.

Response: FISH, INVERT, VEG

Genus: None

Describes a technique of "loop analysis" applied to a variety of hypothetical lake ecosystems in an attempt to qualitatively assess the potential of biomanipulation as a lake restoration technique. The technique is based on the equivalence of a set of linear differential equations at or near equilibrium and their matrices and loop diagrams. The only information required is that the number of system components and their direct interactions (in terms of positive, negative, or no impact) be specified. In general, results support current ecosystem theory and several recent field studies. Complex food webs of algae, zooplankton, forage fish, and game fish are discussed.

487. Idstrom, J. 1986. A field manager's experience with wetland restoration. Pages 29–32 *in* J. L. Piehl, ed. Proceedings, wetland restoration: a techniques workshop, Minnesota Chap. Wildl. Soc., Fergus Falls.

Response: None

Genus: None

Provides an overview of a wildlife manager's perspective on wetlands restoration projects on intensively farmed land in the Owatonna/Albert Lea/Mankato areas of Minnesota. Baseline wetland surveys, restoration publicity, local contacts, funding, and planning are discussed in terms of reaching the goal of restoring wetland areas. The wetland complex, with both shallow and deeper water areas, is noted as the best system for meeting the needs of most marshland wildlife.

488. Ischinger, L. S., and K. Schneller-Mcdonald. 1988. Wetland restoration and creation in the west: what do we really know? Pages 29–36 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American west. Soc. Wetland Scientists, Rocky Mountain Chap., Denver, Colo.

Response: SUCCESS

Genus: None

Provides an overview of published literature for the Rocky Mountain and intermountain west contained in the Wetland Creation/Restoration database, developed by the U.S. Fish and Wildlife Service, National Ecology Research Center. Of 1,000 articles in the data base, 79 are concerned with noncoastal freshwater wetlands in the west. General trends, including project objectives, measured responses, and project duration, are discussed. Only 10 records provide discussion of criteria for determining project success. Research information needs are included.

489. Ivanov, K. E. 1984. Theoretical principles of modern hydrology of swamps. Water Resour. 10(6):543–549.

Response: None

Genus: None

Presents basic principles of modern swamp hydrology. These principles became the basis for experimental investigations developing quantitative models that examine (1) the hydrologic equivalance of swamplands and mathematical transformation of swamps to geometric shapes; (2) relationships between balance of water supply, vegetative cover, surface relief, and physical properties of peat; and (3) stability of swamp and swamp-lake systems, incorporating water–balance, biological, and mechanical criteria.

490. Jackson, T. A., and R. N. Woychuk. 1981. Mercury speciation and distribution in a polluted river-lake system as related to the problem of lake restoration. Pages 93–101 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, Portland, Maine, EPA 440/5-81-010.

Response: FISH, SHELLF, SOIL, CHEM, WQUAL

Genus: None
Reviews available techniques for preventing mercury pollution of inland waters and evaluates the feasibility of applying these techniques to the Wabigoon River system of northwestern Ontario, Canada. The Wabigoon River and an associated chain of lakes are polluted with mereury from a ehlor-alkali plant/paper mill complex. Sediment methyl mercury levels are relatively high throughout the system, despite an exponential decrease in total mercury downstream from the industrial complex. River water, and therefore surface waters of lakes, are continually contaminated from mercury released from the mud. Dredging, chemical treatment, covering contaminated sediments with layers of material (e.g., sand, gravel), and biomanipulation to reduce mercury in the system are discussed.

491. Jackson, W. L., and B. P. Van Haveren. 1984. Design for a stable channel in coarse alluvium for riparian zone restoration. Water Resour. Bull. 20(5):695–703.
Response: VEG, HYDRO
Genus: Many
Describes the design of a stable stream channel for a section of Badger Creek near Salida, Colorado, which was heavily impacted by overgrazing, timber harvest, road construction, and mining. Hydrology and channel geometry data were used to derive design channel slope and sinousity. Channel bed and bank stability were analyzed, resulting in the design of a channel that allowed for adjustment (becoming narrower and deeper) as banks became stabilized through revegetation. Floodplain design and control of lateral migrations also are discussed.

492. Jagsehitz, J. A., and R. S. Bell. 1966. American beachgrass (establishment-fertilization-seeding). Univ. Rhode Island, Agric. Exp. Stn., Kingston, Bull. 383. 43 pp.
Response: VEG
Genus: *Ammophila*
Discusses establishment of American beachgrass (*Ammophila breviligulata*) along the coastal shoreline of Rhode Island. Experiments were conducted on planting, storing, plant spacing, depth of planting, fertilizing, culm and seed head produetion, harvesting seeds, germination, and establishment. Results indicated that transplanting culms was the most successful means of establishing beachgrass in active sand areas. October-April was the best season to transplant beachgrass. Fertilizing stock plants several months in advance produced 2–3 times as many culms for planting. Detailed recommendations for establishing beachgrass are presented.

493. Jaworski, E., and C. N. Raphael. 1979. Mitigation of fish and wildlife habitat losses in Great Lakes coastal wetlands. Pages 152–156 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.
Response: FISH, INVERT, ECON, WFOWL
Genus: None
Provides an overview of wetland rehabilitation along the U.S. Shoreline of the Great Lakes. The functions and values of these wetlands are described, mostly in terms of production of fish and wildlife habitat. Strategies for mitigation of habitat loss include (1) preservation of existing wetlands, (2) rehabilitation of existing resources, and (3) substitution of replacement ecosystems. Enhancement of existing wetland habitat involves restoration of the shrub-swamp fringe along the upland boundary, removal of revetments and dikes (which prohibit exchange between coastal wetlands and open lake), water quality improvements, enhancement of the submersed aquatic food base (for diving ducks), and protection of coastal wetlands from excessive sediments or nutrient loading.

494. Jenkins. R. 1972. Ecosystem restoration. Pages 22–33 *in* Proceedings of the 3rd midwest prairie conference. Kansas State Univ., Manhattan.
Response: None
Genus: *Ammophila, Distichlis, Juncus, Panicum, Phragmites, Scirpus, Spartina, Typha*
Discusses the Nature Conservancy's program of preserving U.S. ecosystem types and efforts to manipulate and restore disturbed areas. The reasons for, the difficulties in, and the methods of such restoration are diseussed and exemplified by the experimental studies of Environmental Concern, Inc. (formerly the Center for Applied Research in Environmental Sciences). Restoration of salt marshes along the Atlantic coast has involved transportation of substrate, planting of seeds in greenhouses, and transplanting of rhizomes and plants to the field.

495. Joanen, T. 1965. Factors influencing the establishment of wigeongrass (*Ruppia maritima*) stands in Louisiana. Proc. Southeast. Assoc. Game and Fish Commissioners 19:78–91.
Response: WFOWL, VEG, SOIL, CHEM, WQUAL
Genus: *Ruppia, Spartina*, many
Describes a study of the factors that affect natural and artificial establishment of wigeongrass. The study site was Rockefeller Refuge at Grand Chenier, Louisiana. Artificial tanks were used for germination, growth, and turbidity studies. Seven ponds were observed and analyzed in terms of water chemistry, soils, vegetative growth, and waterfowl use of wigeongrass. Wigeongrass grew in salinities of 2,075–18,500 ppm in the study ponds and 1,160–19,000 ppm in the experimental tanks.

496. Johnson, C. 1966. Practical operating procedures for progressive rehabilitation of sand and gravel sites. National Sand and Gravel Association, Silver Spring, Md. 75 pp.
Response: None
Genus: None
Presents an overview of equipment, operations, and proposals for rehabilitation of sand and gravel sites. Descriptions, operating results, rehabilitation potential, and recommended procedures are included for the three steps in sand and gravel processing: (1) clearing the site; (2) stripping, stockpiling, and excavating; and (3) processing and transporting. A case study of planning procedures for the progressive development of the Three Lakes community project in Denver, Colorado, is presented. Simultaneously planning excavation operations and site development, prior to excavation, is the dual role of resource extraction and land rehabilitation.

497. Johnson, L, and S. Specht. 1975. Revegetation and restoration at a subarctic dam site. Am. Soc. Agric. Eng., St. Joseph, Mich., Pap. 75–2501. 8 pp.
Response: VEG, SOIL, CHEM
Genus: *Alnus, Alopecurus, Festuca, Lolium, Salix*
The U.S. Army Corps of Engineers Cold Region Research and Engineering Lab began a revegetation experiment at a dam site on the Chena and Tanana rivers, 17 miles east of

Fairbanks, Alaska. Restoration is difficult in the subarctic due to cooler temperatures and nutrient poor shallow soils. A mixture of grasses was seeded in the area with the addition of a fertilizer treatment. Cuttings of native *Salix* and *Alnus* provided increased slope stability. Observations of grazing by geese and cranes on the introduced grasses was an indication of potential use by wildlife.

498. Johnson, L. A., S. D. Rindge, and D. A. Gaskin. 1981. Chena lakes project revegetation study: three-year summary. U.S. Army Corps Eng., Alaska Dist., Anchorage, Creel Rep. 81-18. 59 pp.

Response: SOIL, CHEM, ECON

Genus: *Alopecurus, Bromus, Festuca, Lolium, Poa, Salix, Trifolium*

Documents results of a 3-year study of revegetaion on the Chena River lakes flood control dam near Fairbanks, Alaska. The study was conducted to determine the best method for establishing permanent vegetation on the gravel dam. Plant species, mulches, erosion potential, required fertilization, and estimated costs are described in detail. Study plots included various combinations of mulch, fertilizer, substrate, and vegetation. Mulches were hay, wood-cellulose-fiber, conwed hydro mulch 2000, peat moss, and peat moss sprayed with woodcellulose-fiber. Vegetation types were grass seed mix, unrooted willow cuttings, or both.

499. Johnson, L. E., and W. V. McGuinness, Jr. 1975. Guidelines for material placement in marsh creation. U.S. Army Eng. Waterways Exp. Stn., Environ. Effects Lab., Vicksburg, Miss., Contract Rep. D-75-2. 225 pp.

Response: HYDRO, SOIL

Genus: None

Examines guidelines for evaluating the physical and operational aspects of marshes created from dredged materials. Topics include (1) alleviating physical effects of the environment on the new marsh, (2) alleviating physical effects of the marsh on the environment, (3) stabilizing the marsh (increasing percent solids of dredged material and obtaining coarse-grained fill), and (4) increasing effectiveness of dredged material disposal operations. Procedural guidelines include (1) determining the viability of marsh creation effort, (2) describing marsh types, (3) comparing alternatives, (4) refining alternatives, (5) choosing the best disposal alternatives, and (6) designing and constructing the marshes.

500. Johnson, R. F., Jr., R. Woodward, and L. M. Kirsch. 1978. Waterfowl nesting on small man-made islands in prairie wetlands. Wildl. Soc. Bull. 6(4):240–243.

Response: WFOWL, ECON

Genus: *Agropyron, Brassica, Chenopodium, Poa, Sonchus, Thlaspi, Urtica*

Determines the use of artificial islands as nesting sites by waterfowl in the Woodworth study area of the Northern Prairie Wildlife Research Center near Jamestown, North Dakota. From 1966 to 1969, 28 islands varying from 0.0002 ha to 0.01 ha were constructed in dry wetland basins. Construction costs averaged $50/island, including 1–2 h of labor. The islands were not seeded, but grasses became established within 1 year. Mallard nest densities were 135.7 nests/island ha and 0.03 nests per upland ha. Islands should be constructed in wetlands with a water depth greater than 0.3 m and have a low profile to deter predation by mammals. The life expectancy of the islands is about 20 years.

501. Jones & Stokes Associates, Inc., et al. 1979. Protection and restoration of San Francisco Bay fish and wildlife habitat. Volume I. U.S. Fish and Wildlife Service, Sacramento, Calif. 44 pp.

Response: FISH, SHELLF, VEG, HUSE, HYDRO, CHEM, WQUAL

Genus: *Salicornia, Scirpus, Spartina, Typha*

Identifies the effects of existing land and water use on various habitats within the San Francisco Bay area and describes what may happen in terms of habitat conversion if regional, county, and city land use plans now in effect are followed. Restoration of productive fish and wildlife habitat to partially compensate for past and future land conversions is evaluated in terms of land use planning policies. Topics include an historical perspective of the area, habitats and controlling factors of San Francisco Bay fish and wildlife, effects of projected land use on these habitats, restoration factors and techniques for use in various types of restorable habitats, the effects of governmental actions on protecting and restoring the habitats, and options for improving these policies.

502. Jordan, W. J., R. L. Peters, and E. B. Allen. 1988. Ecological restoration as a strategy for conserving biological diversity. Environ. Manage. 12(1):55–72.

Response: SUCCESS

Genus: None

Describes the restoration of native ecological communities, as opposed to rehabilitation to a "socially acceptable condition." Discusses the employment of restoration efforts to effectively conserve biological diversity. An overview of restoration efforts by habitat type includes saltwater marshes, freshwater wetlands, and lakes and rivers. Special applications of restoration include native reserve design and management, right-of-way management, landscaping, and agricultural lands. Describes key legislation.

503. Josselyn, M., and J. Buchholz. 1984. Marsh restoration in San Francisco Bay: a guide to design and planning. San Francisco State Univ. Tech. Rep. 3. 104 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, VEG, SOIL, CHEM, SUCCESS

Genus: *Salicornia, Scirpus, Spartina*

Provides data and guidelines for creating successful marsh habitat in sensitive areas of San Francisco Bay. Summarizes scientific experiments and methodology on three completed wetland projects. Measures variables include elevation, sediment salinity, soil pH, submergence, and seasonal precipitation. A section on habitat design for animals using wetlands discusses specific vegetation requirements for benthic invertebrates, fish, mammals, and birds. This information is intended to aid in the design of wetland restoration for specific habitat needs.

504. Josselyn, M., and J. Buchholz. 1982. Summary of past restoration projects in California. Pages 1–10 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Publ. Rep. T-CSGCP-007.

Response: None

Genus: *Batis, Salicornia, Spartina, Suaeda, Zostera*

Provides a summary of past wetland restoration projects within the coastal zone of California. Most projects involved establishment-reestablishment of tidal flow to stimulate wetland vegetation growth and development of associated wildlife habitat. The projects are divided into three categories: experimen-

tal plantings, dike breaching or construction of tidal gates, and major substrate alterations. Presents information on each project and includes location, size, objectives (wildlife habitat, mitigation, public access, research, flood control, sewage treatment), planning agency, habitats created (mudflats, islands, lagoons, marshes), and monitoring.

505. Josselyn, M., and R. Perez. 1982. Salt marsh restoration from salt evaporation ponds: vegetation establishment and sediment properties. Page 100 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: VEG, SOIL, CHEM

Genus: *Cotula, Salicornia, Spergularia*

Describes the natural vegetation of Hayward Marsh in south San Francisco Bay. This 81-ha (200-acre) site was formerly a solar evaporation pond system. Before dike breaching the sediment salinities varied from 9 to 181 ppt. Ten months after tidal flooding, soil salinity dropped to 10–22 ppt. Revegetation occurred by way of airborne and floating seeds and vegetative growth from drifting plant fragments. Plant establishment has been limited by sediment scouring, inadequate seed stock, season, and distance of seed dispersal.

506. Josselyn, M. N. 1986. Effectiveness of coastal wetland restoration: California. Pages 246–251 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings of the National Wetland Symposium: Mitigation of Effects and Losses. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Provides an overview of the effectiveness of coastal wetland restoration in California in terms of policy and technology. Describes major problems (land subsidence, shoreline erosion, limited water availability, and habitat loss) and their technological solutions. The effectiveness of the various techniques is assessed by comparing their advantages and problems. Identifies research needs in terms of wetland hydrology (specifically as it relates to plant growth), long-term assessment of wetland development, the habitat requirements of individual species, effects of public access and development on habitat use by wildlife species, and use of wastewater and urban runoff in creation of wetland habitat.

507. Kadlec, J. A., and L. M. Smith. 1984. Marsh plant establishment on newly flooded salt flats. Wildl. Soc. Bull. 22(1):388–394.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Bassia, Chara, Chenopodium, Eleocharis, Phragmites, Potamogeton, Ruppia, Salicornia, Scirpus, Typha, Zannichellia*

Examines the early stages of marsh plant establishment on newly flooded salt flats previously devoid of emergent vegetation on the Bear River National Wildlife Refuge near Brigham City, Utah. Three units averaging 2,000 ha were developed to create shallow water permanent pools, resulting in flooded areas with ditches, ridges, and undisturbed level areas between ditches. The sediment was sampled in April, June, and September for conductivity. Relative densities of glasswort *Salicornia, Bassia*, and *Chenopodium* in the moist area varied from 0.8 to 8.6 seedlings per sample. Vegetation colonization patterns are described. Sediment conductivity was sensitive to water level fluctuation and precipitation. Includes mean conductivities of saturation extracts (from 1:5 soil per water suspensions) of sediment samples.

508. Kadlec, J. A., and W. A. Wentz. 1974. State-of-the-art survey and evaluation of marsh plant establishment techniques: induced and natural. Vol. I. Report of research. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Contract Rep. D-74-9. 226 pp.

Response: VEG

Genus: *Avicennia, Najas, Phragmites, Populus, Potamogeton, Sagittaria, Salicornia, Salix, Scirpus, Spartina, Typha, Vallisneria*, many

Describes techniques and environmental conditions associated with the establishment of plants in saltwater and freshwater wetlands. Includes propagation, means of dispersal, and growth success. Environmental conditions that hinder plant establishment include physically unsuitable substrates, nutrient deficiencies, polluted sediments, excessive wind or current, turbidity, and unfavorable water depths (fluctuations). Discusses factors affecting plant establishment in specific saltwater or freshwater sites, establishment techniques, and species selection.

509. Kadlec, R. H. 1979. Wetland tertiary treatment at Houghton Lake, Michigan. Pages 101–139 *in* R. K. Bastian and S. C. Reed, eds. Aquaculture systems for wastewater treatment: seminar proceedings and engineering assessment. U.S. Environmental Protection Agency, Washington, D.C.

Response: MAMMALS, NGBIRDS, SOIL, CHEM, WQUAL, ECON

Genus: *Alnus, Betula, Carex, Chamaedaphne, Cladophora, Populus, Potamogeton, Salix, Typha, Utricularia*

Discusses a wetland tertiary treatment system at Houghton Lake, Michigan. Treated water from a holding pond was discharged onto a State-owned peatland. All nitrogen and phosphorus were removed from 378,500 L/day (100,000 gal/day) within a 2-ha (5-acre) area. Maximum water depth increased 10–15 cm at the center of the discharges. The pH dropped rapidly to background levels as the water flowed through the wetland. Chloride flowed through the active area with little change. No soil erosion or plant mortality occurred. Suspended solids were deposited close to the discharge. Odor problems were slight. No net virus or coliforms were transported to the wetland. Animal populations exhibited little response to the discharge after 2 years of operation.

510. Kadlec, R. H. 1988. Wetland hydrology and water pollution control functions. Pages 168–173 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the National Wetland Symposium: Wetland Hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers Berne, N.Y.

Response: None

Genus: None

Describes four wetland hydrologic processes: mass transfer (how materials are added to or removed from the water sheet); time and distance effects (localized events combined with water transport as water is collected, passed through a wetland system, and discharged through an outlet stream); dryout (dry periods cause internal redistribution of solutes and water in wetlands); and freezing (water quality alterations in northern wetlands).

511. Kadlec, R. H. 1983. The Bellaire wetland: wastewater alteration and recovery. Wetlands 3:44–63.

Response: HYDRO, CHEM, WQUAL, SUCCESS

Genus: *Alnus, Cornus, Fraxinus, Impatiens, Larix, Picea, Rhus, Thuja*

Summarizes the results of a study that measured changes and recovery of an 18-ha wetland after 11 years of receiving wastewater discharge in Bellaire, Michigan. Recovery was measured in terms of phosphorus and dissolved inorganic nitrogen in the water. A water budget for this wetland was developed and used to determine the seasonal change in phosphorus and dissolved nitrogen. Water samples were taken at the points of inflow and outflow, frozen, and sent to a lab for analysis. Nitrogen, phosphorus, and suspended solids were retained or removed by the wetland. General observations idicated that the wetland initially provided effective wastewater treatment, but that vegetation was damaged within a 30-m radius around the discharge points.

512. Kadlec, R. H. 1987. Monitoring wetland responses. Pages 114–120 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: SUCCESS, HYDRO, CHEM, SOIL

Genus: None

Describes a wide range of wetland responses that can be monitored. Examples from Houghton Lake, Bellaire, and Kinross, Michigan, are used for illustrating monitoring approaches. Discusses remote sensing, edge sampling, and internal transects. Describes advantages and disadvantages of monitoring approaches. Hydrodynamics, chemodynamics, and soil-sediment analyses are noted as important components of wetland monitoring.

513. Kadono, Y. 1982. Occurrence of aquatic macrophytes in relation to pH, alkalinity, Ca^{++}, Cl^{-} and conductivity. Jpn. J. Ecol. 32:39–44.

Response: VEG, CHEM, WQUAL

Genus: *Brasenia, Ceratophyllum, Egeria, Elodea, Hydrilla, Hydrocharis, Myriophyllum, Najas, Nuphar, Nymphaea, Nymphoides, Spirodela, Trapa, Utricularia, Vallisneria*

Discusses the occurrence of aquatic macrophytes in relation to pH, alkalinity, Ca^{++}, Cl^{-}, and conductivity of water, based on samples collected from 500 sites at lakes, ponds, rivers, and irrigation ditches throughout Japan. Presents results based on 20 species found at 10 or more sites. Most species showed a wide tolerance to various chemical parameters; however, occurrence of many species was significantly correlated with pH, alkalinity, and Ca^{++} of water, indicating the species selection for waters of more limited chemical parameters.

514. Kane, T. C., M. C. Miller, W. H. Hopple, M. Schonhoft, and K. Vulinec. 1982. The ecology of gravel pit lakes in southwestern Ohio. Pages 191–195 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17 -1982.

Response: INVERT, VEG

Genus: None

Summarizes information on 46 artificial lakes in sand-gravel mined areas along the Little Miami River near Cincinnati, Ohio. Lakes varied in age from 1 to 72 years. Describes phosphorus levels, primary productivity, pH, and macroinvertebrate populations (dominated by chironomids).

515. Kantor, R. A., and D. J. Charette. 1986. Computerized monitoring system for wetlands mitigation projects in New Jersey. Pages 266–269 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings National Wetland Symposium: Mitigation of Effects and Losses. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Describes the development and use of a computerized monitoring system for tracking information on wetland mitigation projects in New Jersey. The data base includes information on location, site charaeteristics, mitigation methods, monitoring, and enforcement actions. Discusses advantages of the system in terms of standardization of information, permit conditions, criteria for success, and providing a means for quick retrieval of relevant information.

516. Keammerer, W. R. 1978. Revegetation monitoring studies on a reclaimed gravel mine. Pages 151–171 *in* Lowland river and stream habitat in Colorado: a symposium. University of Northern Colorado, Grecley.

Response: VEG

Genus: *Eleocharis, Eustoma, Populus, Salix, Scirpus*, many

Describes a detailed study of revegetation at the White Rocks site (a former gravel-mined area) near Boulder, Colorado. After four growing seasons, four vegetation communities have developed at the site: pond's edge (sedges and semi-aquatic grasses, berm slope (grasses), upland prairie, and upland berm. The pond's edge community includes an area 3–4 m from the shoreline; dominant vegetation is American bulrush *Scirpus americanus*) and *Eleocharis macrostachya*.

517. Keddy, P. A., and T. H. Ellis. 1985. Seedling recruitment of 11 wetland plant species along a water level gradient: shared or distinct responses? Can. J. Bot. 63(10):1876–1879.

Response: VEG

Genus: *Acorus, Alisma, Bidens, Eupatorium, Lythrum, Polygonum, Sagittaria, Scirpus, Spartina, Typha*

Describes an experiment to test and compare seedling recruitment of wetland plants along a water level gradient to determine if all species have similar requirements for maximum recruitment or if requirements for recruitment differ among species. Seeds were collected from wetland plants in Lanark County and Ottawa-Carleton, Ontario, Canada. Most species showed significant differences in recruitment along a water level gradient, but they did not exhibit shared preferences. Differing recruitment requirements produce different distributions of mature plants.

518. Keller, E. A., and E. K. Hoffman. 1976. A sensible alternative to stream channelization. Public Works 107(10):70–72.

Response: HYDRO, ECON

Genus: None

Discusses the stream restoration program established in Mecklenburg County, North Carolina, as an alternative to widening, straightening, or deepening a stream channel for flood correction or control. The stream is evaluated in the field and delineated on maps. Right-of-ways are obtained from property owners. Detailed field inspections were performed to determine specific design. Effort was made to keep live trees along banks to provide bank stability. Channel banks were sloped and seeded; riprap was used when necessary to prevent excessive erosion. The result was a meandering stream with

sand-gravel bars, which provided a more esthetically pleasing environment and by way of much of the flood hazard.

519. Keller, M., and S. W. Harris. 1966. The growth of eelgrass in relation to tidal depth. J. Wildl. Manage. 30(2):280–285.

Response: VEG

Genus: *Zostera*

Describes the growth of common eelgrass (*Zostera marina*) in an undisturbed environment in relation to tidal depth in South Humboldt Bay, California. Contours of +1.0, +0.5, +0.0, –0.5, –1.0, and –1.5 ft were chosen to record percent cover and density of turions. Total eelgrass biomass increased with decreases in elevation. Optimum growth occurred in areas exposed to the air less than 5% of the time. Near the upper elevation limits of eelgrass growth, survival of individual plants depends on the presence of small depressions that retain water at low tide.

520. Kelly, J. A., Jr., C. M. Fuss, Jr., and J. R. Hall. 1971. The transplanting and survival of turtlegrass, *Thalassia testudinum*, in Boca Ciega Bay, Florida. Fish. Bull. 69(2):273–280.

Response: VEG, SOIL

Genus: *Thalassia*

Restoration of previously destroyed seagrass beds in Boca Ciega Bay, Florida, was undertaken to control erosion and deposition of substrates and to recreate essential ecological functions. One hundred and twenty turtlegrass (*Thalassia*) plugs and sprigs were transplanted and anchored with rods, pipes, and bricks; rods were the most effective. Three months after transplanting, mortality was 60% for the plugs and 57% for the sprigs. Results indicated that continuous growth of *Thalassia* depends on the activity of vigorous rhizome apexes. The hormone NAPH was used to induce rapid and heavy rooting and was a main factor contributing to transplant success. Analyzed favorable soil conditions required for transplant survival.

521. Kennedy, H. D. 1955. Colonization of a previously barren stream section by aquatic invertebrates and trout. Prog. Fish-Cult. 17:119–122.

Response: FISH, INVERT

Genus: None

Documents the colonization of a bypass channel by aquatic invertebrates and trout at the U.S. Fish and Wildlife Service's Convict Creek Experiment Station in eastern California. The bypass channel had been dry for several years before watering. The channel was devoid of pools and shelter; bottom material consisted of boulders, rubble, and large gravel. After 87 days, aquatic invertebrate groups were similar in composition and life stage to those of the natural channel. Mean numbers were higher than the natural channel. Trout that populated the bypass were mainly a result of downstream drift and were less numerous and smaller than trout of the natural channel.

522. Kentula, M. E. 1986. Wetland creation and rehabilitation in the Pacific northwest. Pages 119–149 *in* R. Strickland, ed. Wetland functions, rehabilitation, and creation in the Pacific northwest: the state of our understanding. Wash. State Univ. Publ. 86–14.

Response: FISH, INVERT, WFOWL, VEG, SUCCESS

Genus: *Alisma, Carex, Deschampsia, Iris, Juncus, Scirpus, Triglochin, Zostera*

Reviews documented projects for wetland restoration and rehabilitation at various wetland sites in the Pacific northwest. Describes examples of creation or rehabilitation of specific wetland types are described, including salt marshes, seagrass beds, tidal freshwater, intertidal mudflats, impounded freshwater, and riverine sites. Projects were 4 ha (10 acres) and were typically 0.4 ha (1 acre) or less. Discusses suggestions on evaluation of restoration projects. Includes a working group report and panel discussion excerpts.

523. Kenworthy, W. J., and M. Fonseca. 1977. Reciprocal transplant of the seagrass *Zostera marina* L.: Effect of substrate on growth. Aquaculture 12:197–213.

Response: VEG, SOIL

Genus: *Zostera*

Describes a laboratory experiment on the growth of common eelgrass (*Zostera marina*). Sediment and plants with rhizomes and root systems were collected from a pond near the University of Rhode Island. Four treatments were used to compare responses: growth effects from a sand to a silt substrate, sand to a sand-silt substrate, no particular original substrate, and a natural to an altered substrate. Growth parameters measured for each treatment were changes in leaf length, changes in plant weight, and new leaf production. Results indicated that plants originating from a natural undisturbed substrate displayed significantly higher leaf production than the other three treatments. Discusses the physiology and ecology of *Zostera marina* in relation to the substrate.

524. Kenworthy, W. J., M. S. Fonseca, J. Homziak, and G. W. Thayer. 1980. Development of a transplanted seagrass (*Zostera marina* L.) Meadow in Back Sound, Carteret County, North Carolina. Pages 175–193 *in* D.P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: INVERT, VEG, HYDRO, SOIL, CHEM, SHELLF

Genus: *Zostera*

Describes the development of a transplanted common eelgrass (*Zostera marina*) meadow in Back Sound, Cartaret County, North Carolina. After 16 months, the leaf biomass, roots and rhizomes and density (about 700 shoots per square meter) were similar to those of undisturbed natural *Zostera* meadows. Plantings reduced currents by 20%, which led to increased deposition of fine sediment and development of sediment ammonium accumulations equal to those of undisturbed meadows. The invertebrate community at the transplant site was similar to that of natural *Zostera* meadows; abundance of bay scallops increased as seagrass density increased. Benthic invertebrates showed a positive correlation between species diversity, density, species evenness and richness, and *Zostera* density. Polychaetes dominated, followed by amphipods, gastropods, and bivalves.

525. Khanbilvardi, R. M., and A. S. Rogowski. 1984. Planning erosion control for a reclaimed area. Pages 155–162 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: None

Genus: None

Describes a simulation model applied to a small strip mined and reclaimed watershed in central Pennsylvania to evaluate the effectiveness of a holding pond and runoff diversions in controlling erosion and sediment yield. The model predicted the site sediment yield and suggested an optimum holding pond location and configuration. Results of the model seemed to reflect actual field conditions observed at the site.

526. King, D. L., J. J. Simmler, C. S. Decker, and C. W. Ogg. 1974. Acid strip-mine lake recovery. J. Water Pollut. Control Fed. 46(10):2301–2315.

Response: CHEM, WQUAL

Genus: None

Presents an overview of acidification of strip-mine lakes and discusses the recovery of acid strip-mine lakes, particularly those of central Missouri. Of the factors that slow the rate of recovery, the most important are related to the watershed that drains the lake. The amount of acid spoils exposed determines the acidity of the lake, but significant changes in acid runoff may occur through interaction with various minerals that compose the soil. Lack of vegetation on drainage areas can prevent recovery for 30 years or more. Discuss the use of organic matter to accelerate recovery and stress that recovery would not be necessary if all acid-producing materials were covered with nonacid soil when coal is strip mined.

527. King, T., L. Hord, T. Gilbert, F. Montalbano, and J. N. Allen. 1980. An evaluation of wetland habitat establishment and wildlife utilization in phosphate clay settling areas. Pages 35–49 *in* D.P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, NGBIRDS, WFOWL, FISH, REPT, AMPHIB, MAMMALS, VEG, WQUAL, CHEM, SUCCESS

Genus: *Baccharis, Eichhornia, Ludwigia, Myrica, Salix, Scirpus, Typha*

Diked ponds used for waste clay storage on phosphate mined land in Polk County, Florida, were evaluated in terms of establishment of wetland habitat. Vegetation was mapped and water quality was sampled (ph, fluoride, phosphorus, nitrates, nitrogen, turbidity, and suspended solids). Wildlife species observed included 8 mammals, 97 birds, and 19 reptiles and amphibians. The most significant function of these clay pond wetlands is use as winter habitat by migratory birds (e.g., waterfowl). Greatest animal density was correlated with areas having about 50% vegetative coverage. These areas were used for feeding, roosting, and sometimes as rookeries for wading birds.

528. Kingsley, R. B., and F. C. Boerger. 1976. Experimental marsh planting programs: Marin Country day school and Muzzi Marsh. Madrone Assoc., San Rafael, Calif., Unpubl. Rep. 49 pp.

Response: VEG

Genus: *Spartina*

Discusses two experimental marsh planting programs initiated in San Francisco Bay in 1974 and 1976. Two years after plugs of cordgrass (*Spartina*) were transplanted to the shore of the Marin Country day school, a healthy stand of marsh had become established in spite of typically heavy wave action and predation by waterfowl. In June 1976, bayward dikes were breached and tidal waters entered the marsh for the first time in more than 15 years. Several weeks later, seeds and plugs of cordgrass were planted. By November 1976, seedling growth was sparse; successes were related to good drainage and soft substrate;and failures were related to premature germination, poor drainage, firm substrate, and smothering by algae.

529. Kleinert, S. J. 1970. Production of northern pike in a managed marsh, Lake Ripley, Wisconsin. Wis. Dep. Nat. Resour. Rep. 49. 19 pp.

Response: FISH, INVERT

Genus: *Carex, Nuphar, Typha*

Presents results of a 3-year study on the production of northern pike (*Esox lucius*) at Perrys Marsh at Lake Ripley, Jefferson County, Wisconsin. Water levels maintained on the 4-ha (10-acre) marsh varied from 5 cm (2 in.) to 1.8 m (6 feet) with an average depth of about .5 m (1.5 feet). The number of northern pike produced in Perrys Marsh was too small 87/.4 ha (87/acre) to significantly improve the northern pike fishery of Lake Ripley. The authors concluded that perrys marsh, dominated by cattail (*Typha*), produced too little zooplankton to provide the fingerlings with the necessary food base.

530. Kleinmann, R., and W. Fink. 1987. Artificial wetland for mitigating acid mine drainage effects. Restor. Manage. Notes 5(1):33.

Response: VEG, WQUAL

Genus: *Scirpus, Sphagnum, Typha*

Describes the construction of a prototype wetland for improving the water quality of a small stream polluted by acid mine drainage at the Friendship Hill National Historic Site in southwestern Pennsylvania. The stream, which harbors no fish or aquatic insects and is highly acidic, was redirected to flow through the wetland. Testing and monitoring of pH, acidity, conductivity, calcium, sulfate, and various metals above, within, and below the wetland will determine whether a larger, similar wetland will be constructed.

531. Klimas, C. V., and H. H. Allen. 1981. Approaches to revegetate reservoir shoreline of Lake Texoma. Pages 2–3 *in* Environmental and water quality operational studies. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Inf. Exch. Bull. Vol. E-81-2.

Response: VEG, HYDRO

Genus: *Agropyron, Amorpha, Andropogon, Arundinaria, Arundo, Betula, Buchloe, Cyperus, Diospyros, Panicum, Paspalum, Phragmites, Quercus, Salix, Sapindus, Spartina, Tripsacum*

Presents preliminary results of shoreline revegetation experiments along the shoreline of Lake Texoma on the border of Texas and Oklahoma. Ten herbaceous species were tested in 1979; 3 additional herbaceous species and 6 woody species were added to the experiment in 1980. Tiers along the shoreline and at a control pond were flooded for 0, 2, 4, 5, 6, 10, or 20 weeks. During 1979, survival was good after 5 weeks of flooding for all species except maidencane (*Tripsacum ductylordes*) and eastern gamma grass (*Panicum hemitomon*). Common reed (*Phragmites australis*) showed significant survival even after 20 weeks of continous flooding. Preliminary data from 1980 indicated that, of the woody species, persimmon (*Diospyros virginiana*) and black willow (*Salix nigra*) showed good survival, even after 45 days of continuous flooding. Field sites will be monitored for an additional growing season.

532. Klimstra, W. D., and J. R. Nawrot. 1986. Wetlands/wildlife habitat development. Pages 187–222 *in* C.L. Carlson and J. H. Swisher, eds. Innovative approaches to mined land reclamation. Southern Illinois University Press, Carbondale.

Response: VEG

Genus: Many

Provides an overview of wetland reclamation practices on mined land. Discusses the effects of the surface mining control and reclamation act on land-use practices and reclamation efforts. Restoration of sediment ponds, streams, slurry ponds, and floodplains is discussed, mainly in general terms of habitat for wildlife and productive land use. Restoration of a mined area to the prior land use may not be possible or even desirable, but restoration to a different stabilized ecosystem may be possible. Discusses public awareness and economic factors.

533. Klimstra, W. D., and J. R. Nawrot. 1982. Water as a reclamation alternative: an assessment of values. Pages 39–44 *in* D. H. Graves, ed. Proceedings 1982 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: HUSE, ECON

Genus: None

Describes the value (i.e., economic contributions) of wetlands and lakes created as a result of surface mining in Illinois. Discusses the economics of lake construction, irrigation supply, and the relation between created wetlands and agricultural land uses.

534. Klimstra, W. D., and J. R. Nawrot. 1985. Wetlands as a byproduct of surface mining: midwest perspective. Pages 107–119 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: None

Genus: None

Reviews current practices for restoring vegetational and physical diversity, controlling erosion, and developing guidelines for habitat enhancement in wetlands associated with surface mining byproducts in westcentral and southern Illinois. Based on previous studies, seasonally fluctuating water levels maximize wetland development potential and moist soil vegetation establishment. Grading can enhance shallow water areas and maximize littoral zones. At least 30 cm of topsoil is recommended for adequate vegetation establishment; however, studies have shown that the presence of quality subsoil is useful for emergent and submergent vegetation establishment. Discusses stream diversion plans and resolution of erosion and bank stabilization problems.

535. Koopman, R. W. 1982. Pits, ponds and people: reclamation and public use. Pages 127–131 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17 -1982.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, HUSE

Genus: None

Describes the reclamation of gravel mining sites about 8 km (5 miles) northeast of Boulder, Colorado, in the floodplain of Boulder Creek. Sawhill and Walden ponds are both being reclaimed for wildlife habitat, fishing and other public recreation, and environmental education. Management considerations include the establishment of long-term objectives (predominantly wildlife habitat), reclamation activities (grading, planting), water level management, supplemental measures for encouraging or managing wildlife, establishment of warmwater sport fisheries, control of public access, minimization of developed facilities, and development of interpretive sites and programs.

536. Knight, R. L., B. H. Winchester, and CH2M Hill. 1985. Ecology, hydrology, and advanced wastewater treatment potential of an artificial wetland in north-central Florida. Wetlands 5:167–180.

Response: FISH, INVERT, NGBIRDS, SHOREB, REPT, VEG, HYDRO, CHEM, WQUAL, SUCCESS

Genus: *Alternanthera, Hydrocotyle, Lemna, Limnobium, Myrica, Salix, Typha*

Describes a 1-year study of an artificial wetland, Lake Coral, Ocala, Florida. Constructed in 1978, this marsh-pond system receives treated effluent from two water treatment plants. Describes plant communities, aquatic invertebrates, and fish and wildlife found at the site. Discusses hydrology and water quality. The wetland system effectively improved the quality of the treated effluent. Except for total phosphorus, the quality of outflow water met or exceeded advanced treatment water quality criteria. Describes design features of the wetland that contribute to its capability for wastewater treatment.

537. Knox, R. F. 1982. Fishery management in Colorado's gravel pit lakes. Pages 208–210 *in* W.D. Svedarsky and R.D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17 -1982.

Response: FISH, HUSE

Genus: None

Provides a brief overview of the Colorado Division of Wildlife's involvement in managing gravel pit lakes for fisheries. Outlines management strategies for cold- and warmwater gravel pits. Habitat development includes proper sloping of bank, creation of small shallow embayments, creation of underwater reef areas or placement of tire and brush structures where bottom contours are absent, and preconstruction planning. The division currently manages 75 pits, with a combined surface area of about 607.5 ha (1,500 acres.)

538. Knutson, P. L. 1977. Planting guidelines for dune creation and stabilization. U.S. Army Corps Eng. Coastal Eng. Tech. Aid 77–4. 26 pp.

Response: None

Genus: *Ammophila, Panicum, Uniola*

Provides guidelines for the propagation of beach grasses for forming and stabilizing coastal dune systems. Discusses American beachgrass (*Ammophila breviligulata*), European beachgrass (*A. arenaria*), sea oats (*Uniola paniculata*), and bitter panicum (*Panicum amarum*). Topics include: use of plantings to control various types of dune damage, plant species selection for various coastal regions, obtaining plant materials, storage of plants, planting methods, postplanting care (fertilization and replanting), and labor requirements.

539. Knutson, P. L. 1976. Development of intertidal marshlands upon dredged material in San Francisco Bay. Pages 103–118 *in* Proceedings of the seventh conference on world dredging, San Francisco, Calif.

Response: VEG, ECON

Genus: *Salicornia, Spartina*

Discusses construction and costs associated with development of the Alameda Creek marsh project on dredged spoil sites in south San Francisco Bay, California, and presents results of experimental plantings of cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia virginica*) on dredged material sites near the project area. The Alameda Creek project indicated that marsh development may be economically practical when used on a case by case basis, particularly for small dredging projects located near suitable diked lowlands. The use of seedlings and rooted cuttings of cordgrass significantly accelerated the rate of revegetation, but differences between planted and unplanted areas after two growing seasons were not significant in the pickleweed experiments.

540. Knutson, P. L. 1977. Summary of CERC research on uses of vegetation for erosion control. Pages 31–37 *in* Proceedings of the workshop on the role of vegetation in stabilization of the Great Lakes shoreline. Great Lakes Basin Commission, Ann Arbor, Mieh.

Response: VEG, SOIL

Genus: *Ammophila, Avicennia, Calamagrostis, Elymus, Juncus, Lathyrus, Panicum, Phalaris, Scirpus, Spartina, Tanacetum, Typha, Uniola*

Summarizes the coastal engineering research center's investigations on the use of vegetation for bank and dune stabilization and briefly discusses the potential application of these findings in the Great Lakes region. Research over the past 20 years has clearly demonstrated that dune grasses can be used to form and stabilize dunes. Vegetative bank stabilization has proven to be an effective and low-cost method of erosion abatement, especially in areas subject to low and moderate wave energies. In the Great Lakes, establishment of vegetation for erosion abatement will probably require plantings behind protective structures (e.g., bulkheads, riprap) to be successful in many areas.

541. Knutson, P. L. 1978. Designing for bank erosion control with vegetation. U.S. Army Corps Eng. Fort Belvoir, Va., Reprint 78–2. 19 pp.

Response: VEG, SOIL, ECON

Genus: *Spartina*

Describes the use of vegetation for controlling erosion on coastal shorelines. Describes planting materials, mostly smooth cordgrass (*Spartina alterniflora*),marshhay cordgrass (*S. patens*), *S. spartinae*, and (*S. foliosa*), planting methods (seeds, sprigs, plugs, nursery seedlings), fertilization requirements, planting maintenance, and labor requirements for different planting methods. Tidal inundation, salinity, and wave climate are especially important in determining site suitability and choosing planting methods. A summary of design guidelines includes a description of the use of planting decision keys for the Atlantic, Gulf, and Pacific coasts. Cost of vegetative stabilization rarely exceeds $5.00/linear foot, based on study examples included in the text.

542. Knutson, P. L. 1977. Planting guidelines for marsh development and bank stabilization. U.S. Army Corps Eng., Fort Belvoir, Va., CETA 77–3. 21 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Spartina*

Provides guidelines for planting marsh vegetation along the coastal United States. Seed application rates, plant spacing teehniques, and fertilizer requirements are used as guidelines for bank stabilization and marsh development projects. Recommended plant spacing for marsh developent is 5.5 or 11 m (18 or 36 feet) depending on planting method and not 3 m (10 feet) for bank stabilization projects. Fertilizer treatment is recommended for all projects. A design key based on elevation, tidal range, salinity, feteh, plant species, and suitable planting methods is provided.

543. Knutson, P. L., J. C. Ford, M. R. Inskeep, and J. Oyler. 1981. National survey of planted salt marshes (vegetative stabilization and wave stress). Wetlands 1:129–157.

Response: VEG, SOIL, SUCCESS

Genus: *Spartina*

Summarizes attempts to establish salt marshes along the coastal United States. for shore stabilization or habitat development. The surveyed marshes had the following general characteristics: exposed to wind waves, located in brackish and salt water environments, and planted with smooth cordgrass (*Spartina alterniflora*) or *S. foliosa*. No rubble or artifieial structures were present in the planted areas. Erosion control was evaluated on the absence or presence of intertidal vegetation. Planting success was measured by the width of the intertidal vegetation zone. Sediment grain size and slope are potential indicators of wave energy and provide information on establishment of vegetation.

544. Knutson, P. L., and M. R. Inskeep. 1982. Shore erosion control with salt marsh vegetation. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Aid 82–3. 24 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Avicennia, Carex, Deschampsia, Distichlis, Juncus, Laguncularia, Paspalum, Phragmites, Rhizophora, Spartina, Triglochin*

Deseribes methodology for establishing marsh vegetation as a more cost-effective method for erosion control than construction of traditional structures. In areas where climate and wave action are severe and have a major influence on marsh establishment, site preparation is necessary to provide suitable substrate. Presents a method for determining site suitability. Sprigs and plugs required 10 man-hours per 1,000 planting units and nursery seedlings required 23 man-hours per 1,000 planting units. Detailed requirements for storing, transporting, and planting are given. Compares planting techniques, spacing, and tidal zones for numerous marsh species.

545. Knutson, P. L., and W. W. Woodhouse, Jr. 1983. Shore stabilization with salt marsh vegetation. U.S. Army Corps Eng., Fort Belvoir, Va., Spec. Rep. 9. 95 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON, SUCCESS

Genus: *Avicennia, Carex, Deschampsia, Distichlis, Juncus, Laguncularia, Paspalum, Phragmites, Rhizophora, Spartina, Triglochin*, many

Provides summary information and guidelines on the use of coastal vegetation for shore erosion control. Potential negative effects are public access, concentration of heavy metals, and the introduction of some nuisance species. Benefits of marsh establishment include maintenance of marsh ecology, nutrient cycling, and improved aesthetics. Discusses planting techniques, plant selection, site suitability, impact assessment, and project costs. Planting specifications are provided for smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), big cordgrass (*S. cynosuroides*), *S. foliosa*, *S. spartinae*,

Lyngbe sedge (*Carex lyngyei*), tufted hairgrass (*Deschampsia caespitosa*), needle rush (*Juncus roemerianus*), common reed (*Phragmites australis*), Red mangrove (*Rhizophora mangle*), *Avicennia germinans, Laguncularia racemosa*, and other species.

546. Knutson, P. L., W. W. Woodhouse. 1982. Pacific coastal marshes. Pages 111–130 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, SOIL, ECON

Genus: *Carex, Deschampsia, Distichlis, Eleocharis, Juncus, Salicornia, Scirpus, Spartina, Triglochin*

Discusses the restoration of marshes along the Pacific coast. Cultural techniques, distribution, elevational range, and salinity range are described for pacific cordgrass (*Spartina foliosa*), pickleweed (*Salicornia*), saltgrass (*Distichlis*), Lyngbye's sedge (*Carex lyngbyaei*), tufted hairgrass (*Deschampsia caespitosa*), and seaside arrowgrass (*Triglochin maritima*). Factors controlling restoration success or failure are wave stress, salinity, soil type, and plant species. Discusses planting costs, plant materials (seeds, sprigs, pot-grown seedlings, and plugs) and planting methods (hand planting, power-driven auger, machine planting).

547. Kollar, S. A., Jr. 1985. SAV reestablishment results—upper Chesapeake Bay. Pages 759–777 *in* O. T. Magoon, H. Converse, D. Miner, D. Clark, and L. T. Tobin, eds. Coastal Zone '85: Proceedings of the Fourth Symposium on Coastal Ocean Management. American Society of Civil Engineers, New York.

Response: WFOWL, VEG, SOIL, CHEM, WQUAL

Genus: *Ceratophyllum, Elodea, Heteranthera, Potamogeton, Vallisneria*

The purpose of this experiment was to test the feasibility of reestablishing submerged aquatic vegetation in upper Chesapeake Bay. The site was Susquehanna Flats, an area previously known for productive fishing, but which now has declining populations of submerged macrophytes. Six primary submerged aquatic vegetative species were introduced on 17 sites. All plantings of pondweed (*Potamogeton*), grasses, and wildcelery (*Vallisneria*) were placed in sediments at 10–15 cm (4–6 in.) below the substrate. Waterstar mudplantain (*Heteranthera dubia*) had the highest success rate at 72–100%. Ideal transplant sites are characterized by depths of 0.8–1.1 m (2.5–3.5 feet) and sediments of at least 21% silt, less than 72% sand, and more than 5% organic matter.

548. Kosowatz, J. L. 1987. Wetlands establish their worth. Eng. News Rec. (October):30–41.

Response: VEG

Genus: *Phragmites, Spartina*

Includes a general discussion of State and Federal regulation of wetlands and a brief discussion of wetland mitigation. Briefly discusses three restoration projects: Wetland Research Inc.'s reclamation of a 182-ha (450-acre) wetland along the Des Plaines River in northern Illinois; the Harmon Meadows project near the Hackensack River in New Jersey, 4.8 km (3 miles) from Manhatten (improvement of 64 ha [158 acres] of degraded saltwater marshes); and the large U.S Army Corps of Engineers' project in southeastern Louisiana that will channel fresh water into bayous and wetlands near Lake Ponchartrain, Baritaria Bay, and Breton Sound.

549. Kraeuter, J. N., and P. L. Wolf. 1974. The relationship of marine macroinvertebrates to salt marsh plants. Pages 449–462 *in* Ecology of halophytes. Academic Press, New York.

Response: INVERT, VEG

Genus: *Distichlis, Juncus, Limonium, Salicornia, Spartina*

Discusses the relation of marine macroinvertebrates to salt marsh plants. Direct and indirect effects of invertebrates on plants are summarized for six taxonomic groups: annelida, gastropoda, pelecypoda, isopoda-amphipoda, decapoda, and insecta-arachnida. Presents effects of plants, light, temperature, and humidity on the invertebrates. Discusses major plant communities, including marshes dominated by cordgrass (*Spartina*), rush (*Juncus*), or saltgrass (*Distichlis*).

550. Kraus, D. B., and M. L. Kraus. 1986. The establishment of a fiddler crab (*Uca minax*) colony on a man-made *Spartina* mitigation marsh, and its effect on invertebrate colonization. Pages 343–348 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings National Wetland Symposium: Mitigation of Effects and Losses. Association of State Wetland Managers, Berne, N.Y.

Response: INVERT, VEG

Genus: *Phragmites, Spartina*

Describes a study to determine whether fiddler crabs (*Uca minax*) could be successfully stocked at a wetland mitigation site at Mill Creek, Hackensack River basin, northeastern New Jersey, and effects of fiddler crab establishment on invertebrate colonization. A naturally established marsh at Sawmill Creek was used as a control site. Water quality, elevation, substrate, and duration of marsh establishment contributed to invertebrate species diversity and density. The greatest number of taxa (12) was found at the control site (sawmill) and the least (4) was found at the Mill Creek nonmitigation site dominated by common reed (*Phragmites australis*).

551. Krause, J., B. Mahan, and M. Harding. 1985. Waterfowl management and wetland development on Peabody coal company surface mines in Illinois, Indiana, and Kentucky. Page 327 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: WFOWL

Genus: None

Presents examples of Peabody Coal Company's mining-related waterfowl management and wetland development in Illinois, Indiana, and Kentucky. Giant Canada geese (*Branta canadensis*) were relocated to lakes on reclaimed surface mines in southern Illinois. In Indiana, a 28-ha lake with smaller wetlands was the site for release of additional geese. Mining operations in Kentucky were modified during the final cut to build a 32-ha impoundment with an 11-ha littoral shelf and 70 nesting islands.

552. Krebs, C. T., and C. E. Tanner. 1981. Cost analysis of marsh restoration through sediment stripping and *Spartina* propagation. Pages 386–390 *in* Proceedings of the 1981 oil spill conference. American Petroleum Institute, Washington, D.C.

Response: VEG, ECON

Genus: *Spartina*

Presents a cost comparison between conventional methods and an alternative surface sediment stripping and cordgrass (*Spartina*) propagation technique for the cleanup of a No. 6

fuel oil spill that heavily effected a *Spartina* marsh on the Potomac River estuary in Maryland. Includes costs for labor, materials, equipment, various combinations of seedlings (bare root vs. potted, fertilized vs. unfertilized, low-energy marsh grid pattern vs. moderate- and high-energy), and propagation patterns. The stripping and propagation technique was estimated to cost 5–28% less than conventional cleanup (which attempts to remove the oil, but makes no attempt to restore the marsh). The stripping and propagation technique not only results in complete removal of oil, but provides for rapid restoration of the marsh ecosystem and shoreline stabilization.

553. Krebs, C. T., and C. E. Tanner. 1981. Restoration of oiled marshes through sediment stripping and *Spartina* propagation. Pages 375–385 *in* Proceedings of the 1981 oil spill conference. American Petroleum Institute, Washington, D.C.

Response: INVERT, VEG, SOIL, CHEM

Genus: *Spartina*

Describes the restoration of marshes contaminated by oil on the Potomac River near Piney Point, Maryland. Several experimental plots were established on both oiled and control sites and smooth cordgrass (*Spartina alterniflora*) was cut in all plots. Sediments were stripped to 7–9 cm and several plots were backfilled to the original marsh level. Seeds and fertilizer were incorporated into backfilled material or subsurface sediments and nursery stock *S. alterniflora* was planted. Discusses effects on benthic fauna, along with the role of *S. alterniflora* in restoration of marsh habitat.

554. Kretser, W. A., and J. R. Colquhoun. 1984. Treatment of New York's Adirondack lakes by liming. Fisheries 9(1):36–41.

Response: FISH, WQUAL

Genus: None

Provides an overview of New York State's ongoing lake neutralization program. Initial treatments (beginning in 1959) used hydrated lime and agricultural limestone, but results were short-lived and had only small beneficial effects on trout populations. Treatments beginning in the mid-1970's focused on lakes effected by acid rain. Emphasis was on rehabilitation of lakes with valuable fisheries and on adequate biological and chemical monitoring. The presence of toxic levels of inorganic aluminum in many acidified drainage lakes complicates lake rehabilitation efforts.

555. Krone, R. B. 1982. Engineering wetlands: circulation, sedimentation, and water quality. Pages 53–61 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog, Rep. T-CSGCP-007.

Response: VEG, HUSE, WQUAL

Genus: *Spartina*

Describes several engineering methods used in the San Francisco Bay area for flooding and sedimentation on diked marshlands. The purpose of these activities is to promote growth of desirable plants and meet specified objectives for human use and flood control by providing as many of the attributes of natural marsh systems as possible. Discusses land surface elevation, flooding and drainage (by gravity), deposition of suspended sediments, control of mosquitoes and algae, development of fresh marsh sediment (for growth of desirable plant species), and methods of constructing channels and dikes.

556. Kruczynski, W. L. 1982. Salt marshes of the northeastern Gulf of Mexico. Pages 71–87 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, SUCCESS

Genus: *Amaranthus, Ammophila, Aster, Distichlis, Juncus, Panicum, Phragmites, Pluchea, Spartina, Uniola*

Describes efforts to create or restore salt marshes in estuarine areas along the Gulf of Mexico, from western Florida to Mississippi. Discusses marsh area losses between 1947 and 1967, along with marsh functions and values. The role of monitoring in establishing criteria necessary for successful restoration of functioning wetlands is noted. Describes some salt marsh creation projects, along with specific planting guidelines for smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), big cordgrass (*S. cynosuroides*), needle rush (*Juncus roemerianus*), seashore saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), *Panicum repens*, *P. amarulum*, *Uniola paniculata*, and *Ammophila brevigulata*. Major factors affecting transplant success are erosion, available soil water, soil salinity, and nutrients. Natural colonization may not provide the ground cover, substrate stabilization, and primary production necessary for habitat development on dredged material disposal sites.

557. Kruczynski, W. L., and R. T. Huffman. 1978. Use of selected marsh and dune plants in stabilizing dredged materials at Panacea and Apalachicola Bay, Florida. Pages 99–135 *in* D. P. Cole, ed. Proceedings Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: WFOWL, VEG, SOIL, CHEM

Genus: *Ammophila, Distichlis, Juncus, Panicum, Spartina, Uniola*

A pilot project investigating the use of dredged material as a manageable resource for habitat development, and a substrate for revegetation (shoreline stabilization) was conducted on Drake, Wilson, and Panacea islands in the Florida panhandle. Application of 10–10–10 fertilizer showed a positive correlation between amount of fertilizer applied and percent biomass, plant height, and number of leaves, parental clumps, shoots, and rhizomes present. Doubling the amount of fertilizer did not produce significant growth difference. The absence of diking on Panacea Island hindered revegetation efforts, but diking on Drake Wilson Island decreased erosion and proved beneficial to plant growth.

558. Kruczynski, W. L., R. T. Huffman, and M. K. Vincent. 1978. Habitat development field investigations, Apalachicola Bay marsh development site, Apalachicola Bay, Florida; Summary Report. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-32. 39 pp.

Response: VEG, SOIL, CHEM

Genus: *Spartina*

Drake Wilson Island, Apalachicola Bay, Florida, was the site of a study to determine the feasibility of marsh development on fine and coarse-grained dredged material in a brackish water intertidal environment. Cordgrass (*Spartina*) sprigs were planted at 0.3- to 2.7-m intervals with 7- to 13-cm attached rhizomes and 5–10 untrimmed leaves. Planting at 1.8–2.7 m produced poor cover. At elevations of 1.0–1.4 m and intervals of 1.8 or 2.7 m, excellent growth was achieved. Recommends a small-scale study of habitat characteristics before undertaking a large-scale project.

559. Krull, J. N. 1970. Aquatic plant-macroinvertebrate associations and waterfowl. J. Wildl. Manage. 34(4):707–718.

Response: INVERT, VEG, SOIL

Genus: *Ceratophyllum, Chara, Heteranthera, Lemna, Myriophyllum, Najas, Potamogeton, Rhizoclonium, Utricularia*

Discusses the association of macroinvertebrates with 12 species of submerged aquatic plants common in central New York. Study sites included waterfowl impoundments and shallow ponds in Seneca, Cayuga, Cortland, and Onondaga Counties. Macroinvertebrates seem to be more abundant in vegetated areas than in nonvegetated areas. On the average, 1 g of animal life was associated with 100 g of plant material. Diversity was greatest in duckweed (*Lemna*) and waterweed (*Elodea*) and lowest in watermilfoil (*Myriophyllum*) and hornwort (*Ceratophyllum*). Hydrophytes believed to be poor waterfowl food plants (e.g., *Elodea*) are important to waterfowl production because they harbor large quantities of macroinvertebrates, which furnish a source of animal protein.

560. Kubichek, W. F. 1940. Collecting and storing seeds of waterfowl food plants for propagation. Trans. N. Am. Wildl. Conf. 5:364–368.

Response: VEG

Genus: *Bidens, Echinochloa, Najas, Polygonum, Potamogeton, Ruppia, Sagittaria, Scirpus, Zizania*

Discusses methods for collecting and storing seeds of waterfowl food plants. Useful tips on harvesting operations, dry and wet storage of seeds, and timing of harvest are included for alkali bulrush (*Scirpus maritimus*), wild millet (*Echinochloa crusgalli*), Pennsylvania smartweed (*Polygonum pennsylvanicum*), sago pondweed (*Potamogeton pectinatus*), bush pondweeds (*Naias* spp.), common wigeonweed (*Ruppia maritima*), duckpotatoes (*Sagittaria* spp.), and annual wildrice (*Zizania aquatica*).

561. Kuehne, R. A. 1975. Evaluation of recovery in a polluted creek after installation of new sewage treatment procedures. Univ. Ky., Water Resour. Res. Inst. Res. Rep. 65. 33 pp.

Response: FISH, INVERT, CHEM, WQUAL

Genus: *Chlorella, Cladophora, Scenedesmus*

Evaluates recovery of a polluted creek, Hickman Creek near Lexington, Kentucky, after installation of a secondary treatment facility and four sequential polishing lagoons to treat wastes before chlorination and discharge into the creek. Six months after the treatment facility opened, physico-chemical tests gave no strong indication of residual pollution effects. Mean values for turbidity, nitrates, and COD (chemical oxygen demand) were higher at the outfall than at 11 stations within the basin. Orthophosphates were considerably higher in lagoon discharge. The rapidity and extent of faunal recovery in the creek was probably associated with the fact that some undisturbed habitat persisted above the point of sewage pollution as well as in parts of the creek.

562. Kusler, J. A. 1986. Wetland restoration/creation: a summary of science views and perspectives. Pages 440–446 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings National Wetland Symposium: Mitigation of Effects and Losses. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Provides an overview of scientific views concerning wetland restoration-creation issues. The following is a sampling of the questions addressed. Can wetlands be successfully restored or created in terms of the functions of naturally occurring wetlands? What are the science-related problems with wetland restoration-creation projects? What are the reasons for inadequate project design? Are some wetland types easier to restore or create than others? Are some wetland functions more easily restored or created than others? What are the most critical parameters in wetland restoration and creation? Can offsite wetland restoration-creation serve the same functions as onsite restoration-creation?

563. Lahti, T. 1977. Restoration of a small suburban southern Wisconsin wetland. Pages 136–163 *in* C. B. Dewitt and E. Soloway, eds. Wetlands: ecology, values, and effects. Proceedings of the Waubesa conference on wetlands. University of Wisconsin, Institute of Environmental Studies, Madison.

Response: INVERT, VEG

Genus: *Acorus, Eleocharis, Iris, Sagittaria, Scirpus, Sparganium, Typha*

The purposes of this study were to examine four wetlands in southern Wisconsin for qualitative analysis of wetland vegetation dynamics (composition and changes up the slope from the waters' edge), and to initiate a wetland restoration project on a severely disturbed site in Madison, Wisconsin. Plant materials were obtained from a nursery. Development was rapid for most species; all had high survival rates. Emphasis was placed on choosing plants that commonly grow in similar settings and on planting them in specific relation to water and groundwater. Problems encountered were invasion of undesirable plants, water loss, seedling die-off, and erosion. Aquatic invertebrates at the sites included mayflies (Ephemeroptera), whirligig beetles, dragonflies (Odonata), water boatmen, naiads, and phantom midges (Chaoborinae).

564. Landin, M. C. 1982. Habitat development at eight Corps of Engineers sites: feasibility and assessment. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Misc. Pap. D-82-1. 244 pp.

Response: FISH, WFOWL, NGBIRDS, SHOREB, HUSE, WQUAL, ECON

Genus: Many

Provides an overview of wetland restoration feasibility at eight habitat development sites: Pointe Mouillee State Wildlife Area, Michigan—marsh restoration on Lake Erie; Santa Ana River, Orange County, California—tidal marsh restoration; Brunswick, Georgia—harbor deepening, habitat development, and marsh valuation; Gifford Hill Mining Company land, northwestern Louisiana—restoration of bottomland hardwoods and other wetlands; Trinity River basin, Texas—disposal and use of dredged materials; Delaware River, Pennsylvania—habitat development sites; Tangier Island, Chesapeake Bay, Virginia—shoreline stabilization and marsh development; Smith Island, Chesapeake Bay, Maryland—dredged material disposal, habitat development, and erosion control. Discusses project effects, habitat development, plant propagation, and costs.

565. Landin, M. C. 1986. The success story of Gaillard Island, a Corps confined disposal facility. *In* Proceedings 19th dredging seminar and western dredging association conference, Baltimore, Md.

Response: FISH, SHELLF, MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Cynodon, Digitaria, Echinochloa, Eupatorium, Scirpus, Sesuvium, Spartina, Strophostyles, Typha*, many

Discusses wildlife use of Gaillard Island, a 5-year-old dredge spoil site in Mobile Bay, Alabama. Briefly summarizes chronological colonization of the island by wildlife and vegetation. The island supports an estimated 16,000 nesting birds, including gulls, skimmers, terns, shorebirds, pelicans, and a few species of songbirds. Shorebirds and waterfowl heavily use the area in winter and during migration. The island has experienced some problems with dike stabilization, which were addressed using a combination of stone armor and wetland establishment.

566. Landin, M. C. 1986. River structures as wildlife habitat. *In* Proceedings flood control workshop.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB

Genus: None

Summarizes wildlife use of river structures generally designed for flood control and sediment entrainment. Structures include levees and borrow pits, dike fields and wing dikes, revetments, low-head locks and dams, bendway cutoffs, and man-made or man-altered islands and bars. Presents a brief summary of wildlife studies on the various types of structures. Recommendations include: proper location and maintenance of structures, encouraging landowners to allow revegetation to occur (i.e., by limiting cattle grazing), design of borrow pits to allow emergent marsh development, and promotion of offshore sandbar formation for waterbird habitat.

567. Landin, M. C. 1985. Bird and mammal use of selected lower Mississippi River borrow pits. Ph.D. dissertation, Mississippi State University, Mississippi State. 405 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, HYDRO

Genus: *Acer, Carex, Cynodon, Gleditsia, Lemna, Paspalum, Polygonum, Populus, Quercus, Sagittaria, Salix, Scirpus, Taxodium*, many

Discusses bird and mammal use of 26 borrow pits along the lower Mississippi River from St. James Parish, Louisiana, to New Madrid, Missouri. Pits were grouped by levels within each of six characteristics: vegetation type, livestock grazing intensity, distance from the river, length of inundation, pit size, and water depths at bankful. Numerous differences were found among pit characteristics, year, season, and mammal and bird use. Both birds and mammals were observed most frequently at borrow pits surrounded by bottomland hardwoods with understory and moderately grazed or occasionally mowed, flooded less than 1 month yearly, at least 1.8 m (6 feet) deep at bankful, at least 12 ha (30 acres) in size, and more than 1.6 km (1 mile) from the river.

568. Landin, M. C. 1978. Annotated tables of vegetation growing on dredged material throughout the United States. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., DMRP Work Unit 4F05. 155 pp.

Response: VEG

Genus: Many

Presents vegetation data from dredged material sites throughout the United States. Revegetation efforts were directed toward establishing wildlife habitat. Factors influencing establishment were location of the site in the waterway; size and configuration; height and gradient; plant propagule sources; salinity; climate; current, wave, and tidal action; and wildlife and human use. In addition, recommendations for wetland habitat planners are included along with a list of 1,120 plant species growing on dredged material islands and other sites.

569. Landin, M. C. 1984. Habitat development using dredged material. Pages 907–917 *in* R. L. Montgomery and J. W. Leach, eds. Dredging and dredged material disposal: proceedings of the conference dredging '84. American Society of Civil Engineers, New York.

Response: SHOREB, VEG

Genus: *Ammophila, Carex, Cynodon, Deschampsia, Distichlis, Equisetum, Pontederia, Salicornia, Spartina, Zizania*

Discusses habitat development, particularly for nesting waterbirds, on dredged material sites constructed by the U.S. Army Corps of Engineers. Discusses success of planting, natural revegetation, stability, and wildlife use for sites in Georgia (Buttermilk Sound), California (Salt Pond #3 in San Francisco Bay), Florida (Apalachiola Bay), Virginia (Windmill Point), Texas (Bolivar Peninsula), Oregon (Miller Sands), Alabama (Gaillard Island), Minnesota (Lake of the Woods), Michigan (Pointe Mouillee), and Louisiana (Southwest Pass in New Orleans).

570. Landin, M. C., C. J. Newling, and E. J. Clairain, Jr. 1987. Miller Sands Island: a dredged material wetland in the Columbia River, Oregon. Pages 150–155 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, SUCCESS

Genus: *Bidens, Carex, Deschampsia, Eleocharis, Iris, Justicia, Polygonum*

Documents 13 years of monitoring a wetland creation project at a 95-ha (235-acre) dredged material island in the Columbia River freshwater intertidal reach. Describes long-term monitoring activities in terms of benthic sampling, erosion control, soil sampling, birds, mammals, fish, and vegetation. Results were compared to data from nearby reference wetlands. Although the plant community at this site is still less productive than that of the natural marshes, but it is slowly progressing to higher levels of productivity. Wildlife is abundant at Miller Sands, and it is concluded that productive wetland habitat has been established.

571. Landin, M. C., and H. K. Smith. 1982. Reclamation of wetlands. Pages 195–206 *in* W. T. Mason, Jr., and S. Iker, eds. Research on fish and wildlife habitat. U.S. Environ. Prot. Agency, Washington, D.C. EPA-600/8-82-022.

Response: None

Genus: *Avicennia, Scirpus, Spartina, Typha*, many

Presents an overview of wetland reclamation programs and aspects of wetlands habitat development. Briefly discusses State, Federal, and private wetland development efforts throughout the United States. Summarizes procedures and techniques used by the U.S. Army Corps of Engineers in the development of wetlands, including planning, plant propagation, and monitoring.

572. Landin, M. C., and J. W. Webb. 1986. Wetland development and restoration as part of Corps of Engineer programs: case studies. Pages 388–391 *in* J. A. Kusler, M. L. Quammen, and

G. Brooks, eds. Proceedings National Wetland Symposium: Mitigation of Effects and Losses. Association of State Wetland Managers, Berne, N.Y.

Response: SHOREB, VEG, SOIL

Genus: *Carex, Deschampsia, Salicornia, Spartina*

Discusses seven studies of wetland development and restoration constructed by or for the U.S. Army Corps of Engineers as part of ongoing dredging activities, research, or mitigation in coastal Oregon, Georgia, Alabama, and Texas. Summarizes success of plant propagation, sediment characteristics, and wildlife use of dredged material sites for restored areas in Buttermilk Sound, Georgia; Miller Sands, Oregon; Gaillard Island, Alabama; and Bolivar Peninsula, Chocolate Bay, Stedman Island, and East Matagorda Bay in Texas. Many of the man-made wetlands have become viable habitats in terms of productivity and wildlife use. Failures seem to have been most common where poorly designed or implemented plans were used, where no monitoring was required, and in wetlands built as mitigation requirements as part of the permitting process.

573. Lane, L. J., and G. R. Foster. 1980. Modeling channel processes with changing land use. Pages 200–215 *in* Symposium on watershed management 1980. Vol. 1. American Society of Civil Engineers, New York.

Response: None

Genus: None

Develops procedures to predict channel morphology for small streams and to relate channel morphology to sediment yield. Sensitivity analysis showed the response or adjustment of stream channels because of changes in discharge and channel characteristics resulting from changing land use. Hydraulics of open-channel flow and a simple erosion equation provide a basis for quantitatively evaluating response of stream channels to changes in discharge, soil properties, and topography. Land-use changes that cause an increase in discharge and hydraulic resistance will cause increased channel widths; narrower channels would result from land uses that produce a larger critical shear stress on a stream.

574. Larimer, E. J. 1969. An investigation of possibilities for creating saltmarsh in the estuaries of the Atlantic and Gulf Coasts. Proc. Annu. Conf. Southeast Assoc. Game Fish Comm. 22:82–88.

Response: VEG, ECON

Genus: *Acnida, Diplanthera, Distichlis, Scirpus, Spartina, Thalassia*

Examines the feasibility of creating or rehabilitating salt marshes in the estuaries of the Atlantic and Gulf Coasts. A comprehensive survey of the available literature was made. Smooth cordgrass *Spartina alterniflora* seems to be the best-suited salt marsh grass for experimental plantings. Fully allocated costs of salt marsh creation would be high, but out-of-pocket costs could be much less by requiring site purchase or easement for spoil deposition involved with dredge and fill projects. Presents recommended procedures and relative costs for various techniques useful in salt marsh creation and restoration.

575. Laroe, E. T. 1977. Mitigation: a concept for wetland restoration. Pages 221–224 *in* Proceedings of the national wetland protection symposium. U.S. Fish Wildl. Serv., FWS/OBS-78/97.

Response: None

Genus: None

Presents an overview of Oregon's land-use program, which establishes legal requirements for mitigation of dredge and fill actions in tidal and intertidal marsh areas. The program requires that dredge and fill activities in tidal or intertidal marshes be mitigated by the creation or restoration of other areas with similar biological potential. First priority areas for restoration site selection are near, and similar to, the dredge-fill sites. Second priority are areas in other parts of the same estuary, chosen according to similarity of salinity, tidal exposure and elevation, substrate, current, solar orientation, and slope. Third priority are areas scarce compared to past abundance and distribution. Discusses legal, economic, institutional, and biological problems and issues.

576. Laroe, E. T. 1979. The biological basis for estuarine ecosystem mitigation. Pages 90–92 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: SUCCESS

Genus: None

Discusses mitigation of estuarine ecosystem loss in terms of compensation and restoration. The object of mitigation is to ensure that restoration efforts are designed to effectively offset adverse effects of a proposed project. The determination of type of appropriate action and the amount of mitigation that will be adequate in a given situation is identified as a major problem area. The greatest adverse effects in estuarine systems are: loss of surface area by filling, loss of benthic habitat by filling or dredging, and deterioration of water quality. Provides guidelines for dealing with these issues. Includes legal and regulatory concerns.

577. Larosa, R. 1984. Environmental resource conservation: riparian system enhancement through water reclamation. Pages 459–464 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. Calif. Water Resour. Rep. 55., University of California Press, Berkeley.

Response: ECON, HYDRO

Genus: *Heteromeles, Platanus, Populus, Quercus, Salix, Sambucus*

Describes a plan for establishing 2,000 native trees on 4 ha of floodplain along Escondido Creek in the San Elijo Lagoon, San Diego, California. The plan calls for planting native trees and shrubs to promote wildlife habitat. Year-round surface water is required to promote root growth. The surface water will be provided by processed wastewater, and a marshland created by inundating a portion of the floodplain by the construction of a low dam. Discusses Federal and State regulations relevant to the use of wastewater in public projects. Costs are estimated at $15,000 for design and planning, $82,000 for construction, and $18,000 for maintenance.

578. Larson, J. L., and F. Stearns. 1986. Restoration of a woolgrass-dominated sedge meadow (Wisconsin). Restor. Manage. Notes 4(2):77.

Response: VEG

Genus: *Agrostis, Ambrosia, Carex, Echinochloa, Epilobium, Eupatorium, Panicum, Phalaris, Poa, Populus, Rhamnus, Rubus, Salix, Scirpus, Solidago*

Discusses sedge meadow (*Carex practicola*) restoration on a drained mined peatland in Waukesha County, Wisconsin. Two plots of 0.5 ha each were mowed in July and two similar plots were left unmowed to serve as controls. Floristic analysis of plots 1 year later indicated that mowed plots supported a higher frequency of sedges and grasses. Disturbance-associated species were more plentiful in mowed plots; willow (*Salix*) and cottonwood (*Populus*) were less frequently found. Mowed plots had a denser mat of woolgrass (*Scirpus cyperinus*), sedges, and grasses. Mowing will be continued to reduce shrub height. An increase in water level may be helpful in limiting shrub encroachment in the sedge meadow.

579. Larson, J. P., C. L. Ricks, T. J. Salamunovich. 1981. Alternatives for restoration of estuarine habitat at the mouth of Redwood Creek, Humboldt County, California. Pages 236–245 *in* R. N. Coats, ed. Proceedings of a symposium on watershed rehabilitation in Redwood National Park and other Pacific coastal areas. Center for Natural Resource Studies, JMI, Inc.

Response: FISH, INVERT

Genus: None

Describes and compares rehabilitation alternatives for estuarine habitat at the mouth of Redwood Creek, near Orick, Humboldt County, California. A major problem is substantial reduction of the anadromous fishery of Redwood Creek because of habitat degradation and alteration of estuarine environment. Describes restoration alternatives: dredging, control of embayment water level, circulation of water through sloughs, partial levee removal, and relocation of levees.

580. Larson, J. S. 1987. Wetland creation and restoration: an outline of the scientific perspective. Pages 73–79 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, SUCCESS

Genus: None

Examines the scientific basis for determining the functional success of a created or restored wetland. Literature addressing the question of whether wetlands can successfully be restored or created is reviewed. Discusses the scientific perspective in some detail in terms of hydrology, soil-substrate, and vegetation. Describes minimum requirements for planning freshwater habitat creation projects. Functional performance is identified as being the scientific standard for determining whether mitigation is effectively replacing lost natural wetlands.

581. Larson, J. S. 1986. Wetland mitigation in the glaciated northeast: risks and uncertainties. Pages 4–16 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass. Environ. Inst. Publ. 87–1.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL, SUCCESS

Genus: None

Provides an overview of the risks and uncertainties involved in wetland mitigation efforts. The mechanisms of wetland functional replacement are complex; major elements are hydrology, soils, and vegetation. Addresses responses to the following questions. How well can functions of a natural wetland be measured. Is enough known about the bio-physical mechanisms of wetland functions to be able to reconstruct a given function at another location? Hydrologists can sometimes construct single-function structures; however, interactions between hydrologic functions along with complex ecological relations pose unique problems. In terms of soil reconstruction, creating the nutrient cycling and water quality functions is extremely diffieult. Discusses vegetation establishment and engineering.

582. Lathwell, D. J., D. R. Bouldin, and E. A. Goyette. 1973. Growth and chemical composition of aquatic plants in twenty artificial wildlife marshes. J. N.Y. Fish Game 20:108–128.

Response: VEG, SOIL, CHEM, SUCCESS

Genus: *Chara, Najas, Polygonum, Potamogeton, Scirpus, Sparganium, Typha, Vallisneria, Zizania*

Ten years after construction, 20 artificial marshes in New York were evaluated in terms of aquatic plant growth and ehemical composition. Measures standing aquatic vegetation to determine marsh productivity and dominant species. Total aboveground biomass for emergents generally varied from 300 to 800 g/m^2. This was 3 to 5 times greater than that of submergents. Prevalent emergents were bulrush (*Scirpus*) and cattail (*Typha*); *Chara* was the dominant submergent. Standing crop was inversely related to water depth; standing crop was 690–833 g/m^2 at 0.3 m (1.0 foot) and 208–355 g/m^2 at 0.9 m (3.0 feet). Mineral composition and macronutrients were measured, including ash, iron, manganese, nitrogen, phosphorus, calcium, and potassium.

583. Lathwell, D. J., H. F. Mulligan, and D. R. Bouldin. 1969. Chemical properties, physical properties and plant growth in twenty artificial wildlife marshes. J. N.Y. Fish Game 16(2):158–183.

Response: VEG, SOIL, CHEM, WQUAL, SUCCESS

Genus: *Chara, Najas, Polygonum, Potamogeton, Scirpus, Sparganium, Vallisneria, Zizania*

Describes studies of soil and water chemistry in 20 artificial marshes in Tompkins County, New York. Constructed in 1958–59, these marshes were planned for evaluation of the influence of water depth, soil reaction, and organic matter on the growth of rooted aquatic plants that are important food sources for wildlife. Information summarized in this study was collected during 1960–67.

584. Lawrence, J. S., W. D. Klimstra, W. G. O'Leary, and G. A. Perkins. 1985. Contribution of surface-mined wetlands to selected avifauna in Illinois. Pages 317–325 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: WFOWL, NGBIRDS, HUSE

Genus: None

Documents the use of surface-mined wetlands by breeding and nonbreeding species in Perry, Fulton, Knox, Peoria, and Williamson-Saline counties in Illinois. More than 400 giant Canada geese (*Branta canadensis*) were released on wetlands consisting of old spoilbank areas, which were minimally graded and later inundated; 38 nests were located on minimally graded islands and 23 nests were on islands with extensive grading. A major problem with the islands was spoilbank erosion. Waterfowl broods were observed on graded wheel-spoil ponds, but not on shovel-spoil or final-cut ponds. Semipermanant ponds with fluctuating water levels often provided

more benefit to wetland birds than permanant impoundments with stable water levels, as currently required by law.

585. Leck, M. A., and K. J. Graveline. 1979. The seed bank of a freshwater tidal marsh. Am. J. Bot. 66(9):1006–1015.

Response: VEG

Genus: *Acorus, Ambrosia, Bidens, Impatiens, Nuphar, Peltandra, Pilea, Polygonum, Sagittaria, Typha, Zizania*

Describes a study of seed bank composition and in freshwater tidal areas of the Hamilton marshes near Trenton, New Jersey. The size and species composition of seed banks in several marsh types was evaluated. Marsh types were: streambank, high marsh dominated by mixed annuals, high marsh dominated by giant ragweed *Ambrosia trifida*, high marsh dominated by common cattail (*Typha latifolia*) and *Acorus calamus*, high marsh in a slight depression along the stream, and a sballow tidal stream dominated by spatterdock cowlily (*Nuphar advena*). Marsh soils contained comparatively more seeds below the surface layer. Describes comparisons of sites, soil depth, and effects of flooding in terms of germination requirements for marsh plant species.

586. Lee, C. R., R. E. Hoeppel, P. G. Hunt, and C. A. Carlson. 1976. Feasibility of the functional use of vegetation to filter, dewater, and remove contaminants from dredged material. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-76-4. 81 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Distichlis, Eichhornia, Jussiaea, Myriophyllum, Phragmites, Populus, Salix, Scirpus, Spartina, Typha*, many

Discusses the feasibility of using vegetation to filter, dewater, and remove contaminants from dredged material slurry in confined disposal sites. Information was compiled from available literature and field evaluations of confined disposal sites in Portland, Los Angeles, New Orleans, Charleston, Philadelphia, and Chicago. Selected vegetation can remove significant amounts of nitrogen and phosphorus from discharged areas. Intolerance of some plants to certain contaminants may preclude their usefulness in dredged material disposal operations. The use of vegetation to remove large amounts of heavy metal contaminants has limited feasibility. Vegetation is useful in dewatering and consolidating fine-textured dredged material. Presents suitability of 50 plants , as well as examples of techniques, designs, and costs.

587. Lee, C. R., R. M. Smart, T. C. Sturgis, R. N. Gordon, Sr., and M. C. Landin. 1978. Prediction of heavy metal uptake by marsh plants based on chemical extraction of heavy metals from dredged material. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-76-6. 107 pp.

Response: VEG, CHEM

Genus: *Distichlis, Spartina*

Presents results of a field and laboratory study conducted to establish the extent of heavy metal absorption and uptake by marsh plant species from 29 dredged material sites along the east and Gulf coasts of the United States and to develop a chemical extraction technique to predict heavy metal concentrations in marsh plants subsequently grown on dredged material. Marsh plant species studied were smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), and seashore saltgrass (*Distichlis spicata*). Evaluates four procedures for extraction of heavy metals from soil. Results indicate that most marsh plants colonizing the dredged material disposal sites contained relatively low concentrations of zinc, copper, lead, chromium, nickel, and mercury, similar to concentrations reported for natural marshes.

588. Lee, C. R., T. C. Sturgis, and M. C. Landin. 1976. A hydroponic study of heavy metal uptake by selected marsh plant species. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-76-5. 62 pp.

Response: VEG, HYDRO, CHEM

Genus: *Cyperus, Distichlis, Scirpus, Spartina*

Presents results of a laboratory study that evaluated the ability of eight marsh plant species, grown in chemically controlled hydroponic solutions, to take up and accumulate heavy metals. Marsh plants were exposed for 6 weeks to zinc, cadmium, nickel, lead, or chromium at concentrations of 0.0, 0.5, or 1.0 ppm. Exposure to heavy metals adversely affected the growth of softstem bulrush (*Scirpus validus*), marshhay cordgrass (*Spartina patens*), smooth cordgrass (*S. aterniflora*), and seashore saltgrass (*Distichlis spicata*) more than chufa flatsedge (*Cyperus esculantus*), saltmarsh bulrush (*Scirpus robustus*), seaside arrowgrass (*Triglochin maritima*), and *Spartina foliosa*. Phosphorus and iron content in the roots seemed to be a major factor in determining the ability of a marsh plant to translocate heavy metals from the roots into other plant parts.

589. Leedy, D. L., and T. M. Franklin. 1981. Coal surface mining reclamation and fish and wildlife relationships in the eastern United States. Vol. II. Opportunities and approaches for fish and wildlife planning and management in coal surface mining, reclamation and postmining land use. U.S. Fish Wildl. Serv., FWS/OBS-80/25. 169 pp.

Response: None

Genus: *Acer, Betula, Carex, Phalaris, Pinus, Populus, Quercus, Robinia*, many

Discusses reclamation planning for fish and wildlife resources on coal surface mined land of the eastern United States. Discusses wetland management measures that include: protection of existing streams and ponds on areas to be mined, siting and construction of new impoundments, and management of streams and ponds on existing surface mined areas. Presents brief guidelines for managing streamside vegetation, stocking wildlife and fish, providing cover and nesting habitat, creating spawning habitat, and liming and fertilizing to improve water quality. Illustrates three examples of management approaches, based on actual and hypothetical situations.

590. Leenhouts, W. 1983. Maintaining a fire subclimax salt marsh community with prescribed fire. Restor. Manage. Notes 1(1):15.

Response: NGBIRDS, VEG

Genus: None

Describes the use of summer burning as a technique for maintaining salt marsh vegetation (a fire subclimax community) at the St. Johns National Wildlife Refuge, Titusville, Florida. The natural salt marsh community is habitat for the endangered dusky seaside sparrow. After 4 years, several areas have shown a significant decrease in woody vegetation. Summer fires are prescribed on a 2- to 3-year rotation in areas containing fire subclimax flora.

591. Lefor, M. W., W. C. Kennard, and D. L. Civco. 1987. Relationships of salt-marsh plant distributions to tidal levels in Connecticut. Environ. Manage. 11(1):61–68.

Response: VEG, HYDRO, SOIL

Genus: *Distichlis, Juncus, Limonium, Plantago, Spartina, Triglochin*

Describes a study of salt marsh vegetation at three study sites in Connecticut: Stonington-Barn Island, Hammonassett, and Sherwood Island. At each site, 10- × 70-m belt transects (covering salt marsh and the wetland-to-upland transition) were established and monitored. Determines elevations and species present and analyzes hourly tide data. Describes the relations between species observations and mhw data. Discusses results of this study in terms of application to marsh restoration efforts.

592. Leitch, J. A. 1980. Economic aspects of wetland restoration in the prairie pothole region. Pages 279–293 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: HUSE, ECON

Genus: None

Discusses some economic effects of wetland restoration on local economies. Wetlands were restored on previously drained croplands in the prairie pothole region of North Dakota. Issues include local public decision making, changes in tax revenue, loss of local employment and business, land management (under public ownership), levels of personal income, crop prices, and productivity of drained wetlands. A case example illustrates the interactions among several of these issues.

593. Lejcher, T. 1986. Hydrology and watershed considerations. Pages 4–9 *in* J. L. Piehl, ed. Proceedings, wetland restoration: a techniques workshop. Minnesota Chapter of the Wildlife Society, Fergus Falls.

Response: HYDRO

Genus: None

Discusses various hydrological considerations in wetland restoration projects. Project planning includes consideration of the entire watershed and correct sizing of the watershed. Discusses determination of channel slopes and watershed storage area. Briefly discusses permit requirements and project considerations such as frequency of maintenance, water level monitoring, alterations in water courses entering or leaving the site, and public awareness.

594. Leopold, L. B., and M. G. Wolman. 1957. River channel patterns: braided, meandering and straight. U.S. Govt. Print. Off., Washington, D.C., Geol. Surv. Prof. Pap. 282-B. 84 pp.

Response: None

Genus: None

Provides an in-depth study of river channel patterns in terms of natural channels and flume experiments. Describes physiographic and hydraulic parameters of braided, meandering, and straight channels. Data obtained from Horse Creek, Cottonwood Creek, and Green River near Daniel, Wyoming; New Fork River near Pinedale, Wyoming; Middle River near Staunton, Virginia; Valley Creek near Downingtown, Pennsylvania; and Popo Agie River near Hudson, Wyoming; are used to illustrate main concepts in channel adjustment (discharge, channel width, velocity, slope, depth, resistance). Describes relations among factors affecting channel configuration.

595. Lere, M. E. 1982. The long term effectiveness of three types of stream improvement structures installed in Montana streams. M.S. thesis, Montana State University, Bozeman. 99 pp.

Response: FISH, VEG, HYDRO

Genus: None

Discusses long-term effectiveness and durability of random boulders, rock jetties, and log step dams installed as habitat improvement structures in the St. Regis River, western Montana, and the Little Prickley Pear Creek and Sheep Creek, central Montana. In the St. Regis, pool-riffle periodicity was related to total number of cutthroat trout (*Salmo clarki*) and brook trout (*Salvelinus fontinalis*). Channelized sections improved with random boulders contained greater trout biomass than sections improved with rock jetties or control sections. Unmitigated channelized sections contained the least trout biomass. More than 89% of all structures, except rock jetties, remained functional after 8–19 years.

596. Lester, J. E., C. V. Klimas, H. H. Allen, and S. G. Shetron. 1986. Shoreline revegetation at Lake Texoma on the Red River, Texas-Oklahoma. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. E-86-1. 49 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Agropyron, Amorpha, Andropogon, Arundinaria, Arundo, Betula, Buchloe, Cyperus, Diospyros, Panicum, Paspalum, Phragmites, Quercus, Salix, Sapindus, Spartina, Tripsacum*

Describes a field study that identified plant species suitable for revegetating reservoir fluctuation zones. Two experimental sites were established at Lake Texoma, Texas and Oklahoma: a control pond and a shoreline site. Ten herbaceous and 6 woody plant species were transplanted at both sites. Soil samples and water quality samples were evaluated throughout the study. Describes the performance of each plant species tested. *Arundo donax* and switchgrass panicum (*Panicum virgatum*) seemed to be best suited for most fluctuation zone applications. Common persimmon (*Diospyros virginiana*), black willow (*Salix nigra*), and indigobush amorpha (*Amorpha fruticosa*) are potentially useful, but may be eliminated by extreme conditions. To minimize erosion and to create wildlife habitat most effectively, a mixture of species across a range of inundation conditions is recommended.

597. Levings, C. D. 1980. An account of a workshop on restoration of estuarine habitats. Can. Fish. Aquat. Sci. 1571. 29 pp.

Response: FISH, VEG, SOIL, WQUAL

Genus: *Carex, Eleocharis, Juncus, Scirpus, Zostera*

Presents summaries, abstracts, and preliminary results from 15 talks given at a workshop on restoration of estuarine habitats at the West Vancouver Laboratory and the Pacific Biological Station, Nanaimo, in British Columbia in 1979. Topics include selecting marsh and eelgrass (*Zostera*) restoration sites in the Fraser Estuary, preliminary results of two pilot projects for marsh transplants in the Fraser Estuary, preliminary results of eelgrass transplants at the Nanaimo River estuary, tidal reactivation of a portion of the Englishman River estuary, possiblity of sand-mud flat restoration, and use of these habitats by fish.

598. Lewis, R. R., III, and F. M. Dunstan. 1975. Use of spoil islands in reestablishing mangrove communities in Tampa Bay, Florida. Pages 766–775 *in* G. Walsh, S. C. Fnedaker, and H. T. Teas,

eds. Proceedings international symposium on biology and management of mangroves. Vol. II. University of Florida, Institute of Food and Agricultural Sciences, Gainesville.

Response: VEG, SOIL, SUCCESS, SHOREB

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the use of spoil islands in Tampa Bay for establishing mangrove communities and subsequent bird nesting habitat. Analyzes historical artificial island creation and stabilization and rookery success dating to 1931. Conditions for creating islands for successful rookeries and mangrove establishment include minimizing ship wakes (which cause erosion) and designing the island in a horseshoe shape. *Avicennia* plantings are suitable for spoil stabilization. Temporary barriers reduced erosion and allowed mangrove establishment. Discusses proper management of existing spoil islands to maintain rookery habitat requires substrate stabilization; both physical and vegetative stabilization.

599. Lewis, R. R. 1982. Restoration of a needle rush (*Juncus roemerianus* Scheele) marsh following interstate highway construction. II. Results after 22 months. Pages 69–81 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Juncus*

Restoration of a construction-damaged marsh site near Tampa Bay, Florida, was initiated by planting 21,000 15.2-cm plugs of needle rush (*Juncus roemerianus*) from a natural marsh. After 22 months, half of the plugs were still alive. None of the plugs planted under a bridge or in areas too steeply graded survived. Nearly 100% survival and a 25-fold increase in number of culms were observed in open areas with an elevation slightly lower than that of the natural marsh.

600. Lewis, R. R. 1982. Mangrove forests. Pages 153–171 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, ECON

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the planting of mangroves for wetland restoration purposes. Describes the natural plant community in terms of productivity, distribution, silvaculture, and historical loss. Discusses plant materials and types. Four planting techniques have been used: direct planting of propagules, aerial planting, transplanting of seedlings or small trees, and planting of nursery seedlings. Summarizes 34 studies involving mangrove planting. Includes estimated costs.

601. Lewis, R. R. 1980. Economics and feasibility of mangrove restoration. Pages 88–94 *in* R. C. Carey, P. S. Markovits, and J. B. Kirkwood, eds. Proceedings U.S. Fish and Wildlife Service workshop on coastal ecosystems of the southeastern United States. U.S. Fish Wildl. Serv., FWS/OBS-80/59.

Response: VEG, ECON, SUCCESS

Genus: *Avicennia, Bruguiera, Laguncularia, Rhizophora, Spartina*

An overview of studies and projects conducted to determine the feasibility of mangrove planting in coastal areas. Three main issues were: what are the advantages to planting versus natural revegetation, how long does it take for planted materials to reach maturity, and when does the biotic community planted system approach that of a natural community? Planting costs varied from $1,140/ha to $216,130/ha depending on whether the seedlings were collected from natural areas or were nursery grown (trees up to 3 years old).

602. Lewis, R. R. 1979. Large scale mangrove restoration on St. Croix, U.S. Virgin Islands. Pages 231–242 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Rhizophora*

Describes the planting of 65,000 red mangrove (*Rhizophora mangle*) seeds near Port Alucroix, St. Croix, U.S. Virgin Islands, to compensate for the loss of mangrove forests due to impoundment construction. Although the soil at the planting site still contained oil residues from a previous spill, test plantings of mangroves indicated that the area was suitable for use. After 6 weeks, seedling survival rate averaged 75%. Seed failure was due to removal of seeds through erosion, burial of seeds by floating debris or seagrass wrack, seed consumption (possibly by crabs), seedling death by natural causes, and planting at elevations that were too high. Total cost was $50,000 (approx. $5,000/.4 ha) for equipment, planning, and 240 man-days of effort.

603. Lewis, R. R. 1982. Low marshes, peninsular Florida. Pages 147–152 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, ECON

Genus: *Spartina*

Describes the role of smooth cordgrass(*Spartina alterniflora*), in the restoration and creation of low marsh areas in southern Florida. Although mangroves are the dominant coastal estuarine vegetation, *S. alterniflora* plantings may be cost effective in such areas for rapid coverage of substrate, shoreline stabilization, sediment trapping (e.g., from street runoff), and nesting habitat for clapper rails and willets. *Spartina alterniflora* plantings are eventually invaded and replaced by mangroves.

604. Lewis, R. R., and K. C. Haines. 1980. Large scale mangrove restoration on St. Croix, U.S. Virgin Islands: II. Second year. Pages 137–148 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Avicennia, Rhizophora*

Presents the second year update on mangrove planting on St. Croix, U.S. Virgin Islands. Approximately 86,000 red mangrove (*Rhizophora mangle*) seedlings were planted on 6.15 ha; 32,000 seeds from black mangroves (*Avicennia germinans*) were broadcasted over the area. After 20 months, survival rates were 40% for red mangroves and 1–2% for black mangroves.

605. Lewis, R. R., and C. S. Lewis. 1978. Colonial bird use and plant succession on dredged material islands in Florida. Vol.II. Patterns of plant succession. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-14. 175 pp.

Response: VEG, SHOREB

Genus: *Avicennia, Baccharis, Casuarina, Cenchrus, Chloris, Eupatorium, Heterotheca, Iva, Juncus, Juniperus, Laguncularia, Myrica, Paspalum, Rhizophora, Sabal, Schinus, Spartina, Sporobolus*, many

Describes vegetative succession at 40 dredged spoil material islands along the coast of Florida, from Merritt Island and Indian River on the eastern shore to the Withlacoochee River area (near Yankeetown) on the gulf shore. Extensive data, including aerial photographs of each site, were collected and evaluated in terms of the relation between island vegetation and nesting habitat for colonial seabirds and wading birds. A total of 141 plant species were found. Describes generalized habitat succession.

606. Lewis, R. R., and C. S. Lewis. 1977. Tidal marsh creation on dredged material in Tampa Bay, Florida. Pages 45–67 *in* R. Lewis and D. Cole, eds. Proceedings of the Fourth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Spartina*

Examines techniques for planting smooth cordgrass (*Spartina alterniflora*) on a dredged material island (fishhook spoil) in Tampa Bay, Florida. In September 1976, 36 plugs of cordgrass from a nearby marsh were planted on 1-m centers. In October, 15 cordgrass plants grown from seed taken near Assateague Island, Virginia, were planted. In November, cordgrass spikelets were harvested and sent to Virginia for germination; plants were returned to Tampa for planting. Number of emergent stems by June 1977 were 267 for experimental plantings, 0 for the control plot, and 331 for the plants germinated in Virginia. Includes differences in culm production at elevations from .5 to 6 m (1.6 to 2.0 feet) mlw and criteria for marsh establishment success based on *S. alterniflora* plantings.

607. Lewis, R. R., C. S. Lewis, W. K. Fehring, and J. A. Rodgers. 1979. Coastal habitat mitigation in Tampa Bay, Florida. Pages 136–140 *in* G.A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: SHOREB, VEG

Genus: *Avicennia, Spartina*

Provides an overview of wetland creation and management on dredged material deposits in Tampa Bay, Florida. Describes three projects: transplanting of black mangrove (*Avicennia germinans*) and cordgrass (*Spartina*) to a new dredged material island (larger trees up to 1 m in height are thriving better than smaller trees; trees planted above mean high water show a much higher survival rate); creation of a *Spartina* marsh on a former upland site through grading, transplanting *Spartina* from a nearby marsh, and fertilizing the plugs; and extending an existing dredged material area to provide habitat for ground nesting birds.

608. Lewis, R. R., and R. C. Phillips. 1980. Experimental sea grass mitigation in the Florida Keys. Pages 155–173 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Halodule, Syringodium, Thalassia*

Describes the progress and condition of seagrass planted at Craig Key in the Florida Keys 1 year after the initiation of a 2-year monitoring program. Plugs and short shoots of turtlegrass (*Thalassia testudinum*), (*Halodule wrightii*), and slender syringodium (*Syringodium filiforme*) were transplanted to the study area; *Thalassia* seeds were planted in both field and laboratory. Seedlings from the lab were planted at the field site. Results so far indicate that *Halodule* is an early colonizing species, followed by *Syringodium* and then *Thalassia*, the climax species. Plugs of seagrass have best survival rates, especially when planted at 1-m intervals.

609. Lewkowicz, M., and S. Lewkowicz. 1977. Restoration of a pond after a five year period of fertilization with beet sugar factory wastes—chemical factors and zooplankton. Acta Hydrobiol. 19(4):315–333.

Response: INVERT, CHEM, WQUAL, VEG

Genus: *Ceratophyllum, Elodea, Lemna, Polygonum, Potamogeton*

Discusses restoration of a pond in Poland that had been fertilized for 5 years with sugar beet factory wastes. Nitrogen was the main factor limiting phytoplankton development. Zooplankton species, which were dominant in the fertilized pond, were eliminated the first month after filling the pond with pure river water, and species characteristic of moderately fertile fish ponds developed. Vascular plant coverage increased from 50% to 80% the year following restoration. Only duckweeds (*Lemna*) decreased after restoration.

610. Lidstone, C. D. 1982. Stream channel reconstruction and drainage basin stability. Pages 43–57 *in* R. R. Stowe, ed. Hydrology symposium on surface coal mines in Powder River Basin, Gillette, Wyo.

Response: None

Genus: None

Presents a systems approach to reconstructing stream channels in conjunction with the restoration of geomorphically stable postmining landscapes, with particular reference to coal mine reclamation in Wyoming. The systems approach entails an understanding of the processes acting on the landscape. Consideration of the affected area as an integral part of the fluvial system is critical in this analysis. The assessment includes collection of detailed baseline data as well as a knowledge of the ongoing sediment transport processes. Following drainage basin and channel design, postmining landscape stability can be predicted using the systems approach.

611. Lieffers, V. J., and J. M. Shay. 1981. The effects of water level on the growth and reproduction of *Scirpus maritimus* var. *paludosus*. Can. J. Bot. 59:118–121.

Response: VEG

Genus: *Scirpus*

Describes the results of a greenhouse experiment testing the effects of water level on the growth and reproduction of alkali bulrush (*Scirpus maritimus*). Plant tubers and rhizomes were collected from wetlands near Winnipeg, Manitoba, Canada. With increasing water depth, there was a shift from vegetative production to seed production. Plants in deeper water had fewer, taller shoots and produced more seeds. Clonal growth was optimum at depths less than 20 cm.

612. Lindall, W. N., A. Mager, G. W. Thayer, and D. R. Ekberg. 1979. Estuarine habitat mitigation planning in the southeast. Pages 129–135 *in* G.A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. Gen. Tech. Rep. RM-65.

Response: SUCCESS

Genus: *Halodule, Syringodium, Thalassia, Zostera*

Provides an overview of mitigation planning for estuarine habitat in the southeast. These areas provide essential habitat for the growth and development of many valuable fish species. Discusses zero habitat loss through mitigation in terms of preservation, restoration, and generation of new habitat (replacement of a habitat by the same kind of new habitat). Provides data on the value of estuarine-dependent fisheries along the South Atlantic and Gulf Coasts, summary of wetland alterations under the U.S. Army Corps of Engineers permit program, and summary of seagrass establishment projects in North Carolina and Florida. Emphasis is placed on the value of adequate documentation (before and after mitigation is implemented) and follow-up procedures for permit activities.

613. Lindau, C. W., and L. R. Hossner. 1981. Substrate characterization of an experimental marsh and three natural marshes. Soil Sci. Soc. Am. 45:1171–1176.

Response: VEG, SOIL, CHEM, SUCCESS

Genus: *Spartina*

Describes the substrate of several marshes near Galveston, Texas. Dredged material was used as the substrate for an experimental intertidal salt marsh. For 16 months, chemical and physical properties of the substrate were monitored. Smooth cordgrass (*Spartina alterniflora*) and *S. patens* were planted and various fertilizer treatments were administered. In a separate study, organic matter, total kjeldahl nitrogen, and NH_4-N were initially lower in an experimental marsh compared to three natural marshes. Elevation was the main factor influencing the distribution and abundance of nutrients and particle size in the marshes. Fertilizer had no significant effects.

614. Lindau, C. W., and L. R. Hossner. 1982. Sediment fractionation of Cu, Ni, Zn, Cr, Mn, and Fe, in one experimental and three natural marshes. J. Environ. Qual. 11(3):540–545.

Respouse: SOIL, CHEM

Genus: None

Compares sediment fractionation of several metals between an artificial and three natural marshes near Galveston Bay, Texas. The artificial marsh was constructed using dredged spoil material. Compares mineralogical properties of all four marshes. Examines total concentrations and partitioning of copper, nickel, chromium, zinc, manganese, and iron among marsh sediment fractions. The primary factor affecting the distribution and abundance of metals in marsh sediments is elevation. In general, metal concentrations at the study sites increased as marsh substrate elevations decreased.

615. Linde, A. F. 1969. Techniques for wetland management. Wis. Dep. Nat. Madison, Res. Rep. 45. 156 pp.

Response: FISH, MAMMALS, WFOWL, ECON

Genus: *Carex, Phalaris, Polygonum, Potamogeton, Scirpus, Typha*, many

Presents results of a survey of wetland management areas in Wisconsin to evaluate wetland management techniques used in various state game management districts. Stresses techniques for managing wetland game species (e.g., waterfowl, muskrats). Discusses: impoundment construction, water level manipulation, wetland farming, nesting island construction, controlled burning, vegetation control, land clearing, pothole and pond construction, and level ditching. The report serves as a manual for wetland management techniques and includes designs, equipment, and costs.

616. Lomax, J. L. 1982. Wildlife use of mineral extraction industry sites in the coastal plains of New Jersey. Pages 115–121 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: FISH, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, VEG

Genus: *Acer, Andropogon, Chamaedaphne, Cyperus, Drosera, Juncus, Myrica, Nyssa, Panicum, Pinus, Salix, Scirpus, Sphagnum, Typha, Utricularia, Vaccinium*, many

Provides an overview of the vegetation and wildlife on mineral extraction sites on New Jersey's southern coastal plains. Describes the areas lakes, ponds, marshes, bogs, and uplands. More than 190 species of vertebrates use these sites.

617. Lombardo, P. S., and T. Neel. 1987. Design of a submerged aquatic off-shore wetland for disposal of treated wastewater effluent in Chesapeake Bay. Pages 147–157 *in* F.J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: ECON

Genus: *Potamogeton, Ruppia, Scirpus, Typha*

Describes the $56 million water reclamation scheme for Mayo Peninsula, Maryland, which uses alternative and on-site wastewater treatment methods. The scheme involves use of individual septic systems, cluster leaching fields, sand filters, freshwater emergent wetlands, ultraviolet disinfection, peat wetlands, and off-shore wetlands. Man-made off-shore submerged wetlands will be the final step of the process, dispersing treatment system effluent into the Rhode River. Other benefits of the off-shore created wetland include additional nitrogen and phosphorous removal.

618. Lorenzen, M. W. 1973. Predicting the effects of nutrient diversion on lake recovery. Pages 205–211 *in* E.J. Middlebrooks, D.H. Falkenborg, and J.E. Maloney, eds. Modeling the eutrophic process. Utah State University, Water Research Laboratory, Logan.

Response: None

Genus: None

Summarizes derivations of three nutrient exchange models used to predict lake recovery. Model I considers the annual net loss of a nutrient to the sediment, proportional to the average concentration of that nutrient in the water. Model II considers both loss to the sediments and return from the sediments as independent processes and assumes that the nutrient concentration in the sediment does not change over time. Model III considers coupled equations describing transfer into and out of sediments. Predicted results can vary substantially among the three models. Recommends further investigation, including field testing, of Model III.

619. Los Angeles Harbor Department, EDAW Inc. 1982. Cabrillo salt marsh construetion. Page 100 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: None

Genus: None

Describes the planning of construction of a 2-ha (5-acre) marsh in the West Channel-Cabrillo Beach recreational complex in Los Angeles. The marsh will be created for biological compensation of U.S. Army Corps of Engineers filling activities. Goals include: provision of viable fish habitat, public

education and recreation, studies of marsh management techniques, and enhancement of intertidal wetland ecosystems. Describes major features of the planned marsh. Standard commercial landscaping methods will be used, so that the project can be bid and built by commercial contractors. Describes hydroseeding, transplanting of native salt marsh vegetation, and temporary supplemental irrigation are described as part of the marsh creation plan.

620. Lum, A. L. 1978. Shorebird fauna changes of a small tropical estuary following habitat alteration: biological and political impacts of environmental restoration. Environ. Manage. 2(5):423–430.

Response: SHOREB, SUCCESS

Genus: None

Describes a project to "restore" Paiko Lagoon, Oahu, Hawaii. The site was a mixture of intertidal and subtidal areas, commonly used by lesser golden-plover (*Pluvialis dominica*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), wandering tattler (*Heteroscelus incanus*), and black-necked stilt (*Himantopus mexicanus*). Local residents requested a habitat improvement project (actually a project to improve aesthetics of the lagoon) that resulted in the leveling of intertidal bars, dredging to a depth of 1 m (4 feet), removal of mangrove vegetation, and creation of small dredged spoil islands. Studies of the effect of the project on shorebirds revealed that bird counts were significantly reduced for three of the five species censused. Discusses political implications. In this case, residents were mistaken in their assumption that because the lagoon was made more aesthetically appealing, its value as wildlife habitat also was increased.

621. Lunz, J. D. 1978. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix E: environmental impacts of marsh development with dredged material: metals and chlorinated hydrocarbons in marsh soils and vascular plant tissues. U.S. Army Eng. Waterways Exp. Stn. Vicksburg, Miss, Tech. Rep. D-77-23. 88 pp.

Response: VEG, SOIL, CHEM

Genus: *Bidens, Echinochloa, Peltandra, Pontederia, Sagittaria, Typha*

Describes the collection and analysis of plant tissue and soils to determine concentrations of metals and chlorinated hydrocarbons. Selected freshwater vascular plants were collected from a dredged material marsh (Windmill Point, James River, Virginia, and two natural reference marshes (Ducking Stool Point and Turkey Island). Plant species with value as food for wildlife were collected and sampled. The experimental marsh plants had higher concentrations of DDE, Kelthane, and nickel. Soils from that marsh had higher concentrations of chromium, cadmium, lead, DDD, Kepone, Chlordane isomers, and Arochlor 1260 (PCB); natural marsh soils had higher concentrations of nickel and zinc. Discusses transfer routes between soil and plants.

622. Lunz, J. D., R. J. Diaz, and R. A. Cole. 1978. Upland and wetland development with dredged material: ecological considerations. U.S. Army Eng. Waterways Exp. Vicksburg, Miss. Tech. Rep. DS-78-15. 50 pp.

Response: VEG, INVERT, FISH

Genus: Many

Provides an overview of ecological considerations for the planning and management of habitat development on dredged material disposal areas. Discusses: historical precedence for habitat development, ecological management philosophy, ecological theories on biota-habitat interactions, general design considerations for habitat development, and special considerations (i.e., habitat displacement, life span of developed habitat, response of target populations, and chemical mobilization within the habitat).

623. Lunz, J. D., T. W. Zeigler, R. T. Huffman, R. J. Diaz, E. J. Clairain, and L. J. Hunt. 1978. Habitat development field investigations, Windmill Point Marsh development site, James River, Virginia; summary report. U.S. Army Eng. Waterways Exp. Stn. Vicksburg, Miss. Tech. Rep. D-77-23. 116 pp.

Response: FISH, NGBIRDS, SHOREB, WFOWL, INVERT, VEG, ECON, SOIL, CHEM

Genus: *Acer, Alnus, Alopecurus, Amaranthus, Artemisia, Bidens, Boehmeria, Cassia, Celtis, Chenopodium, Cyperus, Dactylis, Datura, Digitaria, Echinochloa, Eclipta, Eleocharis, Eleusine, Eragrostis, Erianthus, Eupatorium, Festuca, Fimbristylis, Galium, Gratiola, Hibiscus, Hypericum, Impatiens, Juncus, Leersia, Lindernia, Liriodendron, Lolium, Ludwigia, Mikania, Mollugo, Oenothera, Oxalis, Panicum, Paspalum, Peltandra, Penthorum, Phytolacca, Pilea, Platanus, Polygonum, Pontederia, Populus, Potentilla, Ranunculus, Rorippa, Rotala, Rumex, Sagittaria, Salix, Scirpus, Solanum, Spartina, Taxodium, Trifolium, Typha, Veronica, Viola, Xanthium, Zea*

Describes the development of marsh habitat on fine-textured, nutrient-enriched dredge material from the James River Channel. A sand dike was constructed to contain sediment. Six months after construction, the substrate contained about 75 plant species, and planting was deemed unnecessary. Ecological monitoring and experimental studies were conducted on plants, soils, sediment, water quality, fish, invertebrates, wildlife, and plant uptake of metals and chlorinated hydrocarbons. The dredged material marsh produced habitat of value to fish and a variety of birds.

624. Lunz, J. D., T. W. Zeigler, R. T. Huffman, R. J. Diaz, E. J. Clairain, and L. J. Hunt. 1978. Habitat development field investigations, Windmill Point Marsh development site, James River, Virginia; Appendix D: environmental impacts of marsh development with dredged material: botany, soils, aquatic biology, and wildlife. U.S. Army Eng. Waterways Exp. Stn. Vicksburg Miss. Tech. Rep. D-77-23. 510 pp.

Response: FISH, INVERT, SHELLF, WFOWL, NGBIRDS, VEG, ECON

Genus: *Alnus, Bidens, Dactylis, Eupatorium, Festuca, Impatiens, Panicum, Peltandra, Polygonum, Pontederia, Sagittaria, Scirpus, Trifolium, Typha, Zizania*, many

Describes the environmental effects of marsh habitat development at Windmill Point, James River, Prince George County, Virginia. A 5.7-ha island composed of dredged material was graded, planted, and seeded; changes in the biota were observed after 1 year and were compared to nearby marsh-upland reference areas. Four major plant zones were arrowhead-pickerelweed (*Sagittaria-Pontederia*; low marsh), beggar tick (*Bidens*; higher marsh), panic grass (*Panicum*), and a small wooded zone. Species distribution and zonation were primarily influenced by elevation and tidal inundation. Within 1 year, much of the vegetation was destroyed by animal activity (i.e.,

Canada geese [*Branta canadensis*]). Describes observations and measurements of benthie biota, fish, birds, mammals, plants, and soils.

625. Lyon, J. T., III. 1975. A comparison of epiphytes on natural and planted *Spartina alterniflora*) marshes. M.S. thesis, North Carolina State University, Raleigh. 48 pp.

Response: VEG

Genus: *Spartina*

Compares produetion of epiphytes on smooth eordgrass (*Spartina alterniflora* from natural and planted dredge spoil marshes at Beaufort and along the Cape Fear River near Snow's Cut, North Carolina. Epiphytes consisted mainly of green or blue-green algae, intermixed with detritus, inorganie material, protozoans, bacteria, and barnaeles. Estimates of annual produetion from standing crop and carbon-14 uptake data indicated that epiphytes in planted marshes were comparable to those in natural marshes. Epiphytie production in salt marshes is not significant when compared to dry matter produced by *Spartina*, but epiphytic algae are a more easily available and easily digested food source and an important component of marsh-estuarine systems.

626. Madsen, C. 1986. Wetland restoration: a pilot project. J. Soil Water Conserv. 41(3):159–160.

Response: WFOWL, ECON

Genus: None

Describes a pilot program in three western Minnesota counties to pay landowners for the use of drained wetlands. Three critical elements are a willing landowner, funds for restoration, and technical guidance. The prospective wetlands were selected by proximity to existing wetlands, present use of drained wetlands, and the relative difficulty of restoring drained wetlands. Ditch plugs or tile blocks were installed in the selected sites to provide an optimum water depth. Adjacent land was planted with nesting cover and uplands were planted with nonuse grass, delayed alfalfa harvest, or no-till small grain. Budget development costs were $64/ha.

627. Madsen, C. R. 1988. Wetland restoration in western Minnesota. Pages 92–94 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: WFOWL, VEG, ECON

Genus: None

Discusses the U.S. Fish and Wildlife Service's (FWS) program to restore selected drained wetlands on private land in western Minnesota. Annual wetland rent payments for 10-year contracts were offered to selected landowners in three counties during a pilot program. Service paid the annual rent for the wetland and Ducks Unlimited and local user groups paid the development costs. On 90 farms,603.5 ha (1,490 acres) of wetlands were restored by interrupting drainage facilities and seeding adjacent land to permanent grass cover. Wetlands were quickly revegetated with hydrophytes; waterfowl and other wildlife immediately returned to the wetlands after flooding. The FWS, cooperatively with the Soil Conservation Service, Ducks Unlimited, and other user groups, is working to restore wetlands on conservation reserve land to take advantage of opportunities to restore wetlands that might otherwise be lost.

628. Magnuson, J. J., H. A. Regier, W. J. Christie, and W. C. Sonzogni. 1980. To rehabilitate and restore Great Lakes ecosystems. Pages 95–112 *in* J. Cairns, Jr., ed. The recovery process in damaged ecosystems. Ann Arbor Scientifie Publications, Ann Arbor, Mieh.

Response: FISH, HYDRO, CHEM, WQUAL

Genus: None

Focuses on the feasibility of rehabilitating the Great Lakes ecosystems. Discusses the historical perspectives of both ecosystem degradation and rehabilitation efforts. Phosphorus loading from munieipalities and diffuse sourees, microcontaminants (e.g., PCBS, DDT, and Mirex), and physical modification of habitat (e.g., shoreline dredging) are targets for rehabilitation efforts. Presents suggestions for the restoration of desirable fish populations through selective reduetion of undesirable species. Discusses an outline of rehabilitation approaehes for the Great Lakes in light of aetual feasibility of sueh aetions.

629. Maguire, J. D., and G. A. Heuterman. 1978. Influence of pregermination conditions on the viability of selected marsh plants. U.S. Army Eng. Waterways Exp. Stn. Vicksburg, Miss. Tech. Rep. D-78-51. 106 pp.

Response: VEG

Genus: *Borrichia, Carex, Deschampsia, Iva, Juncus, Sagittaria, Salicornia, Scirpus, Spartina*, many

Describes the results of laboratory tests to determine the viability, germination, and storage requirements of seeds from 13 marsh plant species found in a variety of wetland types throughout the United States and considered best suited for wetland establishment. Tables provide analyses of effects of storage, salt solution, and temperature on various plant species. Optimum storage conditions, thermoperiods, and seed germination duration also are recorded. Direct seeding is a viable method of plant establishment on both dredge material and natural marsh substrate. Seeds also may be used to produce transplants for nursery operations.

630. Maiero, D. J., R. W. Castle, and O. L. Crain. 1978. Protection, cleanup and restoration of salt marshes endangered by oil spills: a procedural manual. U.S. Environ. Prot. Agency, Cincinnati, Ohio EPA-600/7-78-220. 153 pp.

Response: None

Genus: *Avicennia, Juncus, Laguncularia, Rhizophora, Spartina*

Addresses protection, cleanup, and restoration phases of spilled oil endangering or contaminating tidal marshlands. The manual follows a step-by-step approach to response actions. Includes oil classification, marsh classification, protective measures, cleanup measures, restoration, and waste handling. Includes recovery evaluation of the need for restoration versus natural recovery, and restoration techniques, including transplanting marsh vegetation and seeding.

631. Maltby, E. 1986. Soils seience base for freshwater wetland mitigation in the northeastern United States. Pages 17–52 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass. Amherst, Publ. 87–1.

Response: SOIL, CHEM, SUCCESS

Genus: None

Describes in detail the relevance of soil characteristics to almost all of the major freshwater wetland functions. Describes soil chemical processes, including effects of waterlogging, oxidized soil layers, nutrients, heavy metals, and accumulation of

organic matter. The organic horizon component of a wetland system is practically impossible to recreate. Includes guidelines for mitigation consideration of the functional effectiveness and long-term success potential of the soils component of the mitigation effort.

632. Mangrove Systems, Inc. 1985. Florida Keys seagrass restoration. Phases I, II. Combined final report. Mangrove Systems, Inc., Tampa, Fla. 75 pp.

Response: VEG, SUCCESS

Genus: *Halodule, Syringodium, Thalassia*

Discusses restoration of seagrass meadows destroyed as a result of bridge construction in the Florida Keys. Of the 26.6 ha (65.8 acres) destroyed, 12.4 ha (30.5 acres) were considered nonrestorable. Restoration consisted of planting primarily *Halodule wrightii* shoots anchored with either staples or nails to the substrate on 13.5 ha (33.3 acres) of destroyed meadows and on 5.6 ha (14.2 acres) of compensatory meadows. Overall success rate of the plantings was 72.8%. Inclues specific information on planting success at the 27 sites planted and recommendations for future plantings.

633. Mangrove Systems, Inc. 1986. Donn Acres Monitoring Report, North Miami, Dade County, Florida. Mangrove Systems, Inc., Key Biscayne, Fla. Unpubl. Rep. 18 pp.

Response: VEG

Genus: *Avicennia, Halodule, Laguncularia, Paspalum, Rhizophora, Spartina*

Presents results of mangrove, cordgrass (*Spartina*), and sea grass plantings at a 13.4-ha (33-acre) site in North Miami, Florida. As mitigation for development of the Donn Acres project, a 13.4-ha (33-acre) lake was excavated and 92,600 mangrove propagules were broadcasted onto 6.1 ha (15 acres), 76,600 smooth cordgrass (*Spartina alterniflora*) were planted as nurse plants for the mangroves, and 1,280 *Halodule wrightii* and 6,525 knotgrass paspalum (*Paspalum distichum*) were planted to stabilize shorelines. After 94 days, mortality of mangroves exceeded 85% at most plots. Cordgrass plants increased from 519 to 875%. Seagrass survival was poor, possibly due to competition from a red alga. The overall success of the planting effort was unclear and future monitoring was seheduled.

634. Marshall, A.R. 1980. Restoring the Florida Everglades. Pages 153–160 *in* R. C. Carey, P. S. Markovits, and J. B. Kirkwood, eds. Proceedings U.S. Fish and Wildlife Service workshop on coastal ecosystems of the southeastern United States. U.S. Fish Wildl. Serv., FWS/OBS-80/59.

Response: None

Genus: None

Presents an overview of the past and present condition of the Florida Everglades. The many adverse effects on this system, resulting from an array of human activities, projects, and priorities, are discussed in terms of changes to the original system. Emphasizes holistic principles of ecosystems. To restore the Everglades effectively, interrelations among a large number of agencies, concerns, and engineering projects and information from a number of scientific fields must be examined and understood. Describes a proposal to begin restoration work. The proposal includes five first-stage objectives and is being considered at the U.S. Department of the Interior level for the Everglades Protection Association.

635. Maryland Department of Natural Resources. 1982. Experimental planting of bay grasses. Md. Dep. Nat. Resour. Leafl.

Response: VEG

Genus: *Ceratophyllum, Elodea, Myriophyllum, Najas, Potamogeton, Ruppia, Vallisneria, Zannichellia, Zostera*

Reviews techniques for establishing bay grass and seagrass beds in Chesapeake Bay, Maryland. Factors to consider before transplanting are depth, turbidity, wave and tidal action, salinity, plant source, bottom composition, and time required to complete the work. If seagrasses are found within a 1.6- to 3.2-km (1- to 2-mile) radius of the replanting site, suitable conditions for transplant survival and growth are probably present. Discusses methods for transplanting.

636. Mason, H. L. 1980. Techniques for creating salt marshes along the California coast. Pages 23–24 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG

Genus: *Salicornia, Spartina*

Describes several techniques for creating salt marshes along the California coast near San Francisco Bay. Cordgrass (*Spartina*) seeds were harvested, stored, and planted. Seeds planted at the same time germinated at different rates over a period of about 1 month. Of the seeds planted on barren dredged spoil material, those that were fertilized showed the best growth 3 years after fertilization.

637. Matter, W. J., and R. W. Mannan. 1988. Sand and gravel pits as fish and wildlife habitat in the southwest. U.S. Fish Wildl. Serv., Resour. Publ. 171. 11 pp.

Response: MAMMALS, WFOWL, SHOREB, NGBIRDS

Genus: Many

Describes the reclamation of disturbed riparian land for fish and wildlife habitat in the arid southwest. Depth, shoreline shape and slope, area and location of sand and gravel pits, and plant species that revegetate disturbed areas can be managed to influence subsequent colonization by animals. Monitoring of critical habitat features, plants, and animals is necessary to document reclamation effectiveness. Includes development of artificial backwaters in floodplains.

638. Mattson, C. P., N. C. Vallario, D. J. Smith, S. Anisfield, and G. Potera. 1977. Hackensack estuary oil spill: cutting oil-soaked marsh grass as an innovative damage control technique. Pages 243–246 *in* Proceedings, 1977 Oil Spill Conference (prevention, behavior, control, cleanup). American Petroleum Institute, Washington, D.C.

Response: VEG, SOIL

Genus: *Spartina*

Presents a marsh grass-cutting technique used as a corrective measure to control an oil spill in the Hackensack River Estuary, New Jersey. On 26 May 1976, a 7.5-million L (2-million gal) oil spill, originating at a riverside tank farm in Jersey City, struck the estuary. On-going hydrology research in velocity and water distribution patterns predicted slick movement. Salt marsh areas were quickly cut. After 5 months, assessment of vegetation and soils indicated that the technique, when quickly applied, was effective where tidal flushing was poor. Delayed cutting in these areas resulted in little regrowth due to prolonged exposure to toxic substances. On well-washed marsh

areas, natural cleansing was a more suitable choice due to unstable muds, which eroded excessively if vegetation was cut.

639. Maugh, T. H., II. 1979. Restoring damaged lakes. Science 203(4379):425–427.

Response: SOIL, CHEM, WQUAL

Genus: None

Presents an overview of lake restoration programs, particularly those of Washington State and the Great Lakes region, and briefly discusses some lake restoration techniques. Discusses sewage treatment, dilution, harvesting plants, chemical precipitants, aeration, and sediment removal by dredging.

640. McBride, J. R., and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. Am. Midl. Nat. 112(2):235–245.

Response: VEG

Genus: *Alnus, Baccharis, Populus, Salix*

Discusses factors influencing woody riparian seedling establishment and survival on gravel bars of Lower Dry Creek, Sonoma County, California. Seedlings became established from May to July. Willow (*Salix* sp.) established preferentially on areas where surface sediment size was < 0.2 cm. Fremont cottonwood (*Populus fremontii*) established more densely on areas of intermediate and large-sized sediments (0.2–1.0 cm). *Baccharis viminea* dominated on the larger sediment sizes. Drought-induced mortality of seedlings was higher on bars where the stream had dried up completely before 1 September. Seedlings established in areas protected from the swiftest current were able to withstand high winter flows.

641. McCaffrey, C. A., and F. G. Buckley. 1978. Use of dredged material islands by colonial seabirds and wading birds in New Jersey. U.S. Army Eng. Waterways Exp. Vicksburg, Miss. Tech. Rep. D-78-1. 225 pp.

Response: NGBIRDS, SHOREB

Genus: Many

Describes a study that assessed vegetative distribution and succession on dredged material islands in relation to interactions and distribution of nesting colonial birds. The study was conducted along the New Jersey Intracoastal Waterway between Cape May Inlet and Manasquan Inlet. Bird surveys were conducted in 1977 using helicopters. Vegetative communities were mapped using aerial photographs and field reconnaissance. Studies 21 dredged material islands in detail. The importance of dredged material islands for colonial seabird and shorebird populations was dependent on the vegetation present. The most important plant communities were common reed (*Phragmites australis*), reed-shrub, and grasslands. Approximately 52,000 pairs (16 species) of birds nested in the study area.

642. McCaffrey, P. M., J. B. Cruce, J. Hall, M. Palmer, and L. Perrin. 1985. Comments on the Kissimmee River restoration project, and responses. Pages 3–26 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: HUSE, HYDRO, ECON

Genus: None

Addresses concerns past and proposed alterations of the Kissimmee River in Florida. Current proposals seek to restore flow to about 66 km (41 miles) of original river channel between Lake Kissimmee and Lake Okeechobee; the section was channelized during 1962 to 1971. Discusses flooding considerations, costs of restoration, and environmental benefits. Representatives from the U.S. Army Corps of Engineers, the South Florida Water Management District, Florida Department of Environmental Regulation, and the Kissimmee River Restoration Project discuss administrative aspects and pros and cons of this issue.

643. McCaffrey, P. M., W. W. Hinckley, J. M. Ruddell, and S. E. Gatewood. 1977. First annual report to the Florida legislature. Coordinating council on the restoration of the Kissimmee River Valley and Taylor Creek-Nubbin Slough Basin, Tallahassee, Fla. 660 pp.

Response: None

Genus: None

Consists of the plan recommended by the coordinating council on the restoration of the Kissimmee River Valley and Taylor Creek-Nubbin Slough Basin to prevent eutrophication of Lake Okeechobee, Florida, by restoring the Kissimmee River and improving water quality of the valley. The primary source of the nutrient problems is runoff from agricultural land uses. Discusses the upland detention-retention system to remove nutrients from runoff water, the feedlot runoff problem of Taylor Creek-Nubbin Slough Basin, alternative restoration plans for Kissimmee River Valley, and legal implications of the proposed plan. The appendixes contain detailed minutes and reports from council meetings concerning restoration of the valley.

644. McCluskey, D. C., J. Brown, D. Bornholdt, D. A. Duff, and A. H. Winward. 1983. Willow plantings for riparian habitat improvement. U.S. Department of the Interior, Bureau of Land Management, Denver, Colo. 20 pp.

Response: VEG

Genus: *Salix*

Presents guidelines for planting willows (*Salix*) to improve riparian habitat. Includes: evaluating streams for willow production potential and suitability for fish and wildlife habitat, planting willow stocks, making stem cuttings for planting, treating stem cuttings with hormones and fungicides, spacing of plantings, and maintaining the project site (e.g., fencing, pest control). Using methodologies outlined in this report, the Bureau of Land Management's Salt Lake District has achieved an 80% rate of successful willow establishment.

645. McConnell, C. A. 1979. Stream channel renovation methods to mitigate natural resource losses. Pages 611–614 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: HYDRO

Genus: None

Provides a brief description of the renovation of 34 km (22 miles) of the Wolf River, Tennessee. The river was blocked by fallen trees, debris, and excessive sedimentation. Guidelines were developed to specify renovation activities (e.g., debris and vegetation removal, planting). Only those obstructions that caused a significant blockage of river flow were to be removed. Stumps and roots were left undisturbed for erosion control and bank stabilization. Includes revegetation of all disturbed areas for wildlife habitat and soil stabilization.

646. McConnell, D. L., and D. E. Samuel. 1985. Small mammal and avian populations utilizing cattail marshes on reclaimed sur-

face mines in West Virginia. Pages 329–336 *in* R.P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands. Pennsylvania State University, University Park.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, CHEM, WQUAL

Genus: *Typha*

Discusses small mammal and avian populations in three cattail (*Typha*) marshes on reclaimed surface mine areas in Northeastern West Virginia. Water quality was variable at the sites, but iron and sulfates improved at outlets of three sites and magnesium at two sites, compared to inlet readings. Small-mammal trap success was higher in marsh areas compared to adjacent reclaimed grass-legume fields. Small mammals seemed to concentrate in the cattails during spring and fall. Marshes also attracted more birds than surrounding reclaimed mined land. Species richness was greater in the marshes.

647. McCreary, S. 1982. Legal and institutional constraints and opportunities in wetland enhancement. Pages 39–52 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: None

Genus: None

Describes the legal, institutional, and management aspects and perspectives of wetland restoration projects. Discusses State and Federal wetland policies and management, institutional issues and land acquisition, watershed and ecosystem management, scientific information relating to wetlands enhancement, and other topics pertinent to wetland restoration activities. Lists 10 recommendations for more effective restoration efforts.

648. McElligott, M. J. 1985. Effects of routing a stream through a surface-mine lake. Pages 303–312 *in* D. H. Graves and R. W. Devore, eds. Proceedings 1985 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, EOS Publications, Lexington.

Response: FISH, INVERT, CHEM, WQUAL

Genus: None

Compares the water quality and benthic and fish communities of six surface mine lakes of St. Clair County, Illinois. Three of the lakes were traversed by surface streams. The stream-influenced lakes had higher diversity and standing erop values for fish, higher benthie diversity and equitability values, adequate phosphorus levels for good productivity, and lower salinity values. Two of the three lakes not influenced by streams had phosphorus values low enough to render them oligotrophie.

649. McIntosh, D. F., and E. B. Mehta. 1977. Federal restoration remedies. Fla. Bar J. 51(3):155–158.

Response: None

Genus: None

Discusses two basie objectives of proposed restoration plans: recapture lost habitat or its equivalent and meet Federal water quality standards by the most economical, least disruptive methods. Discusses legal consequences of the Federal Water Pollution Control Act of 1972 and criteria for restoration enforcement. A minimum of three witnesses was recommended for meeting the court's restoration criteria: a biologist, an architect or civil engineer, and an accountant. Discusses restoration objectives and specific minimal legal requirements for dissolved oxygen and identifies fill depth for mangrove and seagrass systems.

650. McKendrick, J. D. 1987. *Arctophila fulva* for revegetating arctic wetlands. Restor.Manage. Notes 5(2):93.

Response: VEG

Genus: *Arctophila*

Describes the initial steps of a 5-year study on the use of the aretie grass pendont *Arctophila fulva* for revegetation of shallow ponds and slow moving stream areas in Alaska. Initial results indicate that by accelerating the spring thawing of ponds, *A. fulva* provides open water for birds in early spring. Natural stands are used as a source for vegetative propagation; this seems to be a more praetical approach than procurement of seed from *A. fulva* "crops."

651. McLaughlin, P. A., and A. Thorhaug. 1978. Restoration of *Thalassia testudinum*: animal community in a maturing four-year-old site: preliminary results. Pages 149–161 *in* D.P. Cole, ed. Proceedings Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, SHELLF, VEG

Genus: *Halodule, Thalassia*

In August and September 1973, the first documented effort to replant seagrass in large scale by seed was conducted at an effluent site at Turkey Point, Biscayne Bay, Florida. Effluents had completely denuded the seagrass bed. Eight months after planting *Thalassia testudinum* seedlings at various intervals with anchor and no anchor treatments, about 80% of the seedlings had survived. The purpose of the study was to ascertain animal communities that recolonized the restored area and to compare these communities with control areas. The restored areas had large numbers of commercially important peneaid and caridean shrimp. Species diversity and total abundance of fishes, annelids, molluscs, and isopods increased over time in the restored areas.

652. McMillan, C. 1970. Environmental factors affecting seedling establishment of the black mangrove on the Central Texas coast. Ecology 52(5):927–930.

Response: VEG

Genus: *Avicennia*

Describes effects of salinity, water turbulence, depth, and temperature on the establishment of black mangrove (*Avicennia germinans*) seedlings from the central coast of Texas. Effects were evaluated under laboratory conditions. Uprooted seedlings exhibited tolerance to a broad range of salinities. Water turbulence inhibited root and seedling development. Seedlings grew roots in various water depths, but did not become established until depths decreased to 5 cm or less. Seedlings rooted throughout a range of temperatures; stemless rooted seedlings were killed when exposed to 39–40° C for 48 h, but rooted seedlings with stems and leaves survived. Includes field observations.

653. McMillan, C. 1980. Culture methods. Pages 57–68 *in* R. C. Phillips and C. P. McRoy, eds. Handbook of seagrass biology: an ecosystem perspective. Garland STPM Press, New York.

Response: VEG

Genus: *Cymodocea, Enhalus, Halodule, Posidonia, Syringodium, Thalassia, Zostera*

Describes techniques for culturing seagrasses. An overview of about 10 studies, including information on time of transplanting, duration of culture, type of study, type of container, substrate and water depth, temperature, CO^2, aeration, and salinity. Reviews results of laboratory studies.

654. McMullen, J. M. 1988. Selection of plant species for use in wetlands creation and restoration. Pages 333–337 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: FISH, VEG, HYDRO, SOIL, CHEM, WQUAL, MAMMALS, WFOWL, NGBIRDS, SUCCESS

Genus: *Carex, Cornus, Potamogeton, Quercus, Sagittaria, Salicornia, Salix, Sparganium, Typha, Viburnum*, many

Discusses the various factors that influence selection of plant species for wetland creation or restoration efforts. Objectives of the restoration plan determine whether plant species with wildlife value or aesthetic qualities (or both) should be emphasized and determine mix of different wetland types to be created. Objectives also can include or determine whether plants with stabilization qualities should be emphasized. Includes examples of plant species to be used to fulfill each of these objectives. Success of plantings is influenced by the accuracy of the predictions made during the planning process; water levels are most important. Other physical factors, time of plantings, type of stock material, and monitoring plans also are among the factors that determine success.

655. McVay, M. E., P. E. Heilman, D. M. Greer, S. E. Brauen, and A. S. Baker. 1980. Tidal freshwater marsh establishment on dredge spoils in the Columbia River Estuary. J. Environ. Qual. 9(3):488–493.

Response: VEG

Genus: *Carex, Deschampsia*

Describes the establishment of tufted hairgrass (*Deschampsia cespitosa*) and slough sedge (*Carex obnupta*) on an intertidal dredge spoil area at miller sands in the Columbia River Estuary. Seeds and transplants were collected from nearby areas. In terms of biomass and seed production, *D. cespitosa* seems to be better suited for marsh establishment on this type of site, even though it is more sensitive to low fertility. *Carex obnupta* is fairly unresponsive to fertilizer treatment and is suited for infertile sandy spoil areas. *Deschampsia cespitosa* may require fertilizer on sandy spoil material at elevations above mean lower low water.

656. Meeks, R. L. 1969. The effect of drawdown date on wetland plant succession. J. Wildl. Manage. 33(4):817–821.

Response: MAMMALS, WFOWL, VEG

Genus: *Asclepias, Calamagrostis, Echinochloa, Eleocharis, Hibiscus, Polygonum, Sagittaria, Scirpus, Sparganium, Typha*, many

Describes a study that tested manipulations of water at the Winous Point Shooting Club in Ohio. Periodic drawdowns were initiated to increase natural vegetative productivity and enhance wildlife values. The entire study area was first drained in July 1956 and reflooded in September. One unit was drained in each of the following 6 years. The vegetation was mapped each August to determine the area occupied by the dominant species. A table describes percent cover for nine species in March, April, May, and June drawdowns for 1956–62. Discusses general conclusions and advantages of partial drawdowns (for wildlife habitat).

657. Mendelssohn, I. A., and E. D. Seneca. 1980. The influence of soil drainage on the growth of salt marsh cordgrass *Spartina alterniflora* in North Carolina. Estuarine Coastal Mar. Sci. 11:27–40.

Response: VEG

Genus: *Spartina*

Discusses the influence of soil drainage on the growth of salt marsh smooth cordgrass (*Spartina alterniflora*) in Oak Island Marsh, southeastern Notrth Carolina, and in laboratory experiments. The occurrence of the height forms of *Spartina* was directly related to marsh soil drainage and aeration in the natural marsh. When the degree of soil drainage was manipulated in greenhouse experiments under low nutrient regimes, biomass production of tall and medium *Spartina* was greatest when the soil-root system was undrained. Short *Spartina* was relatively unaffected by the soil drainage treatments. In phytotron greenhouse experiments under high nutrient regimes, the biomass of tall *Spartina* transplants also increased as soil drainage decreased; however, stagnant conditions (5-cm constant water level) resulted in the least growth.

658. Menendez, R. 1972. Limestone treatment of an acid stream: effects on chemistry, benthos, and trout. W. Va. Dep. Nat. Final Rep. D-J-Proj. F-12-R. 133 pp.

Response: FISH, INVERT, CHEM, WQUAL

Genus: *Salicornia, Spartina*

Discusses the effects of limestone treatment on the chemistry, benthos, and trout of Otter Creek, an acidic stream in northern West Virginia. Neutralization of the natural acid load was achieved by tumbling limestone aggregate in a steel drum rotated by stream flow. During 4 years of treatment, no noticeable changes occurred in the distribution or abundance of the benthos that could be attributed to the limestone neutralization. Standing crop of trout increased about 28 kg/ha (25 lbs/acre) in a 1.6-km (1-mile) section below the treatment station. The influence of acid tributaries reduced the effects of treatment in downstream areas.

659. Metz, E. D. 1986. Restoration of an urban coastal wetland system (California). Restor. Manage. News 4(1):28.

Response: NGBIRDS, VEG

Genus: *Salicornia*

Describes the planned restoration of an 84-ha coastal wetland in Los Angeles. This wetland supports glasswort (*Salicornia*), which is critical habitat for the endangered Belding's savanna sparrow (*Passerculus sandwichensis*) . The restoration will take place in phases to produce a reduced tidal regime to preserve *Salicornia* habitat. A series of automated slide gates and cells within the wetland will result in different hydraulic regimes for various areas of the wetland.

660. Metz, E. D. 1987. Guidelines for planning and designing a major wetland restoration project: Ballona Wetland Case Study. Pages 80–87 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: SHOREB, VEG, HUSE, HYDRO, ECON

Genus: None

Describes the planning and design for the restoration of Ballona Wetland in Los Angeles, California. In this 87.5-ha

(216-acre) area, 61 ha (150 acres) of saltwater wetlands and 10.3 ha (25.4 acres) of freshwater wetlands will be restored, along with adjacent dunes, coastal strands, coastal sage scrub, and grassland savannah. Discribes the regulatory context and funding sources. Analyzes goals and objectives and long-term management is planned.

661. Meyer, J. L. 1985. A detention basin/artificial wetland treatment system to renovate stormwater runoff from urban, highway, and industrial areas. Wetlands 5:135–146.

Response: HUSE, SOIL, CHEM, WQUAL, ECON, SUCCESS

Genus: *Nuphar, Phalaris, Phragmites, Typha*

Describes an artificial wetland system that can be used to treat stormwater runoff and other wastewater. Describes and illustrates the design criteria for a detention basin-artificial wetland treatment system. This system treats both the dissolved and solid components of stormwater runoff by sedimentation, filtration, and pollutant absorption. Discusses artificial wetland hydrology, substrate, vegetation and litter, and pollutant removal effectiveness. Overall pollutant removal of the system varied from 90 to 99% (90% removal of nitrogen and phosphorus and 100% removal of contaminants associated with particulate material).

662. Michalski, M. F. P., D. R. Gregory, and A. J. Usher. 1987. Rehabilitation of pits and quarries for fish and wildlife. Ontario Ministry of Natural Resources, Canada. 59 pp.

Response: FISH, WFOWL, VEG, SUCCESS

Genus: Many

Provides a detailed description of six steps for successful rehabilitation of sand and gravel pits in Ontario, Canada. Identifies preferred after-uses that includes an extensive checklist for choosing site uses and discussion of multiple use and site viability for specific uses. Includes biophysical analysis habitat requirements for species groups and methods for confirming habitat development feasibility. Describes site planning and progressive rehabilitation. Final rehabilitation of the site for fisheries or wildlife include specific guidelines for planting, grading and contouring, and providing cover and other habitat requirements. Resource management is the final step, focusing on maintaining and enhancing wildlife habitat. Appendixes provide additional information on habitat requirements and plant selection.

663. Millar, J. B. 1973. Vegetation changes in shallow marsh wetlands under improving moisture regime. Can. J. Bot. 51:1443–1457.

Response: VEG

Genus: None

Describes vegetation changes in 71 shallow marsh areas near Melfort, Saskatoon, and Swift Current, Saskatchewan, Canada, over a period of about 10 years. Conclusions include: complete conversion of shallow marsh to open water requires at least 2 years of continuous flooding, awned sedge (*Carex atherodes*) may be an indicator of wetlands that are likely to remain as stable shallow marshes, presence of some deep marsh emergents in shallow marshes does not necessarily indicate a wetter moisture regime, the degree of year-round flooding a wetland has experienced is reflected in the presence of rooted submergents, wetlands of less than .4 ha (1 acre) usually have a restricted moisture regime, and vegetation and basin size and depth relations may be used to assess wetland potential for waterfowl production.

664. Millar, J. B. 1971. Shoreline-area ratio as a factor in rate of water loss from small sloughs. J. Hydrology 14:259–284.

Response: WFOWL, HYDRO

Genus: None

Discusses rate of water loss from small sloughs in central Saskatchewan, Canada. Daily rate of shoreline-related seepage loss to groundwater was estimated at .05–.10 cm/305 m (0.02–0.04 in./1,000 feet) of shoreline on heavy lacustrine clay and .17 cm (0.07 in.) on sandy lacustrine material and medium textured glacial till. Up to 60–80% of the shoreline-related water loss was attributed to transpiration by marginal phreatophytic vegetation and evaporation from the soil surface. On the average, shoreline-related water loss accounts for 60% or more of total water loss in sloughs .04 ha (0.10 acres) or less in size and not more than 30–35% of total loss in sloughs larger than .4 ha (1 acre).

665. Miller, A. C. 1979. Development of wildlife compensation features at water resource projects. Pages 615–616 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: None

Genus: None

Describes the use of a modified habitat evaluation procedure by the U.S. Army Corps of Engineers to account for terrestrial habitat changes at two locations: Big Blue Lake, Indiana, and Louisville Lake, Illinois, both proposed lake projects for flood control, recreation, water supply, and fish and wildlife. Describes the flood pool, wetland development, recreation lands, and mitigation and enhancement for wildlife compensation. No new land purchases have been authorized, although additional lands for mitigation purposes were recommended by the U.S. Fish and Wildlife Service.

666. Miller, H. A., J. G. Sampson, and C. S. Lotspeich. 1985. Wetlands reclamation using sand-clay mix from phosphate mines. Pages 193–200 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Acer, Carya, Celtis, Fraxinus, Gordonia, Ilex, Liquidambar, Magnolia, Nyssa, Quercus*

Describes a forested wetland research project in northern Hardee County, Florida. A mixture of sand and clay from phosphate mines was used to create perched water tables at reclamation sites. Six hectares of phosphate mine spoil was divided into five plots. In each plot, a different soil type was spread over the perched water table along an elevation gradient from standing water to high flood stage. A grid planting system was used for testing success of both pure and mixed stands of native hardwood trees in a variety of soil and flood conditions. As the system matures, quantitative data will be generated.

667. Miller, R. J., and E. E. Mackintosh. 1987. Sand and gravel pit rehabilitation in northern Ontario. Ontario Ministry of Natural Resources, Ontario, Can. 24 pp.

Response: VEG, SOIL

Genus: None

Provides an overview of government regulations and policy and approaehes to rehabilitation of sand and gravel pits in northern Ontario, Canada. Outlines rehabilitation in each region of Ontario. Steps for successful rehabilitation include planning, stripping and stockpiling of topsoil, site eleaning and grading, planting and seeding, and postrehabilitation management. Emphasizes the necessity of selecting an after-use for a site before mining begins. Appendixes include additional information on planting suitable species.

668. Miller, T. S. 1987. Techniques used to enhance, restore, or create freshwater wetlands in the pacific northwest. Pages 116–121 *in* K. M. Mutz, and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American West: Eighth Annual Meeting of the Society of Wetland Scientists. Soc. Wetland Scientists, Wilmington, N.C.

Response: SUCCESS

Genus: Many

Provides an overview of techniques and guidelines for wetland creation, restoration, or enhancement. Discusses goals and objectives, site selection, conceptual design plans, site preparation, plant establishment, species diversity, and plant material size. Presents a description of specific activities and goals for the following habitat types: open water, emergent marsh, scrub-shrub swamp, forested swamp, and riparian areas. Describes reasons for failures and ideas for preventing them. It is concluded that the potential for success is greater when there are detailed plans; biologists are involved with construction and planting efforts; a monitoring plan is developed; and there is a contingency plan to be used if components of the original design are not successful.

669. Miller, W. 1988. Plants for man-made wetlands a growth industry. Fla. Environ. (April):1, 17.

Response: VEG

Genus: *Canna, Iris, Juncus, Nuphar, Nymphaea, Panicum, Paspalum, Pontederia, Sagittaria, Scirpus, Spartina*

Provides an overview of wetland plants native to Florida that can be used in wetland restoration projects. Discusses planting zones, depth, plant size, plant source, design of littoral shelves, planting season, and maintenance. Recommendations reflect aquascaping principles, along with wetland restoration or creation considerations.

670. Milleson, J. F. 1976. Environmental responses to marshland reflooding in the Kissimmee River Basin. Resour. Plan. Dep. Cent. S. Fla. Flood Control Dist. Tech. Publ. 76–3. 44 pp.

Response: FISH, INVERT, SHELLF, VEG

Genus: *Bacopa, Hydrochloa, Leersia, Pontederia, Sagittaria*, many

Discusses the responses of fish, shellfish, and vegetation to reflooding of marsh in the Kissimmee River Basin, Florida, after a 4-month drawdown. Populations of fishes, freshwater shrimp, and crayfish, and vegetation biomass increased rapidly during the first 6 months after reflooding. After 22 months of inundation (the end of the study), water levels were decreased and fish and shellfish density increased in deeper portions of the marsh. Plant diversity decreased throughout the study; however, deep marsh plant indicator species increased in percent composition by weight and occurrence. Vegetation biomass declined by the end of the study from its initial doubling within the first 6 months to a loss of 22% of preflooding biomass.

671. Milne, B. S. 1974. Ecological succession and bird-life at a newly excavated gravel pit. Bird Study 21:267–278.

Response: WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Elodea, Juncus, Potamogeton, Ranunculus, Salix, Typha*

Discusses ecological succession and bird use of gravel pits in England. High densities of breeding birds (particularly those species characteristic of bare gravel habitats), migrant waders, and an increasing winter population of dabbling ducks were associated with early ecological stages (while the pit was being actively worked and immediately following gravel extraction). As the pit matured, density and variety of breeding birds sharply declined and diving ducks dominated waterfowl populations on the pits. Includes recommendations for managing gravel pits to promote bird use.

672. Mitchell, D. L. 1981. Salt marsh reestablishment following dike breaching in the Salmon River Estuary. Ph.D. dissertation, Oregon State University, Corvallis. 158 pp.

Response: VEG, SOIL, CHEM

Genus: *Agrostis, Atriplex, Carex, Deschampsia, Distichlis, Eleocharis, Holcus, Hordeum, Juncus, Potentilla, Salicornia, Scirpus, Spergularia, Triglochin*, many

Discusses salt marsh reestablishment following dike breaching of a 22-ha, 15-year-old permanent pasture in the Salmon River Estuary, Lincoln County, Oregon. One year after half the dike was leveled and tidal creeks were reopened, upland pasture species of plants were nearly eliminated. Two years after dike breaching, in areas of high residual species cover, the most successful colonizers were fat-hen saltbush (*Atriplex patula*), *Hordeum brachyantherum*, and Lyngbye's sedge (*Carex lyngbyei*). On areas of mostly bare mud, *Spergularia marina* and *Salicornia virginica* colonized most rapidly. Soils were more anaerobic and had 5–10 ppt greater salinity than control marshes; soil pH was similar. Recommends entire dike removal for future restoration efforts on marshes of the Salmon River Estuary.

673. Mitsch, W. J., M. A. Cardamone, J. R. Taylor, and P. L. Hill, Jr. 1985. Wetlands and water quality management in the Eastern Interior Coal Basin. Pages 121–137 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: VEG, CHEM, WQUAL

Genus: *Betula, Cephalanthus, Dulichium, Eleocharis, Rhynchospora, Saururus, Sphagnum, Typha*

Describes the suitability of wetlands for improving water quality in the coal fields of western Kentucky and southwestern Indiana. Compares streams with and without wetlands by their capacity for removing dissolved substances. Discusses effects of several natural wetland systems on water quality. Describes conductivity, pH, turbidity, dissolved iron and manganese, and sulfate for these systems. Hydrologic concerns and wetland restoration are discussed. Describes alternative ecosystems that are not natural duplicates, but are created specifically for a habitat function.

674. Monsen, S. B. 1983. Plants for revegetation of riparian sites within the intermountain region. Pages 83–89 *in* S. B. Monson and N. Shaw, compilers. Managing intermountain

rangelands—improvement of range and wildlife habitats. U.S. For. Serv. Gen. Tech. Rep. INT-152.

Response: VEG, SOIL

Genus: *Aster, Cornus, Phalaris, Pinus, Populus, Salix*, many

Discusses revegetation of riparian sites within the intermountain region for the control of soil erosion and streambank deterioration. Grazing by livestock has had the most destructive effect on riparian vegetation. Riparian habitats have responded slowly to management and revegetation programs. Reconstruction of the entire plant community may be required for seriously altered sites. Selection of appropriate planting seasons is often difficult due to flooding and high runoff during the optimum planting season. Guidelines are presented on stabilizing sites, controlling weeds, seeding, transplanting, and managing the improved site. Recommended riparian plantings include a list of 25 grasses, 13 forbs, and 36 trees and shrubs adapted to various plant communities of the intermountain west.

675. Montalbano, F., K. J. Foote, M. W. Olinde, and L. S. Perrin. 1979. The Kissimmee River channelization: a preliminary evaluation of fish and wildlife mitigation measures. Pages 508–515 *in* G.A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: FISH, WFOWL

Genus: None

Presents an overview of fish and wildlife habitat mitigation measures implemented because of the channelization of the Kissimmee River, Florida. Mitigation included pool marshes above water control structures along the canal, construction of impounded wetlands and water control structures for waterfowl habitat, placement of dredged material to reduce destruction of critical habitats, construction of fish breeding canals, and deposition of dredged material to maintain access between the canal and remnants of the oxbows and channel of the original river. Evaluates these actions in terms of fish and wildlife habitat improvement. Realization of benefits can occur only with the expenditure of substantial funding for ongoing management of these resources. Such expenses should be considered part of the continuing cost of public works project operation.

676. Montalbano, F., W. M. Hetrick, and T. C. Hines. 1978. Duck foods in central Florida phosphate settling ponds. Pages 247–255 *in* Surface mining and fish/wildlife needs in the eastern United States. Proceedings of a symposium. U.S. Fish Wildl. Serv., FWS/OBS-78/81.

Response: WFOWL

Genus: *Cephalanthus, Cyperus, Dulichium, Echinochloa, Eichhornia, Hydrilla, Leersia, Lemna, Ludwigia, Panicum, Potamogeton, Salix, Scirpus, Typha*

Investigates the potential of phosphate settling ponds in southcentral Florida as wintering habitat for ducks. Ducks were collected from four ponds and their gizzards were analyzed to determine percent composition of food items. Total plant material consumed by 112 specimens was 70.3 by volume; the most common plants were *Cyperus*, *Ludwigia peruviana*, and *Hydrilla*. Observations indicated that waterfowl use was highest on ponds with a high degree of interspersion of open water and emergent vegetation. Recommends periodic drawdowns and reflooding were recommended for retarding expansion of emergent vegetation and maintaining some open water.

677. Mooring, M. T., A. W. Cooper, and E. D. Seneca. 1971. Seed germination response and evidence for height ecophenes in *Spartina alterniflora* from North Carolina. Am. J. Bot. 58(1):48–55.

Response: VEG, CHEM, WQUAL

Genus: *Spartina*

Documents the response of three height forms of smooth cordgrass (*Spartina alterniflora*) to temperature and salinity in water and to assess seed viability. Short and medium plants were collected on Ocracoke Island; tall forms were collected on Oak Island. Seeds were subjected to different temperature and salinity solutions. Optimal germination occurred in 6–8% NaCl at 65–95° F. Germination capacity decreased with increased salinity levels. In addition, the seeds need to be stored in a moist environment over the winter to avoid desiccation, which decreases germination capacity. Differences in height forms resulted from environmental conditions, not genetic differences.

678. Moreno, F., J. Martin, and J. L. Mudarra. 1981. A soil sequence in the natural and reclaimed marshes of the Guadalquivir River, Seville (Spain). Catena 8:201–221.

Response: SOIL, CHEM

Genus: *Beta, Cyperus, Eleocharis, Melilotus, Salicornia, Scirpus, Suaeda, Trifolium*, many

Analyzes five soil profiles from a saline zone and one from an adjacent nonsaline zone in natural and reclaimed marshes of the Guadalquivir River, Seville, Spain. The soils developed after infilling of an ancient lake, which was connected to the open sea, and are composed primarily of nonexpendable clay. Techniques involved in reclaiming the soil were not discussed. Hydraulic conductivity, except in top layers, as well as aeration porosity, were low; nonavailable water holding capacity and linear extensibility were high. Reclamation or permanent agricultural use did not increase the hydraulic conductivity of the profile, although salt content was diminished considerably in top layers.

679. Morris, J. H., C. L. Newcombe, R. T. Huffman, and J. S. Wilson. 1978. Habitat development field investigations Salt Pond No. 3, marsh development site, South San Francisco Bay, California. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss, Tech. Rep. D-78-57. 22 pp.

Response: VEG, SOIL, ECON

Genus: *Salicornia, Spartina*

South San Francisco Bay was the site for a study of marsh development on dredged material. This project sought to determine the optimum elevation and tidal flow necessary for *Spartina* and glasswart *Salicornia* revegetation and to assess costs of planting methods. Two planting methods were used: planting on foot and planting by tractor. Planting was done between April and February on dewatered 2-year-old substrate at 0.5- to 1.0-m intervals. Intervals > 1.0 m did not produce adequate cover over the 2-year study. Hand-planting by walking was the most successful, cost-effective method. *Spartina* have become well established in the lower two-thirds of the intertidal zone and *Salicornia* was successful in the upper third.

680. Morrison, D. G. 1982. Principles of revegetating mined lands. Pages 51–58 *in* W.D. Svedarsky and R. D. Crawford, eds.

Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: VEG, SOIL

Genus: None

Describes the basic concepts involved in the revegetation of mined lands for erosion control, wildlife habitat, and aesthetics. Discusses early successional species characteristics, along with three models of succession: a facilitation model (early successional plants modify the environment so that it becomes more suitable for later successional species), a tolerance model (late successional species are dispersed later or grow more slowly than early successional species), and an inhibition model (halting of a successional sequence by midsuccessional species). Describes alternative strategies for revegetation of mined sites. This paper does not specifically refer to wetland species; however, the concepts are applicable.

681. Morton, J. W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. U.S. Fish and Wildlife Service, Washington, D.C. 33 pp.

Response: None

Genus: None

Provides an overview of the physical, chemical, and biological effects of dredged material disposal on estuarine systems. The most important physical effects are alteration of circulation patterns due to changes in bottom topography, and filling-in of channels, fish spawning areas, and so forth, from long-term erosion of spoil mounds. The most significant chemical effect is the release of heavy metals and other contaminants from dredged materials. Effects on benthic communities include burial, habitat destruction, and uptake and accumulation of contaminants released from polluted sediments. Describes alternative methods of spoil disposal; of these, the most promising is habitat creation. However, contaminant recycling by marsh revegetation is a significant problem that must be addressed before habitat creation is attempted in a specific area.

682. Moss, B. 1983. The Norfolk Broadland: experiments in the restoration of a complex wetland. Biol. Rev. 58(4):521–561.

Response: None

Genus: Many

Provides a detailed description of the Norfolk Broadland, East Anglia, Norwich, Great Britain. Changes in this wetland complex are documented since medieval times. Eutrophication, fish kills, erosion, outbreaks of avian botulism, and decreased fen diversity are identified as major current problems meriting restoration efforts. Various restoration attempts have focused on reducing phosphorus input. Discusses the possible reinstating of a higher intensity of zooplankton grazing.

683. Mulligan, H. F., A. Baranowski, and R. Johnson. 1976. Nitrogen and phosphorus fertilization of aquatic vascular plants and algae in replicated ponds I. Initial response to fertilization. Hydrobiologia 48(2):109–116.

Response: VEG, CHEM, WQUAL

Genus: *Ceratophyllum, Chara, Elodea, Myriophyllum, Potamogeton*, many

Discusses establishment of submerged vascular plants in experimental ponds subjected to replicated inorganic fertilization at Cornell University, Ithaca, New York. High fertility levels tended to eliminate benthic plant populations and increase phytoplankton standing crops. Canadian waterweed (*Elodea canadensis*) grew in the highest nutrient levels, but spiked watermilfoil (*Myriophyllum spicatum*) and common hornwort (*Ceratophyllum demersum*) seemed to be eliminated. Curlyleaf pondweed (*Potamogeton crispus*) produced an abundance of winter buds under conditions of high fertility. Benthic plant and phytoplankton populations were similar among control and low fertility ponds.

684. Myers, C. W., and W. D. Klimstra. 1963. Amphibians and reptiles of an ecologically disturbed (strip-mined) area in southern Illinois. Am. Midl. Nat. 70(1):126–132.

Response: AMPHIB, REPT

Genus: *Bromus, Melilotus, Platanus, Populus, Rhus, Rubus, Solidago*

Discusses the relative abundance of amphibians and reptiles on land strip-mined for coal, 19–29 years previously, in Perry County, Illinois. The majority of species in the vicinity had invaded the new environment. Semiaquatic species were especially successful. Small and secretive species were poorly represented, probably because of the low organic content of the soil and the arid environment. A few larger snake species were common. Box turtles were seemingly unable to successfully invade the strip-mined lands. Amphibians and reptiles were more abundant in ponds produced by surface or subsurface water filling low places between spoils rather than inundation of old haulage roads and final cuts, which were usually longer, narrower, and deeper.

685. Nash, D. A. 1974. Beachgrass takes hold on canal spoil. Soil Conserv. 40(5):6.

Response: VEG

Genus: None

Describes an experimental planting project on a spoil flat along the Chesapeake and Delaware Canal, Delaware. Cape American beachgrass (*Ammophila breviligulata*) was planted in .4 ha (1 acre) of dredged sandy material varying from loamy sand to silty clay loam. Plantings were 45.7 cm (8 in.) apart in staggered rows, for maximum erosion control. Despite harsh site conditions, including a pH range of 2.5 to 6.5, about 35% of the plantings survived the first year and began to produce new plants by lateral runners.

686. Nawrot, J. R. 1985. Wetland development on coal mine slurry impoundments: principles, planning, and practices. Pages 161–172 *in* R.P. Brooks, D.E. Samuel, and J.B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University School of Forestry Resources, University Park.

Response: SOIL, CHEM, WQUAL, SUCCESS

Genus: *Cyperus, Phragmites, Potamogeton, Scirpus, Spartina, Typha*

Provides a summary of hydrogeochemical principles and plans involved in the implementation of wetland development practices on coal mine slurry impoundments in Illinois. Slurry impoundment zones are discharge area, intermediate area, low saturated and unsaturated sections, and impounded saturated and unsaturated sections. Reclamation efforts are based on working with slurry as a unique soil rather than as a waste material. Reclaimed slurry impoundments are evaluated on the concentration of pyritic materials and potential acidity values. The pyritic concentration is decreased by adding soil cover with limestone amendments to enhance the root zone. Ponds older than 10–20 years may be able to receive limestone directly. Describes and compares site conditions for each zone.

687. Nawrot, J. R. 1981. Stabilization of slurry impoundments without soil cover: factors affecting vegetation establishment. Pages 469–476 *in* D.H. Graves, ed. Proceedings 1981 symposium on surface mining hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: VEG, SOIL, CHEM

Genus: *Phragmites, Typha*

Investigated the physical and chemical soil parameters, plant tissue analyses, density, and biomass production of common reed (*Phragmites australis*) at coal mine slurry impoundments in Williamson, Franklin, and Perry Counties in southern Illinois. Reed and common cattail (*Typha latifolia*) established on non-mine related areas also were examined for comparison. Reed is highly adapted to colonization of slurry sites, primarily due to the mature plant's dependence on the more favorable subsurface zone (pH 5.3), while avoiding the adverse effects of the toxic surface (pH 4.0). Plants established from underground rhizomes generally survive and expand during their first growing season; plants established from runners fail to become established due to drought and phytotoxic surface conditions.

688. Nawrot, J. R., D. M. Downing, and M. L. Fuson. 1981. Reedgrass and slurry pond reclamation. Mining Congress J. 67(9):23–28.

Response: WFOWL, VEG, SOIL

Genus: *Echinochloa, Phragmites, Typha*

Describes several experimental planting projects to restore coal mine slurry refuse areas and stabilize banks. The study site was Mine No. 1, Monterey Coal Company, Carlinville, Illinois. Common reed (*Phragmites australis*) was selected primarily for bank stabilization capabilities. Rooting materials were collected from nearby slurry impoundment areas, sectioned into 30.5- to 45.7-cm (2- to 18-in.) and 15- to 20-cm (6- to 8-in.) segments, and planted by hand. Reed successfully stabilized shoreline areas, flourishing under a number of different environmental characteristics. Its presence also increased the accumulation of organic matter on the slurry surface and, along with plantings of cattail (*Typha latifolia*) and Japanese millet (*Echinocola crusgalli*), improved wildlife habitat.

689. Nawrot, J. R., and W. D. Klimstra. 1985. Mined land wetlands: research activities of the Cooperative Wildlife Research Laboratory. Min. Matters 7(2):1–2.

Response: FISH, WFOWL, VEG, HUSE, WQUAL

Genus: None

Provides a brief overview of the reclamation of wetlands in coal mined areas of Indiana and Illinois. The reclamation goals include providing enhanced habitat for fish and waterfowl and increasing recreational opportunities. Lakes interspersed with shallow ephemeral waters and islands create habitat for waterfowl and shorebirds. Grading of highwalls and spoilbank areas along cut lakes enhances the littoral zone for flora and fauna. The Illinois Cooperative Wildlife Research Unit at southern Illinois University, Carbondale, has studied plantings on abouit 202.5 ha (500 acres) of inactive slurry ponds over the past 8 years.

690. Nawrot, J. R., and W. D. Klimstra. 1986. Wetland habitat reclamation: it's a wonder we have any. Min. Matters 8(3):3–4.

Response: WFOWL, VEG, WQUAL, ECON

Genus: None

Reviews aspects of wetland development policies, financial support, and restoration implementation in Illinois for the last 10–15 years. Original reclamation implementation was slow due to a lack of understanding of basic wetland hydrological and biological principles. However, stricter environmental regulations have been in effect, reflecting increased concern in saving and restoring wetlands. The Illinois Cooperative Wildlife Research Unit continues to work with the mining industry to reclaim large areas of wetlands in a cost-effective

691. Nawrot, J. R., W. D. Klimstra, S. M. Jenkusky, and T. J. Hickmann. 1982. Illinois state reclamation plan for abandoned mined lands: resource document. Illinois Cooperative Wildlife Research Unit, Southern Illinois University, Carbondale. 235 pp.

Response: None

Genus: Many

Provides a general description of known or suspected abandoned mine lands in Illinois eligible for reclamation. A resource review section discusses socio-economic, climatic, topographic, soil, land use, water and coal resources, flora and fauna, recreation uses, and historical sites. A section on assessing the effects of past coal mining in Illinois includes information on environmental regulations, mined land inventories, affected areas, and problem areas. A resource review for each county contains information on threatened and endangered wildlife and their ranges and habitats; includes maps with site specific information on coal mined lands.

692. Nawrot, J. R., and D. B. Warburton. 1986. Wetland habitat development techniques for coal mine slurry impoundments. Pages 587–612 *in* Proceedings of the national mined land reclamation conference. 28–29 October, St. Louis, Mo.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Ceratophyllum, Cyperus, Polygonum, Pontederia, Rumex, Sagittaria, Salix, Scirpus, Spartina, Typha*

Describes methods and management techniques for vegetation establishment on inactive coal mine slurry impoundments. Reclamation efforts in Iowa and Indiana were based on working with slurry as a soil rather than as a waste material. Describes four management zones in terms of soil acidity, soil moisture, and suitability for wetland plant establishment. Planting strategies included planting perennial *Rhizomatous* species in the spring in .3- to 1.5-m (1- to 5-feet) intervals to allow for spreading of the rhizomes. Discusses the timing of water level manipulations, monitoring soil and groundwater chemistry, and controlling wildlife grazing on newly vegetated areas.

693. Nawrot, J. R., A. Woolf, and W. D. Klimstra. 1982. A guide for enhancement of fish and wildlife on abandoned mine lands in the eastern United States. U.S. Fish Wildl. Serv., FWS/OBS-80-67. 101 pp.

Response: None

Genus: *Festuca, Phalaris, Pinus, Quercus, Taxodium, Trifolium*, many

Presents guidelines for enhancing fish and wildlife on abandoned mine lands in the eastern United States. Discusses general and regional features of abandoned mine lands for the Appalachian, eastern interior, western interior, and Texas coal regions. Justification for fish and wildlife considerations includes an overview of the Surface Mining Control and Reclamation Act of 1977. Presents a framework for land use options and recommendations. Presents five studies to illustrate types of abandoned mine reclamation for fish and wildlife benefits; problem conditions, reclamation goals, techniques, costs, and contributions to fish and wildlife. Discusses 11 examples of typical problem sites in various environmental settings.

694. Nawrot, J. R., and S. C. Yaich. 1982. Slurry discharge management for wetland soils development. Pages 11–18 *in* D. H. Graves, ed. Proceedings 1982 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: SOIL, CHEM, WQUAL

Genus: None

Provides detailed information about site characterization and monitoring of hydrogeochemical parameters at two inactive slurry impoundments in southwestern Illinois and Indiana. Discusses vertical and horizontal zonation (saturated-unsaturated substrate stratification, particle size gradients). Presents reclamation considerations for various management zones.

695. Nawrot, J. R., and S. C. Yaieh. 1982. Habitat enhancement of coal mine slurry impoundments through wetland development. Pages 228–242 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, WQUAL, CHEM

Genus: *Betula, Echinochloa, Leersia, Phragmites, Platanus, Polygonum, Populus, Quercus, Salix, Scirpus, Taxodium, Typha*

Describes research conducted by the Illinois Cooperative Wildlife Research Unit, Carbondale, Illinois, on the reclamation of coal mine slurry impoundments. Includes physical and chemical faetors affeeting revegetation on slurry and in inactive tailings basins. Low zones (closest to the decant end) with level topography, high water table, and adequate nutrients are best suited for establishment of wetland species. Diseharge and "intermediate" zones require treatment with calcium carbonate to neutralize aeidie conditions for successful establishment of vegetation. Although current regulations require slurry impoundments to be covered with 1 m (4 feet) of soil for reclamation, greater revegetation success may be achieved by direct establishment of vegetation on slurry.

696. Nawrot, J. R., and S. C. Yaich. 1983. Slurry pond forestation: potential and problems. Pages 180–194 *in* P. E. Pope, ed. Proceedings third annual better reclamation with trees conference. Purdue University, Department of Forestry and Natural Resources, West Lafayette, Ind.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Acer, Betula, Fraxinus, Liquidambar, Pinus, Platanus, Quercus, Taxodium*, many

Provides an overview of slurry pond forestation results at a number of sites in Illinois and Indiana. At all sites, no two ponds were alike, no pond was homogeneous, and existing conditions will change over time. Discusses studies, description of sites, forestation practices, and limiting factors (such as accessibility, fertilization, neutralization amendment). Refinement of techniques and site preparation methods will be needed for full-scale implementation of slurry reclamation without soil cover and for enhancement of forest diversity at reclamation sites.

697. Nawrot, J. R., and S. C. Yaich. 1982. Wetland development potential of coal mine tailings. Wetlands 2:179–190.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Betula, Echinochloa, Leersia, Phragmites, Platanus, Polygonum, Populus, Quercus, Salix, Taxodium*

Summarizes research and plans for developing wetland wildlife habitat and improving water quality on coal mine tailings basins in Illinois. Due to phytotoxic conditions in slurry impoundments, seedling establishment was difficult; however, reclamation was possible through the use of Rhizomatous propagules of common reed (*Phragmites australis*). Smartweed (*Polygonum*), oak (*Quercus*), cutgrass (*Leersia*), cottonwood (*Populus*), and other plants were planted on a 8-ha (20-acre) site at 600 cuttings per hectare. Acidity, nutrient status, and substrate particle size and distribution were measured at the study site; results are presented in a table. All plantings were done without addition of soil cover, as is eurrently required by Federal law.

698. Neill, C., and R. E. Turner. 1987. Restoration of dredge canals in coastal marshes. Restor. Manage. Notes 5(1):32.

Response: VEG, SOIL

Genus: None

Provides an overview of the restoration of dredged canals by backfilling spoil banks into the canals, thus restoring fish and wildlife habitat and natural hydrological conditions (e.g., overland flow). Evaluates effectiveness of this effort in terms of the degree of canal filling and the percent cover of recolonized marsh vegetation. Average canal depth was reduced from 2.4 m to 1.1 m. Equipment operator performance, soil organic content, and the presence of plugs to restrict water flow had the greatest effect on restoration success.

699. Nelson, N. F. 1954. Factors in the development and restoration of waterfowl habitat at Ogden Bay Refuge, Weber County, Utah. Utah Dep. Fish Game Publ. 6. 87 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, HUSE, HYDRO, SOIL, CHEM, WQUAL

Genus: *Aster, Bassia, Chara, Distichlis, Hordeum, Polygonum, Potamogeton, Rumex, Salicornia, Salix, Scirpus, Typha, Xanthium*, many

Discusses the development and restoration of waterfowl habitat at Ogden Bay Refuge, Weber County, Utah. This 5,589-ha (13,700-acre) refuge was developed between 1939 and 1948 and consists of a series of lakes, ponds, potholes, and numerous shallow streams formed by a system of dikes and headgates used to control water levels. Studies plant development on water level-controlled plots from 1946 to 1952. Presents results of these studies, including plant succession, salinity, water and soil quality, waterfowl use, hunter use, and incidence of avian botulism.

700. Nelson, R. W., G. C. Horak, and J. E. Olson. 1978. Western reservoir and stream habitat improvements handbook. U.S. Fish Wildl. Serv., FWS/OBS-78/56. 250 pp.

Response: FISH, VEG, HYDRO, ECON, SUCCESS

Genus: *Alnus, Carex, Quercus, Salix*

Serves as a guide for selecting effective habitat improvement methods in 19 Western States. Focuses on identifying measures recommended by the Fish and Wildlife Service, critically evaluating the implemented habitat and population improvement measures that were effective, and identifying additional measures not recommended by the Service. Includes habitat improvement methods for reservoir flood basins, conservation pools, dam discharge systems, streamside protection, stream flows, and riffles and pools. Population improvement included propagation, passage, stocking, and control measures for fish and propagation and control measures for wildlife. Includes diagrams and costs of the improvements.

701. Newcombe, C., J. H. Morris, P. L. Knutson, and C. S. Gorbics. 1979. Bank erosion control with vegetation, San Francisco Bay, California. U.S. Army Corps of Engineers, Fort Belvoir, Va. Misc. Rep. 79–2. 39 pp.

Response: SHELLF, VEG, SOIL, CHEM, WQUAL

Genus: *Spartina*

Determines biological means of controlling erosion in San Francisco Bay. *Spartina foliosa* seeds, plugs, and sprigs were planted in three shoreline areas with and without wave breakers. The most successful planting technique was a cordgrass-mussel biconstruct, which was extremely resistent to wave activity. Survival of plugs varied from 58 to 98% with wave breakers and 0 to 88% without wave breakers. General conclusions were: average density of stems was 650/m^2 and average stem height was 0.79 m, seeding was not effective, plugs were the most resistent to wave activity, and cordgrass-mussel plugs were most effective for bank stabilization in areas exposed to wave action.

702. Newcombe, C. L. 1978. The role of marsh plants in shoreline stabilization. Pages 12–14 *in* Proceedings conference IX: water...what if? International Erosion Control Association, Freedom, Calif.

Response: INVERT, VEG, SOIL

Genus: *Spartina*

Describes the use of smooth cordgrass (*Spartina alterniflora*) and marshhay patens (*S. patens*) in shoreline stabilization, especially in places where wave action is severe. Research on the ribbed mussel (*Ischadium demissum*) revealed that this economically valuable sea mussel requires more marshland habitat for suitable production. A mussel-cordgrass interdependent association in these marshlands is vital for mussel culture and marine shoreline stabilization. This plant and animal mat are extremely resistant to high-energy wave action, providing an effective alternative to riprap.

703. Newling, C. J., and M. C. Landin. 1985. Long-term monitoring of habitat development at upland and wetland dredged material disposal sites, 1974–1982. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-85-5. 224 pp.

Response: FISH, INVERT, SHELLF, MAMMALS, WFOWL, NGBIRDS, SHOREB, SOIL, CHEM, SUCCESS

Genus: *Alisma, Amaranthus, Ammophila, Bidens, Borrichia, Carex, Cyperus, Deschampsia, Distichlis, Eleocharis, Elodea, Iris, Juncus, Lotus, Panicum, Plantago, Polygonum, Polygonum, Rorippa, Sagittaria, Salicornia, Salix, Scirpus, Sesbania, Solidago, Spartina, Typha*, many

Discusses results of 8 years of monitoring habitat development at six wetland and three upland dredged-material sites. Wetland sites were Windmill Point in the James River, Virginia; Buttermilk Sound near the Altamaha River, Georgia; Drake Wilson Island in Apalachicola Bay, Florida; Bolivar Peninsula in Galveston Bay, Texas; Salt Pond No. 3 in south San Francisco Bay, California; and Miller Sands Island in the Columbia River, Oregon. Includes site histories and descriptions, site research and development, and details of monitoring efforts, including quantitative results of plant, soil, and invertebrate sampling for many of the sites. Despite a lack of management since construction, the sites maintained plant commmunities generally comparable to, or more productive than, those on natural reference areas.

704. Newling, C. J., M. C. Landin, and S. D. Parris. 1983. Long-term monitoring of the Apalachicola Bay wetland habitat development site. Pages 164–186 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, VEG, SOIL, CHEM, SUCCESS

Genus: *Ambrosia, Bromus, Cynodon, Cyperus, Digitaria, Distichlis, Echinochloa, Eclipta, Erechtites, Eremochloa, Euphorbia, Hydrocotyle, Juncus, Juncus, Liatris, Lycopodium, Mikania, Osmunda, Panicum, Paspalum, Phragmites, Plantago, Polygonum, Prunus, Sagittaria, Scirpus, Sesbania, Spartina, Stenotaphrum, Taraxacum, Taxodium, Typha, Vigna, Yucca*, many

Describes the physical condition, vegetation, and wildlife use of the Apalachicola Bay wetland habitat development site at Drake Wilson Island. This island was enlarged in 1976 by diking with sandy clay and filling with coarse sandy dredge material. Cordgrass (*Spartina*) was then planted. Comparisons were made between the habitat development site and three nearby natural marshes during 1980–82. The success of this marsh recreation effort was measured in terms of a vigorous marsh plant community comparable to those of the natural marshes, and heavy use by numerous species of wildlife, especially clapper rails (*Rallus longirostris*) and other shorebirds.

705. Newton, J. 1984. Fifteenmile Creek riparian recovery, Wasco County, Oregon. Pages 80–83 *in* proceedings, Pacific northwest range management short course: range watersheds, riparian zones and economics, interrelationships in management and use. Oregon State University, Corvallis.

Response: FISH, VEG, HYDRO, SOIL

Genus: Many

Describes the restoration of a severely eroded section of Fifteenmile Creek in northcentral Oregon, after the channel was straightened and streambank vegetation was removed in earlier efforts to reduce effeets of flooding. The new restoration scheme included the grading of vertical cut banks, seeding (grass mixture), armoring vulnerable sites, constructing rock check dams (to reduce stream velocity), and excluding livestock to encourage revegetation.

706. Niering, W. A., and M. L. Kraus. 1986. Science base for freshwater wetland mitigation in the northeastern United States: vegetation. Pages 122–130 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass., Amherst, Publ. 87–1.

Response: VEG, SUCCESS

Genus: None

Describes a set of variables for assessing the role of vegetation in various wetland functions. Recommends the creation of wetlands with multifunctional roles. Includes data requirements for assessing wetland functions in terms of vegetation; minimum requirements (areal extent of wetlands, percent cover, animal and plant species lists, cover type, stem density, slope, microtopography, plant vigor, surface water connections, habitat structure, vegetation:open water ratio); detailed data requirements (animal species lists, nitrogen and phosphorus uptake); and highly detailed data requirements (stem density, evapotranspiration, net primary production rates).

707. Niesen, T., and M. Josselyn. 1981. The Hayward regional shoreline marsh restoration: biological succession during the

first year following dike removal. Tiburon Cent. Environ. Stud. Tech. Rep. 1. 185 pp.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, VEG, SOIL, CHEM

Genus: *Atriplex, Cotula, Polypogon, Salicornia, Spartina, Spergularia*, many

Discusses biological succession after removal of a dike to restore an 81-ha (200-acre) salt pond system at Hayward Marsh, San Francisco Bay, California. Presents aspects of soil chemistry and emergent vegetation, benthic invertebrate colonization, fish populations, and bird use as separate papers within the report. No natural seeding of *Spartina foliosa* was observed and planting was recommended. Pickelweed (*Salicornia virginica*) and other wetland-upland zone plants seem to be colonizing rapidly. Densities of many colonizing invertebrates are approaching those found on adjacent bay mud flats. Fish use of the area is seasonal. Nesting habitats for shorebirds were disrupted by construction, but shorebird and waterfowl use of the area for feeding has improved.

708. Nordby, C., J. Zedler, P. Williams, and J. Boland. 1980. Wetlands restoration and enhancement of Imperial Beach. San Diego State Univ. Tech. Rep. 17. 17 pp.

Response: VEG

Genus: *Spartina*

Describes the mortality rate of transplanted *Spartina foliosa* in the Tijuana Estuary near Imperial Beach, California. Results of the artificial seeding experiments showed that *S. foliosa* establishment did not occur. However, by transplanting shoots and seedlings, the success rate was about 100%. Presents the effects of fertilizer and tiling (to improve surface drainage) on *S. foliosa* growth. The researchers noted an increase in *S. foliosa* through natural expansion by seeds, probably due to decreased soil salinities, heavy rainfall, and flooding.

709. Norrgard, R. 1986. Additional comments on wetland restoration. Pages 38–48 *in* J. L. Piehl, ed. Proceedings, wetland restoration: a techniques workshop, Minnesota Chapter of the Wildlife Society, Fergus Falls.

Response: SUCCESS

Genus: None

Provides an overview of wetland restoration in Minnesota. Five basic questions are posed and answered as part of the planning process for restoration: what is missing, what is needed, what are the limitations, are there incentives, and how can success be evaluated? Discusses economic and regulatory considerations. Includes a sample wetland restoration worksheet for establishing baseline information and a form for recording construction activities.

710. Norris, F. A., and L. J. Paulson. 1982. A desert wetland created by wastewater flows: current trends and problems. Wetlands 2:191–206.

Response: HUSE, CHEM, WQUAL

Genus: *Phragmites, Tamarix, Typha*

Investigates the influence of an artificial wetland created by wastewater on the water quality of effluents in the Las Vegas Wash, Clark County, Nevada. The wash is comprised of an upper and lower component and is bordered by tamarisk (*Tamarix*). Cattail (*Typha*) and reed (*Phragmites*) are the dominant marsh species. Five stations in the wash were sampled every 2 weeks to obtain nutrient load data. Presents average changes in alkalinity, temperature, conductivity, dissolved oxygen, total dissolved solids, and suspended solids. Nutrient dynamics of a desert wetland are similar to those in temperate regions except that they are transient in nature because of unstable soils and sparse vegetation.

711. North Carolina Wildlife Resources Commission. 1979. Guidelines for mountain stream relocations in North Carolina. North Carolina Wildlife Resources Commission, Division of Inland Fisheries, Raleigh. 13 pp.

Response: None

Genus: *Acer, Alnus, Amelanchier, Betula, Carya, Cornus, Festuca, Lespedeza, Phalaris, Phleum, Platanus, Quercus, Rhododendron, Robinia, Salix, Tsuga*

Presents 15 standard guidelines for stream relocations to aid road project reviews by the North Carolina Wildlife Resources Commission and to assist engineers in designing projects. Includes matching original channel in length, slope, meander pattern, depth, and width; sloping banks; stabilizing banks with riprap and vegetation; planting trees and shrubs; establishing right-of-ways; fencing from cattle grazing; providing fisherman access; using suitable substrates; installing culverts and stream crossings; and using instream structures to enhance habitat. Instream structure guidelines include design and placement of boulders, low water rock dams, and stone and rock deflectors for low, medium, and high gradient streams.

712. Novick, H. 1983. Bolsa Chica Ecological Reserve: avian response to wetland restoration. Calif. Dep. Fish Game Unpubl. Rep. 47 pp.

Response: FISH, WFOWL, NGBIRDS, SHOREB

Genus: *Enteromorpha, Frankenia, Juncus, Limonium, Monanthochloe, Ruppia, Salicornia, Spartina, Suaeda, Typha, Ulva*

Compares avian populations at the Bolsa Chica Ecological Reserve in southern California before and after the wetland was restored to tidal influence in 1978. A total of 53 avian surveys were conducted from October 1969 to March 1972 and 1980–1981. Species abundance and richness increased significantly following restoration. Use by endangered California least terns (*Sterna antillarum*) and brown pelicans (*Pelecanus occidentalis*) increased. Abundance of California gulls (*Larus californicus*) and American avocets (*Recurvirostra americana*) declined significantly. Wetland restoration of Bolsa Chica also has seemingly increased winter avian use of adjacent degraded wetlands.

713. Novick, H., and R. Hein. 1982. Bolsa Chica—a coastal wetland restoration project. Page 101 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: FISH, SHOREB

Genus: *Salicornia*

Describes the restoration of the Bolsa Chica wetland near Huntington Beach, California. In 1978, tidal influence was restored to 61 ha (150 acres); containment levels and islands for nesting terns were constructed. An additional 34 ha (85 acres) are scheduled for similar restoration. Three species of fish were present before the project; the original marsh was significantly altered by dam construction and other human activities (farming, oil development, urban development). After 3 years, 32 species of fish were found in the area. Bird species diversity and abundance have increased; the brown

pelican (*Pelecanus occidentalis*) now uses the area and least terns (*Sterna antillarum*) nest there.

714. Nunnaly, N. R. 1978. Stream renovation: an alternative to channelization. Environ. Manage. 2(5):403–411.

Response: VEG, HYDRO, SOIL, ECON

Genus: None

Describes stream renovation as a viable cost-effeetive alternative to channel dredging for erosion control and reduction of flooding. Compares hydraulic effects and recommends the following: minimize channel straightening and slopes, promote bank stability (trees, grass seeding, some riprap) and minimize channel reshaping, and design channel form to emulate natural form. Specific examples are cited from stream renovation work (Brian Creek) in Charlotte, North Carolina. Long-term monitoring is planned for this renovation effort, to determine stormwater discharge effectiveness.

715. W. K. Nuttle, and J. W. Harvey. 1988. Geomorphological controls on subsurface transport in two salt marshes. Pages 253–261 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: *Distichlis, Polygonum, Rumex, Scirpus, Spartina, Typha*

Describes subsurface transport in Belle Isle Marsh near Boston, Massachusetts; and Carter Creek Marsh in the lower York River, Virgina. Detailed models are formulated and calibrated, and water content-hydraulic head observations at both sites are compared with model results. Factors that control lateral drainage in salt marsh sediments include: morphology of marsh surface; timing of successive flood events; hydraulic properties of sediment; and evapotranspiration.

716. O'Brien et al. 1986. Hydrology and the construction of a mitigating wetland. Pages 82–100 *in* J.S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass. Publ. 87-1.

Response: HYDRO, WQUAL, SUCCESS

Genus: None

Describes the role of hydrology in wetland mitigation efforts. The physical characteristics responsible for the hydrology of a specific site must be identified and be recreated if hydrologic response is to be duplicated. Interactions between the wetland's physical character, geology, topography, ground water, and proximity to streams are considered in the mitigation effort. Diseusses geology, streamflow, wetlands and flood control, water quality, groundwater, and aquifers in terms of their relation to the functioning of a freshwater wetland system.

717. O'Donnell, A. 1987. The policy implications of wetlands creation. Pages 141–144 *in* J. Zelazny and J.S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation Washington, D.C.

Response: SUCCESS

Genus: None

Provides an overview of the purpose of wetland creation efforts and includes several case examples as well as discussions of on site versus offsite mitigation, inkind versus out-of-kind mitigation, the integrity of the 404 program, and determination of wetland creation "success." Emphasizes comprehensive monitoring of both the lost and replaced wetland functional values.

718. O'Leary, W. G. 1980. Waterfowl habitats provided by surface mine wetlands in southwestern Illinois. M.A. thesis, Southern Illinois University, Carbondale. 141 pp.

Response: INVERT, WFOWL, VEG, SOIL, CHEM, WQUAL

Genus: *Chara, Echinochloa, Eleocharis, Najas, Potamogeton, Sagittaria, Setaria, Typha*

Evaluates waterfowl use of surface mine wetlands on a 333-ha site in Perry County, Illinois. Documents basin type and morphometry, soil ehemistry, water quality, aquatic plants, invertebrates, and degree of use by migrating waterfowl. Results indicated that grading of overburden materials yielded large pond size, greater shore length, more gradual slopes, and wider littoral and moist soil zones. Waterfowl use was highest in ponds characterized by gradually sloping basins (8%), large surface areas (1.5 ha), good water quality (8.3 ph), and extensive moist soil and littoral zones, which provided high quality waterfowl foods. Presents recommendations for increasing quality waterfowl habitats on lands surface mined for coal.

719. O'Leary, W. G., W. D. Klimstra, and J. R. Nawrot. 1984. Waterfowl habitats on reclaimed surface mined lands in southwestern Illinois. Pages 377–382 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: WFOWL, SOIL, CHEM, WQUAL

Genus: *Chara, Echinochloa, Eleocharis, Jussiaea, Najas, Potamogeton, Setaria*

Presents data on the physical, chemical, and biological characteristics of surface mine wetlands in southwestern Illinois and their use by waterfowl. Results indicated that increased grading of overburden materials yielded larger pond size, greater shore length, more gradual slopes, and wider littoral and moist soil zones. Enhanced aquatie plant diversity and cover were associated with watersheds that were mixtures of A, B, and C soil horizons. In the absence of sueh soil characteristics, waters exhibited harsher chemical environments, lower plant diversity and cover, and less waterfowl use. Aquatie sites with steep slopes had low waterfowl use. Discusses the current regulatory programs of reclaimed surface mined lands and how they might be altered to promote the development of wetland habitats to improve waterfowl resources.

720. O'Neill, E. J. 1972. Alkali bulrush seed germination and culture. J. Wildl. Manage. 36(2):649–652.

Response: WFOWL, NGBIRDS, VEG

Genus: *Scirpus*

An experiment was conducted near Tule Lake, California, to seed several hundred acres with bulrush (*Scirpus*). Previous seeding projects failed due to the difficulties in seed germination and propagation. An earthen pit was dug and filled with 15–20 cm (6–8 in.) of water and a sodium hypochlorite solution. Seeds were added and the pit was covered; 12–15 days were required to break dormancy at temperatures of 130–135° F. The newly sprouted seedlings were removed immediately for aerial broadcasting. Yields of 460–919 kg/ha (410–820 lb/acre) were produced and increased use of the bulrush fields by waterfowl and nongame birds was observed.

721. Odum, W. E. 1987. Predicting ecosystem development following creation and restoration of wetlands. Pages 67–70 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources: proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: VEG, HYDRO, SOIL, SUCCESS

Genus: *Phragmites, Scirpus, Spartina, Typha*

Provides an overview of what is currently known about long-term wetland ecosystem development and how this relates to the success of creation or restoration projects. Discusses problems such as invasion by undesirable species.

722. Ogawa, H., A. M. Asce, and J. A. Male. 1985. Simulating the flood mitigation role of wetlands. J. Water Resour. Plan. Manage. 112(1):114–128.

Response: HYDRO

Genus: None

Presents a simulation approach to the evaluation of flood mitigation potential of inland wetlands in three watersheds in eastern Massachusetts. The design of the simulation experiment included the size of the wetland, its location in the watershed, and its location relative to downstream flood damage areas and flood storage capabilities.

723. Ohmart, R. D., W. O. Deason, and C. Burke. 1977. A riparian case history: the Colorado River. Pages 35–47 *in* R. R. Johnson and D. A. Jones, tech. coord. Importance, preservation and management of riparian habitat; a symposium. U.S. For. Serv. Gen. Tech. Rep. RM-43.

Response: VEG

Genus: *Atriplex, Populus, Prosopis, Salix, Tamarix, Tessaria*

Summarizes changes in the riparian cottonwood (*Populus*) communities along the Colorado River on the California–Arizona border from 1539 to present. This type of examination should provide information helpful in future management decisions. Cottonwood-willow (*Salix*) communities were depleted due to demand for fuelwood and clearing for agriculture. Tamarisk (*Tamarix*) was introduced for soil stabilization in the early 1800's and dominated the area from 1910 to 1920. After the late 1880's, fuel demands decreased and about 50 years later, the cottonwood community redeveloped. Photographs of the river are used for vegetation comparisons.

724. Oldenburg, R. C., R. A. Montgomery, T. M. Harder, and G. V. Burger. 1982. Gravel pits as fish and wildlife habitat at the Max McGraw Wildlife Foundation. Pages 215–220 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, HUSE

Genus: None

Describes mining and reclamation activities at Max McGraw Wildlife Foundation land in Kane County, Illinois. Describes reclamation plans focusing on upland habitat development as well as creation of a deepwater lake, two shallow lakes, and marshes. Development of the project included site preparation and mining, progressive rehabilitation, and final reclamation. Project success so far is measured in terms of erosion control, grassland habitat, waterbird diversity, sport fishery development (including crayfish stocking), and implementation of a monitoring–research program.

725. Oliver, J. J., and M. E. Reilly. 1981. Patch formation and competition among the flowering plants of a salt-water marsh, Elkhorn Slough, California. Estuaries 4:263.

Response: VEG

Genus: *Atriplex, Frankenia, Jaumea, Salicornia*

Outlines a study of competition between *Salicornia viriginica* and several upland plant species in Elkhorn Slough, California. The lower saltwater marsh area is dominated by *S. virginica*, but patches of upland species are present. Discusses seed germination and seedling survival of several species. Experiments are in progress; wrack manipulation and seedling occurrence in the lower marsh are being examined.

726. Olmsted, L. L., and D. G. Cloutman. 1974. Repopulation after a fish kill in Mud Creek, Washington County, Arkansas, following pesticide pollution. Trans. Am. Fish. Soc. 103(1):79–87.

Response: FISH

Genus: None

Discusses fish repopulation, after a fish kill caused by pesticide pollution, of Mud Creek, Washington County, Arkansas. Twenty-nine species of fishes were eliminated from the study area. Immediately after the pesticide dissipated, fish (primarily immatures) began repopulating the stream. Presents chronology and rate of repopulation of each species, as well as factors influencing the rate of repopulation and population structure. After 1 year, most species had repopulated the kill zone at population levels similar to those before the fish kill. However, most individuals were young fish; few larger game fish were collected.

727. Olney, P. J. S. 1962. Gravel pits as waterfowl reserves. Pages 414–420 *in* Proceedings, Project MAR conference: conservation and management of temperate marshes, bogs, and other wetlands. Internatl. Union Conserv. Nat. Resour. Publ. 3.

Response: WFOWL

Genus: Many

Discusses the number and distribution of gravel pits in Britain, and emphasizes their importance as waterfowl habitat. Describes plant species that have been successfully introduced in gravel pit areas in terms of their food value for various species of ducks. Lists invertebrates and fishes found in these areas also, along with their food value. Discusses plant competition and species failure. Includes guidelines for providing waterfowl cover, nesting, and loafing sites; grading shorelines; and managing water levels. Management techniques have been successful for increasing numbers of waterfowl, as well as other avifauna.

728. Olson, R. A. 1981. Wetland vegetation, environmental factors, and their interaction in strip-mine ponds, stockdams, and natural wetlands. U.S. For. Serv. Gen. Tech. Rep. RM-85. 19 pp.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Potamogeton, Typha*

Summarizes water regimes, chemical features, temperature factors, light penetration, substrate properties, and physical characteristics of strip-mine ponds and stockdams of the northern great plains region. Discusses the wetland plant community composition and wildlife habitat quality (for consumptive and nonconsumptive resource uses) that result from the interaction of various environmental factors. Stresses the need for further research on the ecology and biology of both flora and fauna of these specialized rangeland ecosystems.

729. Orth, R. J. 1977. The importance of sediment stability in seagrass communities. Pages 281–300 *in* B.C. Coull, ed. Ecology of marine benthos. University of South Carolina Press, Columbia.

Response: INVERT, VEG, SOIL

Genus: *Thalassia, Zostera*

Examines the effect of sediment stability on eelgrass(*Zostera*) and *Thalassia* seagrass beds on the basis of faunal distribution in Chesapeake Bay and Bermuda. In Chesapeake Bay, a transect line was constructed across a 43-m wide *Zostera* bed. *Zostera* was clipped and then sampled at six stations. At the Bermuda site, *Thalassia* was taken from 10 sampling stations and sediment cores were taken from 3 stations. The average number of faunal species in eelgrass beds was 3–14 species. Similar experiments in Bermuda produced samples of 12–55 faunal species in the *Thalassia* beds and 8–22 species in the adjacent sand beds.

730. Orth, R. J., and K. A. Moore. 1982. The effect of fertilizers on transplanted eelgrass, *Zostera marina* L., In the Chesapeake Bay. Pages 104–131 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM

Genus: *Zostera*

Compares the effects of various fertilizers on the growth of eelgrass (*Zostera*). Effects of slow release fertilizer (osmocote), rapid release fertilizer, and ammonium nitrate were compared to unfertilized control plots. Best growth results were obtained with osmocote. After 216 days osmocote-treated eelgrass plugs had a survival rate of 86% (compared to 72% for control plugs), produced 325% more shoots, and increased 220% in area compared to control plots. Best results were obtained when nutrients were incorporated into the soil.

731. Palermo, M. R., and T. W. Eigler. 1976. Feasibility study for Dyke Marsh demonstration area, Potomac River, Virginia. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-76-6. 121 pp.

Response: SOIL, ECON

Genus: None

Presents results of an investigation to determine the engineering feasibility of using dredged materials to expand Dyke Marsh on the Potomac River, Fairfax County, Virginia. Evaluates site-specific feasibility of marsh expansion using dredged material; sizing of the demonstration area to meet water-quality and storage needs; preliminary design of the containment facility; procedures for placement of dredge material; and identification of alternative construction methods, materials, and costs. Preliminary data indicated that material obtained from maintenance dredging would be suitable marsh substrate and extension of the marshland was feasible from the engineering perspective. Recommends more detailed field and laboratory investigations.

732. Palermo, M. R., and T. W. Zeigler. 1977. Detailed design for Dyke Marsh demonstration area, Potomac River, Virginia. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-13. 217 pp.

Response: SOIL, ECON

Genus: None

Documents the results of a project that used dredged material to construct a marsh demonstration area on a portion of the Dyke Marsh on the Potomac River, south of Alexandria, Virginia. Dredged material was obtained from a navigation channel in the Potomac River. Emphasizes economic and engineering considerations. Dike construction material consisted of coarse-grained sand or sand and gravel mixtures. Riprap was used to retain dike stability. Single layers of polyethylene reduced interior dike slope erosion. Discusses general requirements for dike construction. Construction costs of the demonstration containment area varied from $475,750 for fill, riprap, and filter cloth to $5,000 for polyethylene sheeting.

733. Pandit, A. K., and D. N. Fotedar. 1982. Restoring damaged wetlands for wildlife. J. Environ. Manage. 14:359–368.

Response: WFOWL, VEG, HUSE

Genus: *Carex, Cyperus, Najas, Nymphaea, Nymphoides, Oryza, Phragmites, Polygonum, Potamogeton, Sagittaria, Scirpus, Sparganium, Trapa, Typha*, many

Focuses on the protection, restoration, and management of wetlands for waterfowl at various locations near Srinagar, India. Discusses causes of wetland deterioration to better determine effective means of restoration. Describes each wetland site; sizes vary from 0.56 to 14.0 km^2. Recommendations include restoration of high value wetland plants and preservation of diverse wetland complexes, which offer the most productive environment for wildlife. Impoundment size, location, and depth are especially important; water depth should be carefully manipulated according to the needs of different waterfowl species.

734. Parnell, C. 1976. Revegetation of the denuded drawdown area, Pine Flat Lake, Kings River, California. U.S. Army Corps of Engineers, Sacramento, Calif. Rep. 1:1975–1976; Rep. 2:1977. 56 pp.

Response: VEG

Genus: *Baccharis, Cephalanthus, Salix*

Determines if denuded drawdown areas in Pine Flat Lake, California, could be revegetated to prevent erosion. Willow (*Salix*), buttonbush (*Cephalanthus*), and baccharis (*Baccharis*) were selected from nursery stock and seeds. *Cephalanthus* survived in completely denuded areas; attempts to germinate seeds in water were successful, but survival rates were low in moist soils. *Baccharis* transplants were successful in the drawdown area, but specific results were not recorded. Less severe wave action and not too sudden drawdowns are important factors for success of revegetation efforts. Gives extensive information on flood tolerance of different plant species in an appendix.

735. Parnell, C. 1977. Revegetation of denuded drawdown area, Pine Flat Lake, Kings River, California. Report 2. January–December 1977. U.S. Army Corps Eng., Sacramento, Calif. 66 pp.

Response: VEG

Genus: *Baccharis, Cephalanthus, Salix*

Discusses growth of buttonbush (*Cephalanthus occidentalis*) and mule fat (*Baccharis viminea*) transplants during 2 years of drought at Pine Flat Lake, Fresno County, California, on the Kings River. A majority of the plants that survived were located in areas that were shaded part of the day because of northern or western exposure, large rocks, or slope gradient. Cattle damage by grazing or trampling) also reduced survival on easily accessible areas (e.g., gradual slope). Mature stands of buttonbush seem to tolerate to drought conditions; how-

ever, watering may be necessary to ensure survivability of young transplants.

736. Parnell, C. 1976. A study: revegetation of the denuded drawdown area, Pine Flat Lake, Kings River, California. Report 1. 1975–1976. U.S. Army Corps Eng., Sacramento, Calif. 35 pp.

Response: VEG

Genus: *Baccharis, Cephalanthus, Salix*

Describes initial attempts to revegetate portions of a denuded drawdown area at Pine Flat Lake, Fresno County, California, on the Kings River. A successful nursery for the propagation of buttonbush (*Cephalanthus occidentalis*) was established. Transplants to the denuded area seemed to be successful after 1 year of growth; however, transplants were not exposed to inundation. Buttonbush seeds germinated more successfully in water—until roots sprouted—than in moist soil. Mule fat (*Baccharis viminea*) plants soaked for 24 h, and transplanted into barren slopes survived, showed minor evidence of growth due to drought conditions. Includes details of buttonbush nursery methodology.

737. Parnell, J. F., D. M. Dumond, and R. N. Needham. 1978. A comparison of plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-9. 286 pp.

Response: WFOWL, NGBIRDS, SHOREB, VEG, SOIL, CHEM

Genus: *Acer, Andropogon, Borrichia, Carpinus, Carya, Celtis, Commelina, Digitaria, Distichlis, Erigeron, Fimbristylis, Fraxinus, Gordonia, Heterotheca, Hydrocotyle, Juncus, Juniperus, Lactuca, Lepidium, Limonium, Liquidambar, Magnolia, Muhlenbergia, Myrica, Nyssa, Persea, Pinus, Quercus, Salicornia, Solidago, Spartina, Taxodium, Uniola, Yucca*, many

Compares diked and undiked dredged material islands in terms of plant succession and nesting potential. Tests numerous islands in estuaries along the northern North Carolina coast for soil texture and chemical content and samples vegetation. Surveys of bird species diversity on both types of islands indicated that diking increased bird diversity, but decreased potential colonial nesting sites. Plant succession on diked and undiked islands follows various patterns of diversity and composition. Numerous tables include soil, avian diversity, and vegetative composition data.

738. Parnell, J. F., and R. F. Soots, Jr. 1978. The use of dredge islands by wading birds. Natl. Audubon Soc. Res. Rep. 7:105–111.

Response: NGBIRDS, SHOREB

Genus: *Baccharis, Myrica*

Summarizes information on avian colonies and wading bird use of dredge spoil islands along the Atlantic and Gulf coasts of the United States. The number of colonies varied from 4 to 26 on dredged islands and from 3 to 37 on natural islands. Colonies on dredged spoil islands were larger and averaged more than 800 nests, whereas those on natural islands averaged 100 nests. Factors suitable for colonization are the association of dredge islands with inlets and dense thickets of waxmyrtle (*Myrica*) and *Baccharis* as preferred nesting sites. Discusses recommendations for managing and constructing dredge islands for wading birds.

739. Passavant, N., and C. A. Jefferson. 1976. Natural reclamation of filled land, Boca Ciega Bay. Pages 76–103 *in* R. R. Lewis and D. P. Cole, eds. Proceedings of the Third Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, VEG, SOIL, CHEM

Genus: *Andropogon, Avicennia, Baccharis, Bacopa, Batis, Casuarina, Cenchrus, Cyperus, Distichlis, Eragrostis, Eupatorium, Eupatorium, Ipomoea, Juncus, Lippia, Oedogonium, Oenothera, Panicum, Paspalum, Physalis, Rhizophora, Ruppia, Sabal, Salicornia, Salix, Sesuvium, Solidago, Spartina, Typha*, many

Describes the natural revegetation of shoreline fill areas in Boca Ciega Bay, Florida. Studies colonization and succession on 19 dredge and fill areas constructed during the 1950's and 1960's. Studies a natural site on Mullet Key as a control. Soil development, effects of different management practices on undeveloped land, and bird colonization were also noted. Shorelines not retained by sea walls were stabilized by native plants. Where sea walls were present, salt resistent vegetation grew along the walls. In some areas, grasses were mowed regularly and spread with sewage sludge; in other areas, ponds were dug for mosquito control.

740. Patchett, J. M. 1982. Conservation, recreation, mining, and rehabilitation in Story County, Iowa. Pages 89–94 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: None

Genus: None

Describes the institutional setting for dealing with rehabilitation of sand and gravel mined areas. Describes goals for establishing effective mining and rehabilitation guidelines. Forethought in planning and implementing sand and gravel operations leads to effective rehabilitation, which can provide enhancement of existing wildlife habitat and recreational resources. Displays a detailed plan and flow chart process for mining operations and site rehabilitation at Story County.

741. Patrick, R. 1959. Aquatic life in a new stream. Water Sewage Works 106(2):531–535.

Response: FISH, INVERT, VEG, SOIL, CHEM, WQUAL

Genus: *Melosira, Oscillatoria, Stigeoclonium*

Discusses the natural succession and establishment of fauna and flora of an experimental stream constructed near Philadelphia, Pennsylvania, by diverting water from Ridley Creek, a stream relatively free from pollution. A bulldozer and backhoe were used to construct the new stream. Riffle areas, pools, backwaters, and cutting and shoaling areas were created to simulate natural streams. The streambed consisted of stones, gravel, and mud (in pools and backwater). Organisms with shorter life spans were the quickest to establish natural and normal populations. Bacteria became established before algae. The invasion of maeroscopic forms was irregular and sporadic. Filter-feeding larvae were the first to invade and become established in the new stream.

742. Pearce, J.B. 1985. Estuarine habitat enhancement and restoration. Trans. N. Am. Wildl. Nat. Resour. Conf. 50:457–464.

Response: None

Genus: None

Presents an overview of estuarine habitat enhancement and restoration. Discusses strategies for planning and implement-

ing estuary enhancement and restoration, including rehabilitation of degraded areas, coordination among States that share estuarine systems, shore protection features, physical habitat manipulation, shellfish restoration, modification of currents and flows, use of nonpolluting materials, and regulation of contaminants that enter the estuary.

743. Pearson, F. H., and A. J. McDonnell. 1975. Limestone barriers to neutralize acidic streams. J. Environ. Am. Soc. Civil Eng. 101(Ee3):425–440.

Response: HYDRO, CHEM, WQUAL

Genus: None

Evaluates acid neutralization by four limestone barriers installed in acidic streams of the Trough Creek watershed, Pennsylvania, and presents a model for determining rational design of barriers. Presents graphs developed from the model for determining the quantity of crushed limestone required to neutralize a stream and for determining the rate of dissolution of limestone in an acidic stream.

744. Pederson, R. L. 1981. Seed bank characteristics of the Delta Marsh, Manitoba: applications for wetland management. Pages 61–69 *in* Selected proceedings of the midwest conference on wetland values and management. Minnesota Water Planning Board, Minneapolis.

Response: VEG, HYDRO

Genus: *Atriplex, Carex, Chenopodium, Phragmites, Potamogeton, Ranunculus, Rumex, Scirpus, Scolochloa, Typha*, many

Discusses the distribution, abundance, and diversity of buried viable seeds from soil samples of 10 marsh compartments and several large bays of the Delta Marsh, Manitoba. Experimental treatment consisted of 250 substrate samples from 8 cover types placed in an outdoor greenhouse under two simulated environmental conditions: drawdown and shallow flooding. The drawdown yielded 40,283 seedlings (34 species), with red goosefoot (*Chenopodium rubrum*), softstem bulrush (*Scirpus validus*), and cattail (*Typha* sp.) most abundant. The submersed treatment yielded 11,831 seedlings (18 species).

745. Pei, Q, J. Meide, Z. Zhengren, and X. Min. 1985. Seed germination experiments of three ecotypes of *Spartina alterniflora*. Pages 237–246 *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing Univ., China. (English abstract)

Response: VEG

Genus: *Spartina*

Discusses seed germination of three ecotypes of smooth cordgrass (*Spartina alterniflora*) imported from North Carolina, Georgia, and Florida, and grown in trial plantings for 3 years in Luoyuan County, Fujian, China. Seeds from the trial plantings were treated with 2–9% NaCl solutions. Results showed a negative correlation between germination rates and NaCl concentration and no germination occurring at 8 and 9%. Florida ecotype germinated most rapidly and regularly, North Carolina was intermediate, and Georgia was the slowest and more irregular to germinate. Rates of germination in 3% NaCl were far lower than controls, supporting the validity of germination in fresh water. Salinity of 3–4% will inhibit germination during the cold, moist storage period.

746. Perez, R. J. 1981. Salt marsh restoration from former salt evaporators: changes in sediment properties. M.A. thesis, San Francisco State University, Calif. 41 pp.

Response: SOIL, CHEM

Genus: *Cotula, Salicornia, Spartina, Spergularia*

Discusses sediment properties of a former evaporation pond system, now a part of the Hayward Regional Shoreline salt marsh restoration project on San Francisco Bay, California. Measures physical and chemical properties were measured before and after the reintroduction of tidal activity. After 1 year, increases in sediment moisture and pH, and decreases in bulk density, organic matter content, salinity, and available boron content were observed. The restoration site was designed to support *Spartina foliosa*. After 1 year of tidal activity, salinity range fell from 10 to 181%, to 10 to 21% and was within the tolerance limits of *S. foliosa*.

747. Perkins, G. A., and J. S. Lawrence. 1985. Bird use of wetlands created by surface mining. Trans. Ill. State Acad. Sci. 78(1–2):87–95.

Response: INVERT, WFOWL, NGBIRDS, SHOREB, VEG, CHEM, WQUAL

Genus: *Carex, Ceratophyllum, Chara, Cyperus, Eleocharis, Elodea, Juncus, Myriophyllum, Najas, Nelumbo, Potamogeton, Scirpus, Typha*

Documents the use of surface-mined water areas by birds in westcentral Illinois. Previously, these wetland areas had been thought to be inadequate as habitat due to low fertility, acidic conditions, and poor fish production. Current evidence from field surveys showed that these wetlands supported 71 invertebrate species. Aquatic vegetation occurred at a depth of 5 m. The physical characteristics of these areas were irregular shorelines, numerous islands, and diverse bottom topography. At least 12 species of birds nested in the area: Canada goose (*Branta canadensis*), mallard (*Anas platyrhychos*), American black duck (*A. rubripes*), blue-winged teal (*A. discors*), wood duck (*Aix sponsa*), hooded merganser (*Lophodytes cucullatus*), mute swan (*Cyanus olor*), American coot (*Fulica americana*), common moorhen, pied-billed grebe (*Podilymbus podiceps*), killdeer (*Charadrius vociferus*), and spotted sandpiper (*Actitis macularia*).

748. Pesavento, B. G. 1984. Factors to be considered when constructing wetlands for utilization as biomass filters to remove minerals from solution. Pages 45–49 *in* J. E. Burris, ed. Treatment of mine drainage by wetlands. Penn. State Univ. Contrib. 264.

Response: CHEM, WQUAL

Genus: *Sphagnum, Typha*

Describes some of the design criteria for creating wetlands to filter acid mine wastewater (specifically for removal of iron and manganese). Describes several mineral loading levels in terms of amount of iron and manganese removed and pH. Flow rates varying from 0.1 to 10 gal/min to 1,001 to 10,000 gal/min are combined with the mineral loading levels, producing a variety of site requirements for wetland construction. Inoculation of manganese-oxidizing bacteria into the marsh is recommended in some instances. Discusses selection of microbes and microflora.

749. Peters, C. R. 1986. The significance of hydrogeology to the mitigation of functions in freshwater wetlands of the glaciated northeast. Pages 337–339 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of impacts and losses. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: None

Focuses on the role of hydrology and hydrogeology in wetland function assessment and in the creation of wetland systems for mitigation purposes. How a wetland relates to the hydrogeology of its surroundings should be determined before impacts to the wetland occur. In the absence of detailed hydrogeologic data, the characteristics of the original wetland should be imitated.

750. Peterson, L. A., Jr. 1957. Vegetative changes at a new reservoir in Nebraska: 1951–1956. U.S. Fish Wildl. Serv., Bur. Sport Fish. 19 pp.

Response: VEG

Genus: *Populus, Salix*, many

Describes an investigation of vegetational changes at Harry Strunk Lake in southwest Nebraska, as a result of new inundation of 30 miles of shoreline. Seven study sites were established; five sites were located on the reservoir shoreline below the highest water surface level. Changes in species composition were determined by comparing photographs of the study sites taken at various times. Water level fluctuations during the first spring and summer resulted in dead or dying vegetation with the exception of willow (*Salix*). Where silting occurred, all herbaceous vegetation and seedlings were smothered. After a year of stable water level conditions, *Salix* and cottonwood (*Populus*) appeared. The third year of stable conditions provided the necessary conditions for natural plant succession.

751. Peterson, S. A., W. D. Sanville, F. S. Stay, and C. F. Powers. 1974. Nutrient inactivation as a lake restoration procedure—laboratory investigations. U.S. Environ. Prot. Agency, Corvallis, Oreg. EPA-660/3-74-032. 118 pp.

Response: FISH, INVERT, VEG, CHEM, WQUAL, ECON

Genus: *Selenastrum*

Presents results of laboratory tests on the ability of certain metal compounds to remove complex phosphate ions from the water of a farm pond near Corvallis, Oregon. This could be used as a technique to control phosphorus levels in eutrophic lakes. Salts of lanthanum, zirconium, and aluminum effectively removed phosphorus with resulting depression of algal growth. Toxicity to fishes and aquatic invertebrates was minimal, but tests demonstrated that some components of metal salts may have adverse effects. Preliminary results indicate that zirconium precipitates phosphorus from the water and holds it at low levels. Recommends further laboratory tests and additional pilot-scale field testing.

752. Petri, M. G. 1965. The ecology of three artificial marsh-ponds on the Tully Forest. M.S. thesis, State University New York, Syracuse. 166 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, CHEM, WQUAL

Genus: Many

Describes a comparative study of three marsh-ponds constructed in 1953 (primarily for wildlife habitat) in Tully Forest, Cortland County, New York. Describes Mason Pond, Padget Pond, and Reagan Pond in terms of physical and chemical characteristics, plankton, fishes, amphibians, reptiles, birds, mammals, and vegetation.

753. Phillips, P. L. 1987. Wetlands mitigation: Harmon Meadow case sends mixed signals. Natl. Wetl. Newsl. 9(5):15–17.

Response: INVERT, VEG

Genus: *Spartina*

Describes the restoration of 51 ha (126 acres) of degraded marsh in Hackensack Meadows, New Jersey, as mitigation for filling 40.5 ha (100 acres) of adjacent tidal wetlands for development purposes. Discusses cost for changes in elevation and water flow and replacement of common reed (*Phragmites australis*) with smooth cordgrass (*Spartina alterniflora*). Discusses involvement of regulatory agencies and Federal interpretations of "mitigation."

754. Phillips, R. C. 1977. Seagrass bed development on dredged spoil at Port St. Joe, Florida. Pages 1–11 *in* R. Lewis and D. Cole, eds. Proceedings of the Fourth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Halimeda, Halodule, Thalassia*

Describes the results of transplanting *Halodule wrightii*, a pioneering seagrass species, on dredge spoil in St. Joseph Bay, Port St. Joe, Florida. Survival of the transplants was affected by stresses from paper mill effluents, dredge spoil substrate, shallow water (with periods of exposure to air), and exposure during record cold winter weather (1976–77). Overall survival at two planting sites was 85% and 93%.

755. Phillips, R. C. 1976. Preliminary observations on transplanting and phenological index of seagrasses. Aquat. Bot. 2:93–101.

Response: VEG

Genus: *Halodule, Thalassia, Zostera*

Discusses the transplanting of several species of seagrasses at Puget Sound, Washington; Tampa Bay, Florida; Izembak Bay, Alaska; and Corpus Christi and Redfish Bays, Laguna Madre, Texas. Describes several techniques, including nonanchoring methods (sods and plugs) and anchoring methods (shoots fixed to buried construction rods or nails). Seagrasses may develop physiological races and thus cannot be transplanted over geographic distances without acclimation. Vegetative materials need to be shipped in massive amounts to restore damaged areas; this may be prohibitive. Identification of the life history phases of species is important for correlating necessary physical environmental conditions.

756. Phillips, R. C. 1980. Transplanting methods. Pages 41–56 *in* R. C. Phillips and C. P. Mcroy, eds. Handbook of seagrass biology: an ecosystem perspective. Garland STPM Press, New York.

Response: VEG

Genus: *Halodule, Syringodium, Thalassia, Zostera*

Describes methods of transplanting seagrasses. Nonanchoring methods include: sediment-free plants and rhizome mat covered with sediment in transplant site, sod (plant and sediment), and plugs. Anchoring methods include: pipes and construction rods, bricks, wire mesh, nails, and plastic anchors.

757. Phillips, R. C. 1980. Planting guidelines for seagrasses. U.S. Army Corps Eng., Fort Belvoir, Va. Tech. Aid 80–2. 28 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Halodule, Ruppia, Syringodium, Thalassia, Zostera*

This state-of-the-art guide to seagrass planting methods was developed for mitigation of wetland loss due to coastal engi-

neering activities. Three planting decision keys are provided: the Atlantic coast north of Beaufort, North Carolina; Beaufort, North Carolina, to Florida and the Gulf coast; and the Pacific coast. Contains selections for elevation, tidal currents, salinity, soil types, and propagation methods. Specific requirements for optimal depth, light, temperature, salinity, nutrients, currents, and waves are important for planting success.

758. Phillips, R. C. 1980. Creation of seagrass beds. Pages 91–104 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG

Genus: *Halodule, Thalassia, Zostera*

Describes various aspects of seagrass restoration in different locations along the Pacific, Gulf, and Atlantic coasts of the United States. Describes the general ecology of seagrass beds. An overview of seagrass transplantation programs and techniques is provided; technique, author, species used, and location are arranged in tabular format. Recommendations include: the use of the plug method for plant establishment, the use of *Halodule* in restoration planting because of its tolerance for wide salinity and siltation variations, and the use of local plant stock as a source of transplant materials.

759. Phillips, R. C. 1982. Seagrass meadows. Pages 173–201 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, ECON

Genus: *Halodule, Syringodium, Thalassia, Zostera*

Describes seagrass transplantation to replenish stocks in areas damaged by pollution, disease, and excessive grazing, and to stabilize dredged materials. Describes annual net production, formation of detritus, and nutrient cycling. Provides a history of habitat loss and associated effects. Includes planting techniques, plant material sources, manpower, and cost analyses. Summarizes various transplant projects in temperate North America, Fiji, and Australia. Includes summary information for species, propagules, location, anchoring method, chemical additives, success, and substrate.

760. Phillips, R. C. 1974. Transplantation of seagrasses, with special emphasis on eelgrass, *Zostera marina* L. Aquaculture 4:161–176.

Response: VEG

Genus: *Halodule, Thalassia, Zostera*

Provides evidence that transplanting seagrasses is a feasible technique for stabilizing, protecting, and revegetating coastlines and disturbed areas. Seagrass was established using seeds and transplants near Woods Hole, Massachusetts. In Tampa Bay, *Halodule* was successfully transplanted using sod fringed with concrete blocks and covered by fish net. Planting of Alaskan eelgrass in Puget Sound was unsuccessful due to the shock of shipping and differences in environmental conditions. Adequate soil around the roots was a major factor in seedling growth success.

761. Phillips, R. C., and R. L. Lewis. 1983. Influence of environmental gradients on variations in leaf widths and transplant success in North American seagrasses. J. Mar. Tech. Soc. 17(2):59–68.

Response: VEG

Genus: *Thalassia, Zostera*

Describes a study to investigate phenotypic and genotypic responses of transplanted seagrasses between various environments, determine whether leaf width is an indicator of environmental stress, and describe seagrass growth over eco-genetic and spatial–temporal gradients. Eelgrass (*Zostera*) transplants were studied at Izembek Lagoon, Alaska, and Hood Canal, Washington. Turtlegrass (*Thalassia*) transplants were taken from Tague Bay, St. Croix, Virgin Islands, and planted west of Buck Island, St. Croix. Provides detailed transplant data and different methods. Presents a planting decision key.

762. Phillips, R. C., M. K. Vincent, and R. T. Huffman. 1978. Habitat development field investigations, Port St. Joe seagrass demonstration site, Port St. Joe, Florida; Summary report. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-33. 52 pp.

Response: VEG

Genus: *Halodule*

Port St. Joe, Florida, was the site for a test restoration project on previously dredged material. *Halodule wrightii* transplants were placed at intervals of 0.9 to 2.7 m in sandy substrate. Initial survival was 78%, but decreased over time, possibly due to mill effluent, exposure, and an unusually cold winter. Transplants with larger plugs of 375 cm2, planted at intervals of 0.9 m, were most successful in producing continuous cover in less than 1 year.

763. Phillips, W. A., and F. D. Eastham. 1959. Riverbank stabilization in Virginia. J. Soil Water Conserv. 14(6):257–259.

Response: VEG, SOIL

Genus: *Festuca, Juncus, Spartina*

Provides an overview of current river shoreline stabilization projects for erosion prevention in eastern Virginia. The bank of a Potomac tributary was graded to a 3:1 slope and seeded with fescue (*Festuca*) and bermudagrass (*Cynodon dactylon*). In addition, smooth cordgrass (*Spartina alterniflora*) sprigs were planted at the low tide mark and marshhay patens (*S. patens*) sprigs were planted at the high tide mark. Recommended methods include: sloping with a dragline and not a bulldozer to minimize the amount of loose dirt pushed to the waters' edge, and sloping in late winter and seeding in early spring to allow for the longest possible growing season.

764. Phleger, C. F. 1971. Effects of salinity on growth of a salt marsh grass. Ecology 52:908–911.

Response: VEG, CHEM

Genus: *Spartina*

Presents results of experiments to test salt tolerance of the coastal salt marsh grass, (*Spartina foliosa*), collected from Mission Bay, San Diego, California. Plants were grown in nutrient solutions at various salinities (0–125% sea water) for 8 weeks. Growth and survival were greatest in fresh water, although the plant grows in sea water in its natural habitat. Percent dry weight of protein, lipid, and potassium was higher and sodium was lower in freshwater cultured plants compared to saltwater plants. The author suggests that *S. foliosa* was originally a freshwater marsh plant and discusses the mechanisms that the plant evolved to thrive in salt water.

765. Piehl, J. 1986. Restoration of drained wetlands. Pages 33–37 *in* J.L. Piehl, ed. Wetland restoration: a techniques workshop. Minnesota Chapter of the Wildlife Society, Fergus Falls, Minn.

Response: WFOWL, VEG

Genus: None

Presents an overview of a wetland restoration program initiated by the United States Fish and Wildlife Service Mid-continent Waterfowl Management Project in westcentral Minnesota. The pilot project area includes Douglas, Otter Tail, and Grant Counties; 567 ha (1,400 acres) of wetlands were restored. Earthen ditch plugs were used to restore small drained sites. In larger wetlands, culverts were added and filter cloth was used to prevent erosion. In some instances, half-round risers were used to control water level. Discusses restoration of wetlands drained by tile systems. Uplands adjacent to wetlands were planted for waterfowl nesting cover. Discusses response of private landowners to this program.

766. Pierce, D. 1982. Planning aid report. Sunset Harbor Navigation and salt marsh restoration study. Bolsa Chica, Orange County, California. U.S. Fish and Wildlife Service, Laguna Niguel, Calif. 62 pp.

Response: FISH, INVERT, MAMMALS, NGBIRDS, VEG, HUSE

Genus: *Abronia, Baccharis, Cotula, Eucalyptus, Heterotheca, Juncus, Lotus, Oenothera, Ruppia, Salicornia, Scirpus, Typha*

Reviews eight alternative development plans for the restoration of the Bolsa Chica wetlands in Orange County, California. This area contains navigation channels and is used heavily by boaters. Alternatives varied from no action to a mixture of wildlife–open space and marina–marsh plans. Biological evaluations of the resources were measured using field surveys, Fish and Wildlife Service data and statistical data. Recommendations included the need for a small boat facility, continued breeding bird census, additional right-of-way agreements, and an expanded diked salt marsh of 446–527 ha (1,100–1,300 acres).

767. Pierce, G. J. 1986. In kind vs. out-of-kind wetland replacement. Pages 287–288 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of impacts and losses. Association of State Wetland Managers, Berne, N.Y.

Response: ECON, SUCCESS

Genus: None

Discusses some of the factors which effect the success of wetland mitigation or replacement projects. Discusses economic factors in terms of reconstruction of hydrology, substrate, and vegetation. Presents factors that contribute to failure of in-kind mitigation projects, along with a list of recommendations for alleviating conflicts associated with agency requests for in-kind replacement and the cost of such replacement.

768. Pierce, G. L. 1986. Succession and stability in freshwater marshes in the northeastern United States. Pages 323–324 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of impacts and losses. Association of State Wetland Managers, Berne, N.Y.

Response: VEG

Genus: None

Describes wetland dynamics in terms of a model that incorporates allogenic and autogenic factors that may affect community succession. Discusses many factors that can retard succession. Hydrological changes, animal effects and seed germination are particularly important factors. Recommendations for wetland plantings in light of these factors include consideration of the statement that the normal state for many freshwater marshes may be dynamic.

769. Pierce, G. J., and A. B. Amerson. 1981. A pilot project for wetlands construction on the floodplain of the Allegheny River in Cattaraugus County, New York. Pages 140–153 *in* R.H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, HYDRO, WQUAL, CHEM

Genus: *Alisma, Asclepias, Carex, Cicuta, Dulichium, Glyceria, Iris, Juncus, Nuphar, Polygonum, Ranunculus, Rumex, Scirpus, Sparganium*

Describes the initiation of a 3-year wetlands development test program, an attempt to create inland freshwater wetlands to compensate for those lost to highway construction. The demonstration project site is near Birch Run Creek on the Allegheny River floodplain in New York. Planning considerations included water chemistry, water level, drawdown, wetland and upland soils, fertilizer, plant species native to the Allegheny River Valley ecosystem, six planting methods, timing, and damage by vertebrates. Environmental analysis of in-place wetlands was conducted to provide information for evaluation of the environmental conditions of the constructed wetlands.

770. Pitre, R. L. 1986. Restoration of wetlands along the Texas Gulf Coast. Restoration and Manage. News 4(1):31–32.

Response: VEG

Genus: *Batis, Distichlis, Salicornia, Spartina*

Reviews the restoration of four filled wetland areas along the Texas Gulf Coast. The fill material was removed and the area was graded to previous contour elevations, which established original hydrodynamic regimes and allowed the soil to maintain natural saturation levels. At this step, turbidity curtains were used to reduce impacts to surrounding wetlands during removal of fill material. Dominant species recorded in the areas included *Spartina alterniflora, S. patens, Distichlis spicata, Batis maritima*, and *Salicornia bigelovii*. Successful revegetation through natural processes was observed.

771. Pitre, R.L. 1981. Successful restoration of filled wetlands at four locations along the Texas Gulf Coast. Wetlands 1:171–178.

Response: VEG

Genus: *Batis, Borrichia, Distichlis, Juncus, Salicornia, Spartina, Suaeda*, many

Describes the restoration of four wetland sites along the Texas gulf coast at Hayes Ridge Lake, Redfish Bay, Port Bay, and the Gulf Intracoastal Waterway. All sites had been subject to unauthorized filling; fill material was removed and previous contour elevations were restored. Revegetation occurred through natural processes and was seemingly more successful (after two growing seasons) in areas that had periodically flooded natural ground elevations.

772. Plafkin, J. L., D. L. Kuhn, J. Cairns, Jr., and W. H. Yongue, Jr. 1980. Protozoan species accrual on artificial islands in differing lentic and wetland systems. Hydrobiologia 75:161–178.

Response: INVERT

Genus: None

Describes a method of using protozoan colonization on polyurethane foam substrates to compare productivity of lentic and wetland habitats in Michigan, Virginia, and Colorado.

Compares sites using nonlinear regression estimates of the parameter g, which reflects the rate at which substrates attained equilibrium species numbers.

773. Platts, W. S., C. Armour, G. D. Booth, M. Bryant, J. L. Bufford, and P. Cuplin, et al. 1987. Methods for evaluating riparian habitats with applications to management. U.S. For. Serv. Gen. Tech. Rep. INT-221. 177 pp.

Response: SUCCESS

Genus: Many

Presents standards for measuring and evaluating riparian habitats. Includes: collection of riparian habitat information (sampling and monitoring); measuring vegetation (overhang, stability, cover, animal use); riparian community classification; riparian soils; remote sensing; water column measurement; stream banks; measuring and mapping organic debris; historic evaluation of riparian habitats; evaluation of stream riparian area conditions using benthic macroinvertebrates; and, planting of riparian sites (site preparation, seeding, plant selection).

774. Platts, W. S., S. E. Jensen, and C. Johnson. 1987. Mitigation through restoration of degraded riverine/riparian ecosystems in the Great Basin hydrographic region and the Snake River hydrographic subregion. U.S. Environ. Prot. Agency, Corvallis, Oreg., Unpubl. Rep. 104 pp.

Response: HYDRO

Genus: *Agropyron, Alnus, Artemisia, Betula, Bromus, Carex, Cornus, Deschampsia, Elymus, Poa, Prunus, Salix*

Provides information useful for restoring riverine–riparian habitats in the Great Basin and Snake River watersheds. Suggests a preliminary, hierarchical classification. Discusses design and monitoring of restoration projects. Includes 12 restoration project profiles in appendixes.

775. Pomeroy, W. M., D. K. Gordon, and C. D. Levings. 1981. Experimental transplants of brackish and salt marsh species on the Fraser River Estuary. Can. Tech. Rep. Fish. Aquat. Sci. 1067. 35 pp.

Response: VEG, SOIL, WQUAL

Genus: *Carex, Distichlis, Enteromorpha, Salicornia, Scirpus*

Discusses survival and growth of brackish marsh plants transplanted as rhizome plugs to three habitats on the Fraser River Estuary, British Columbia, Canada. Survival of Lyngbye's sedge (*Carex lyngbyei*), American bulrush (*Scirpus americanus*), and alkali bulrush (*S. maritimus*) was negligible at one location characterized by relatively high salinities (> 3 ppt) and wave focussing due to jetties. At a more sheltered and lower salinity location, plug success was 65–69% for *S. americanus and C. lyngbyei*. Survival was 71–84% for these species at a site exposed to strong river currents and moderate wave action. Presents data on seed production, shoot density, maximum plant height, and sediment characteristics.

776. Posey, D. M., D. C. Goforth, and P. Painter. 1984. Ravenwood Shellrock Mine: wetland and upland restoration and creation. Pages 127–134 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON, HYDRO

Genus: *Acer, Andropogon, Carex, Cladium, Eleocharis, Ilex, Myrica, Nuphar, Nymphaea, Panicum, Persea, Pinus, Pontederia, Prunus, Quercus, Sabal, Sagittaria, Scirpus, Serenoa, Spartina, Stipa, Taxodium, Typha, Woodwardia*, many

The reclamation of a Shellrock Mine at Ravenwood included creation of a wetland-upland buffer and lakes and wetlands within ravenwood, which is scheduled for future high-density residential development. Transplanted vegetation included trees up to 9 m tall at about $55–65 per tree or $7,500/ha. Dredging was used to provide fill for upland areas. Lake design included a double littoral zone produced by contouring concentric rings of shallow water at the lake perimeter. Survival rates of transplanted wetland plants averaged more than 90% after 1 year. Exact depths of wetland shallows were designed to accommodate natural precipitation cycles.

777. Pratt, J. R., J. Cairns, Jr., and P. M. Stewart. 1985. Development of microbial communities in mined lakes. Pages 239–259 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School Forestry Resources, University Park.

Response: INVERT, CHEM, WQUAL

Genus: *Eichhornia, Hydrilla, Panicum, Typha*

Examines the development of microbial communities in 21 lakes of different ages created as a result of phosphate mining in Polk County, Florida. Age of lakes varied from less than 6 months to 7 years. Microbial colonization was sampled by placing artificial substrate to depths of about 50 cm. Measurements were taken at 0.5, 1, 3, 8, and 10 days after colonization. Turbid, young lakes failed to accrue species. Lakes 6 months to 8 years old had 15–90 species; 60-year-old natural lakes typically had 60–80 species. Lakes greater than 2 years of age had microbial communities similar to older, natural lakes, even though the water chemistry was different.

778. Pratt, J. R., and J. Cairns. 1985. Determining microbial community equilibrium in disturbed wetland ecosystems. Pages 201–209 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: INVERT, CHEM, WQUAL, SUCCESS

Genus: None

Describes a study of the microbiota of 16 reclaimed and 2 active mine cuts in Polk County, Florida. Most reclaimed lakes were less than 10 years old; age varied from 2 months to more than 60 years. Substrate sampling yielded data on microbial colonization and community dynamics. Physical and chemical parameters of the water were sampled. Newly reclaimed lakes had low pH, high levels of trace metals and nitrates, and relatively simple protozoan communities. After about 2 years, the microbial community structure and dynamics of reclaimed lakes were similar to those of natural lakes and old reclaimed lakes. These analyses provide a functional measure of the response of communities to new habitat conditions.

779. Price, J. W. 1987. The marsh that Arcata built. Sierra 72(3):51–53.

Response: FISH, WFOWL, SHOREB, VEG, HUSE, WQUAL, ECON, SUCCESS

Genus: *Typha*

Describes the use of wastewater effluent to create freshwater wetlands at the Arcata Marsh and Wildlife Sanctuary, Arcata, California. Site preparation involved digging out a 1.5-m (5-feet) deep lake, creating islands with extra fill; diking and filling an old pasture; and flooding an abandoned lumber mill site. Topsoil was removed and respread after grading. No

vegetation was planted. Wetlands were created as an alternative to a regional sewage treatment facility. Waterfowl and fish thrive at the sanctuary, water quality is better than what the plant would have discharged, and the sanetuary is heavily used by residents for education and recreation. Discusses potential use of cattails (*Typha*) for ethanol or methane production.

780. Prichard, D. E., and L. L. Upham. 1986. Texas Creek riparian enhancement study. Trans. N. Am. Wildl. Nat. Resour. Conf. 51:298–303.

Response: FISH, INVERT, VEG, HYDRO, SOIL

Genus: *Salix*

Discusses the effects of riparian habitat enhancement treatments on a .8-km (0.5-mile) section of the Texas Creek in central Colorado. The greatest improvement oceurred on a portion of the creek that had intensive habitat treatment (gabion struetures, resloping and riprapping of banks, and planting of willow cuttings) plus exclusion of livestock. Streambank stability, bank cover, pool-riffle ratio, spawning habitat, and number and size of brown trout (*Salmo trutta*) increased. Deferred seasonal livestock grazing improved streambank stability, bank cover, and number of brown trout. Streambank stability and number of brown trout increased on the segment that received no treatments and no grazing.

781. Princeton Aqua Science. 1985. Compliance, mitigation and marsh creation survey and report. U.S. Army Corps of Engineers, Baltimore, Md.

Response: FISH, INVERT, MAMMALS, WFOWL, VEG, SOIL, SUCCESS

Genus: *Peltandra, Scirpus, Spartina*

Reviews 17 marsh creation mitigation projects in the U.S. Army Corps of Engineers Baltimore District. Records site conditions for vegetation, sediments, substrate stability, and shoreline stability. A site was selected for mitigation based on the presence of shoreline stabilization factors, fish and wildlife habitat, or food chain support. The projects were evaluated for completion, failure or success based on plant mortality, and lack or presence of follow-up planting or monitoring after construction.

782. Pritchett, D. A. 1987. Creation, restoration, and enhancement of vernal pools. Restor. Manage. Notes 5(2):92.

Response: VEG, HYDRO

Genus: None

Describes several vernal pool projects in California. A series of interconnected vernal pools was created near Santa Barbara. Describes excavation, flooding, and seeding (from surface scrapings from nearby natural vernal pools). Vernal pools at a local public nature reserve were either enhanced by placement of dams, restored by debris removal and excavation, or created by excavation and subsequent seed inoculation (from natural vernal pools). All projects are being monitored; so far inoculum has established plants successfully, but flooding may require careful regulation.

783. Pulver, T. R. 1976. Transplant techniques for sapling mangrove trees, *Rhizophora mangle, Laguncularia racemosa,* and *Avicennia germinans*, in Florida. Fla. Dep. Nat. Resour., Mar. Res. Publ. 22. 14 pp.

Response: VEG, CHEM, WQUAL

Genus: *Avicennia, Laguncularia, Rhizophora*

Focuses on comparison of techniques for planting mangroves using survival and growth as indicators of transplant success. Success was highest when a rootball approximately half the original tree height was removed with the tree to sustain it during the recovery period. The mangrove species were pruned before transplanting. Black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*) recovered well from extensive pruning, but red mangrove (*Rhizophora mangle*) survived only if the distal end of the branch was pruned to a size not greater than 1 cm in diameter. Includes the tolerance to cold, salinity, xerie conditions, and pruning for each species. Gives specific guidelines and techniques for planting.

784. Quammen, M. L. 1986. Measuring the success of wetlands mitigation. Natl. Wetl. Newsl. 8(5):6–8.

Response: SUCCESS

Genus: None

Provides an overview of wetland mitigation success evaluation (i.e., the effectiveness of artificially created marshes in providing the functions and values of natural marshes). The type of mitigation treated here is compensation, mitigation for destroyed wetland habitat. In many instances, success of wetland restoration is difficult to assess because: project objectives (e.g., restoration goals) are not clearly stated, permit conditions fail to clearly define which wetlands are most in need of restoration or replacement, variability among natural marshes is not recognized, and specifications for restoration projects are not reviewed for feasibility and scientifie validity. Discusses compliance monitoring.

785. Quammen, M. L. 1986. Summary of the conference and information needs for mitigation in wetlands. Pages 151–158 *in* R. Strickland, ed. Wetland functions, rehabilitation, and creation in the pacific northwest: the state of our understanding. Wash. State Univ., Dep. Ecol. Publ. 86–14.

Response: INVERT, VEG, SOIL, CHEM, SUCCESS

Genus: None

Summarizes suggestions for determining the importance of wetlands in relation to mitigation actions: habitat that is in short supply should be restored, restoration–creation should occur as close as possible to the original site to increase the chances of recovery, knowledge of wetland functions and habitat design criteria for specific sites should be applied, Fish and Wildlife Services Habitat Suitability Index models provide information on habitat support capability and size requirements, and compliance success monitoring describes qualitative field measurements and assesses how often agency recommendations are accepted and implemented. Functional success assessment is used to determine if the restoration–creation process successfully replaced original wetland functions.

786. Race, M. S. 1985. Critique of present wetlands mitigation policies in the United States based on an analysis of past restoration projects in San Francisco Bay. Environ. Manage. 9(1):71–82.

Response: VEG, SUCCESS

Genus: *Distichlis, Grindelia, Salicornia, Spartina*

Provides an analysis of past wetland restoration projects in San Francisco Bay, and a critical overview of present wetland mitigation policies within the United States. Analysis of published information on 13 restoration projects in the bay area leads to questions regarding the actual status and success of

these projects. Problems include insufficient or inconsistent information, inaccurate reports of success, and premature adoption of mitigation policies and ideas without adequate supporting data. Natural habitats are being replaced by artificial wetlands of questionable long-term value. Recommendations address permit processes, marsh establishment techniques, continued research, and cost effectiveness.

787. Race, M. S., and D. R. Christie. Coastal zone development: mitigation, marsh creation, and decision-making. Environ. Manage. 6(4):317–328.

Response: SUCCESS

Genus: None

Provides an overview of mitigation as part of coastal zone development processes. Mitigation requirements in several States are described and evaluated, as are several wetland creation studies. Addresses several major issues: some mitigation requirements consider number of wetland units (e.g., acres) to be created or restored for every unit (acre) altered or destroyed; however, if equivalent units are measured in terms of productivity, this may not in fact be an equitable trade-off; decisions involving artificial marsh location and the length of time such a marsh is monitored or maintained before it is deemed "successful" are often based on insufficient data; bases for comparison between natural and man-made salt marshes underscore the fact that a marsh is more than the presence of vegetation; and mitigation is offered as justification for wetland development and destruction.

788. Raisanen, D. L., S. D. Leimer, and G. N. Textor. 1988. Hydroperiod prediction for four new palustrine wetlands. Pages 144–151 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: None

Describes the use of hydraulic and hydrologic modeling along the east branch of the Du Page River, Du Page County, Illinois. Hydrologic modeling to predict water surface elevations was based on a U.S. Army Corps of Engineers water surface profile model.

789. Ranwell, D. S., D. W. Wyer, L. A. Boorman, J. M. Pizzey, and R. J. Waters. 1974. *Zostera* transplants in Norfolk and Suffolk, Great Britain. Aquaculture 4:185–198.

Response: VEG

Genus: *Zostera*

Describes a series of experiments in which *Zostera nolti* and *Z. marina* var. *angustifolia* turfs were transplanted on sheltered estuarine mud flats in Norfolk and Suffolk, Great Britain. Growth rates (as measured by cover area) were comparable to those of natural turfs under good conditions. *Z. nolti* growth was favored in areas where a close balance between the forces of erosion and accretion occured; transplanting was most successful on mud flats where mud surface level changes were at least 7 cm/year or 3 cm/week. Initial results of single turion (offsets) planting were encouraging; using turions instead of turfs could reduce the costs of *Zostera* transplanting.

790. Ray, D. K., and W. O. Woodroof. 1986. Approaches for restoring and creating wetlands in California's coastal zone. Pages 392–402 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of impacts and losses. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Provides an overview of coastal wetland restoration and creation in California. Provides a table listing estuarine wetland mitigation projects. Describes various approaches for restoring diked tidelands and filled areas and mitigating the effects of sedimentation, oil and gas development, and large scale projects. Discusses mitigation standards and assesses the adequacy of mitigation proposals. Acreage requirements and indicator species are used as examples for assessing the "success" of mitigation efforts.

791. Reark, J. B. 1982. An in-situ fertilizer experiment using young rhizophora. Pages 166–180 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM

Genus: *Avicennia, Rhizophora*

Mangroves were planted at Poinciana Island, Dade County, Florida, in riprap planters using various soils. Severe chlorosis developed in red mangrove (*Rhizophora mangle*), but not in black mangrove (*Avicennia germinans*). Various fertilizers were applied to remedy the chlorosis (5–8–5 acid formula, 6–6–6 formula, 7–2–7 formula, and no-treatment control). After 1 year, only the 5–8–5 acid formula seemed to be successful.

792. Reark, J. B. 1983. Comparisons of nursery practices for growing of *Rhizophora* seedlings. Pages 187–195 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, ECON

Genus: *Rhizophora*

Red mangrove (*Rhizophora mangle*) propagules were planted in a slathouse under uniform conditions. Compares growth and germination in 4 types of media (glass jars, nursery pots, tree pots, and jiffy 7 peat balls). After 6 weeks, plant survival was 68% in glass jars, 58% in nursery pots, 81% in tree pots, and 95% in jiffy 7 peat balls. *Rhizophora mangle* that grew in tree pots and jiffy 7 peat balls had longer shelf life.

793. Rechard, R. P., and V. R. Hasfurther. 1980. The use of meander parameters in the restoration of mined stream beds in the eastern Powder River basin. University of Wyoming, Institute of Energy and Environment, Laramie. 414 pp.

Response: HYDRO, SOIL

Genus: *Carex, Poa, Populus, Salix, Spartina*

Examines stream pattern parameters, wave length, radius of curvature, width to depth ratio, and sinuosity of 19 ephemeral and intermittent streams in the eastern Powder River basin of Wyoming to develop empirical relationships for stream restoration after surface mining. Examines wavelength spectrally, visually, and by computer averaging. Includes documentation of computer programs for the parameter examination process to allow similar examinations of stream basins at other locations. Suggests several design procedures for restoration of streams.

794. Redfield, A. C. 1972. Development of a New England salt marsh. Ecol. Monogr. 42(2):201–237.

Response: None

Genus: *Aster, Atriplex, Distichlis, Juncus, Limonium, Lyngbya, Phragmites, Plantago, Salicornia, Scirpus, Solidago, Spartina, Suaeda, Typha, Vaucheria*

Describes the development of marshes at Barnstable, Massachusets, from bare sand or mud flats, to intertidal marsh, to high marsh underlain by substantial peat deposits. Vegetation, tides, sedimentation, and sea level are primary factors in marsh development. Presents theories about salt marsh structure along with the history of Barnstable marsh. Describes the spread of vegetation, vertical accretion, and stages in development for intertidal marshes; surface relief, drainage, pond holes, anddescribes effects of ditching for high marshes. Discusses the erosion of marshes and the stability of creek banks.

795. Redmond, A. M. 1981. Considerations for the design of an artificial marsh for use in stormwater renovation. Pages 188–199 *in* R. H. Stovall, ed. Proceedings of The Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, WQUAL, CHEM

Genus: *Bacopa, Cladium, Nuphar, Pontederia, Sagittaria, Scirpus, Utricularia*

Describes a proposed artificial marsh in the watershed of Lake Jackson, Florida. The marsh would reduce the effects of stormwater (sediments, excess nutrients, heavy metals, and hydrocarbons) on Lake Jackson through sediment trapping and vegetative uptake of dissolved pollutants. Stoplog spillways and dikes would compartmentalize the marsh into three areas: a sawgrass (*Cladium*) marsh, functioning to retain sediment; a bullrush (*Scirpus*) marsh, providing sediment retention and uptake of dissolved pollutants; and a flag marsh of emergent, submergent, and floating plants, functioning to retain sediment and take up excess nutrients.

796. Reed, R. B., and D. E. Willard. 1987. Wetland evolution in midwestern reservoirs. Pages 167–179 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: VEG

Genus: *Acer, Carex, Cephalanthus, Ceratophyllum, Cornus, Justicia, Lemna, Myriophyllum, Nelumbo, Phalaris, Platanus, Polygonum, Populus, Salix, Typha*

Discusses natural establishment of wetlands in four reservoirs (Geist, Morse, Monroe, and Pataka) from 9 to 44 years old in central and southern Indiana. Information on the evolution of these wetlands came from historical records, aerial photographs, and site inspections to verify boundaries and check present conditions. Suggests that shallow water zones are colonized within 3 years. Rapid initial growth occurs in former floodplains. Once existing shallow areas become fully vegetated, siltation along wetland margins gradually reduces water depth and wetland expansion follows, proceeding slower than initial growth. Wetland evolution in reservoirs is complicated by the influence of widely fluctuating water levels.

797. Reed, S., R. Bastian, and W. Jewell. 1979. Engineering assessment of aquaculture systems for wastewater treatment: an overview. Pages 1–12 *in* R. K. Bastian and S. C. Reed, eds. Aquaculture systems for wastewater treatment: seminar proceedings and engineering assessment. U.S. Environmental Protection Agency, Washington, D.C.

Response: None

Genus: *Alternanthera, Eichhornia, Lemna, Ludwigia, Scirpus, Typha*, many

Presents an overview of the use of aquaculture systems for wastewater treatment. Discusses wetland processes, aquatic plant systems, and combined systems for treating wastewater and for harvesting fish, shellfish, and plants. Examples of combined systems include marine polyculture (Woods Hole Oceanographie Institute, Massachusetts), solar aquacell system (Hercules, California), marsh-pond system (Brookhaven National Laboratory, New York), and finfish in stabilization ponds (Benton, Arkansas). Presents 12 recommendations for additional research and studies on the use of aquatic systems for wastewater treatment.

798. Reed, S. C., E. J. Middlebrooks, J. C. Corey, C. W. Hall, W. E. Odum, and J. M. Davidson. 1987. Research and development needs for utilization of aquatic plants for water treatment and resource recovery. Pages 1009–1022 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Eichhornia, Phragmites*

An overview of a panel discussion on engineering plant-water-sediment processes, resource recovery, ecological considerations, and environmental issues related to aquatic plant use for wastewater treatment. Further research needs include development of alternatives for using water hyacinth, use of multiple plant species, evaluation of current wastewater treatment systems, determination of the amount of energy required for each process, optimal system design use of artificial wetlands, and studies involving the uptake of potential contaminants from aquatic systems.

799. Reed, W. C., and M. C. Heath. 1974. Saltmarsh relocation and restoration in Maine. Maine Department of Transportation, Augusta. 54 pp.

Response: VEG

Genus: *Distichlis, Spartina, Zostera*

Presents the results of a restoration feasibility study to enhance Maine's salt marshes. Field evaluations were made at sites between Portland and Rockland. Favorable seed production was dependent on the amount of restricted tidal water flow due to channelization, and the amount of gravel substrate exposed. Discusses tidal relations, substrate types, and substrate nutrient supply characteristics of this area in relation to restoration and other effects on the marshes.

800. Reeves, G. H., and T. D. Roelofs. 1982. Influence of forest and rangeland management on anadromous fish habitat in western North America: rehabilitating and enhancing stream habitat. 2. Field applications. U.S. For. Serv. Gen. Tech. Rep. PNW-140. 38 pp.

Response: FISH

Genus: None

Describes techniques for rehabilitating and enhancing habitat to increase natural production of anadromous salmonids in the pacific northwest and Alaska. Reviews methods to enhance spawning (e.g., restoring gravel through use of gabions or weirs), rearing (e.g., creating in-stream cover and pools), and riparian habitat (e.g., rehabilitating overgrazed areas), and to improve access (e.g., fishways, culverts).

801. Reichard, N. 1984. Riparian habitat restoration: some techniques for dealing with landowners, livestock, and eroding streambanks. Pages 128-137 *in* T. J. Hassler, ed. Proceedings, Pacific northwest stream habitat management workshop. Humboldt State University, Arcata, Calif.

Response: VEG, SOIL

Genus: None

Describes restoration of riparian areas in northern coastal California (by the Redwood Community Action Agency) in terms of working with landowners, rehabilitating areas destroyed by livestock grazing, and stabilizing stream banks. Emphasis is on using affordable materials for restoration (preferably those located on-site), allowing for vegetative reestablishment in conjunction with bank stabilization and grazing exclosures, and setting up restoration projects that require little or no maintenance.

802. Reimold, R. J. 1980. Marsh creation: impact of pesticides on the fauna, use of infrared photography, ditching and diking. Pages 132-135 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: SOIL, CHEM, INVERT, VEG

Genus: *Juncus, Spartina*

Describes a case study of the effects of toxaphene on an estuarine system near Brunswick, Georgia, including the proper use and interpretation of color infrared photography, effects of ditching and diking on habitat creation projects, and a comparison of several species diversity indixes. Over an 8-year period, nekton was sampled in the polluted estuary and in a pristine estuary nearby (Duplin). Describes a second study involving watershed alterations at glacial lake, Hackensack, New Jersey.

803. Reimold, R. J. 1980. Creation of a southeastern United States salt marsh on dredged material. Pages 6-22 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop.

Response: INVERT, SOIL, VEG, CHEM, WQUAL

Genus: *Baccharis, Batis, Borrichia, Distichlis, Iva, Juncus, Limonium, Salicornia, Scirpus, Spartina, Sporobolus*

Describes the creation of a salt marsh on dredged material at Buttermilk Sound near the mouth of the Altamaha River, Georgia. The sandy substrate of this habitat development site was graded to establish an elevation gradient from mean high water to mean low water. A set of research plots was established. Planting variables included: elevation, species planted, and fertilization. Marsh development success was monitored by soil nutrient analysis, presence–abundance of macroinvertebrates (fiddler crabs, snails) and other wildlife, plant growth, and chemical analysis of surrounding waters. Measures plant productivity (above and belowground).

804. Reimold, R. J., and S. A. Cobler. 1986. Wetland mitigation effectiveness. U.S. Environmental Protection Agency, Boston, Mass. 139 pp.

Response: VEG, SOIL, SUCCESS

Genus: *Carex, Distichlis, Juncus, Phragmites, Pontederia, Spartina, Typha, Zostera*

Reviews five representative wetland mitigation sites in New England, including site-specific evaluations of preproject and postproject conditions, mitigation effectiveness, and generic recommendations for more effective mitigation. The projects consisted of construction of a shopping center, a 1.1-km (0.7-mile) section of an expressway, two industrial parks, and a marina. Affected wetlands varied from .7 to 8 ha (1.8 to 20 acres) of salt, brackish, or freshwater marshes. Recommended mitigation included creation or enhancement of wetlands, using various planting, landforming, and filling techniques. The review of the five sites indicated that mitigation recommendations lacked many important details. Provides a checklist approach to identifying information needs for successful mitigation design.

805. Reimold, R. J., M. A. Hardisky, and P. C. Adams. 1978. Habitat development field investigations, Buttermilk Sound marsh development site, Atlantic Intracoastal Waterway, Georgia; Appendix A: propagation of marsh plants and postpropagation monitoring. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. 78-26. 1498 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Borrichia, Distichlis, Iva, Juncus, Spartina*

Buttermilk Sound, near the mouth of the Altamaha River, Georgia, was the site for a habitat development experiment to test the feasibility and effects of marsh development on dredged material. The site was graded to a 3.7% slope with three tidal inundation zones: less than 6 h, 6 to 18 h, and > 18 h daily. The substrate consisted mainly of homogeneous quartz sand to a depth of 3 m. Sprigs of selected marsh plants were planted during June 1975, with fertilizer treatments. The plants were monitored for their response to the fertilizer treatment and to inundation levels. Includes recommendations for creation of marsh habitat in brackish water. Provides lists of successful plant species in each tidal zone.

806. Reppert, R. T., W. Sigleo, E. Stakhiv, L. Messman, and C. Meyers. 1979. Wetlands values: concepts and methods for wetlands evaluation. U.S. Army Corps Eng., Fort Belvoir, Va. Res. Rep. 79-R1. 109 pp.

Response: WFOWL, VEG, HUSE, WQUAL, SUCCESS

Genus: *Alnus, Carex, Cephalanthus, Distichlis, Eleocharis, Iva, Juncus, Phragmites, Potamogeton, Puccinellia, Rhizophora, Ruppia, Salicornia, Salix, Scirpus, Spartina, Thalassia, Typha, Zostera*, many

Identifies specific requirements for wetland evaluation methods. Discusses basic concepts, specific criteria, functions, characteristics, and delineation. Wetland functions include: natural biological functions; use as sanctuaries, refuges, or scientific study areas; shoreline protection; groundwater recharge; flood and stormwater storage; water quality improvement; hydrologic support; and cultural values. Evaluation methods include a nonquantitative evaluation based on deductive analysis of individual functional characteristics, and a semiquantitative method in which relative values of two or more alternatives are established through mathematical ratings.

807. Reuter, D. D. 1986. Wetland shrub management study (Wisconsin). Restor. Manage. News 4(1):29.

Response: VEG, ECON

Genus: *Alnus, Betula, Cornus*

Estimates the cost and measure the effectiveness of managing shrub invasion of a fen and sedge meadow in the Summerton Bog Preserve, Marquette County, Wisconsin. Shrub treatments included prescribed burns, manual torching, and manual cutting. *Cornus stolonifera, Betula sanbergii*, and *Alnus rugosa* were temporarily reduced in presence and dominance;

no major overall shrub response was apparent. Treatments done early in the year were easier and more cost effective, but showed little difference in shrub mortality.

808. Rhongzong, Z. 1985. A report of planting experiments in Donpian tideland in Wenling, Zhejiang. Pages 320–321 *in* Research advances in *Spartina*—achievements of past 22 years. J. Nanjing Univ., China.

Response: VEG, HYDRO, SOIL

Genus: *Spartina*

Summarizes cordgrass (*Spartina*) planting experiments in the Dongpian tideland, Wenling, Zhejiang, China. Plantings were most successful during the first half of the year, the best elevation was 3.0 m. Recommends planting 3–5 plants per planting hole. Plants formed a complete coalesced plantation within 1, 1.5, and 2 years when planted using 50- × 50-cm, 100- × 100-cm, and 200- × 200-cm spacings, respectively. Less spacing was suggested for highly erodable areas. Propagation of planting materials using pot culture and rice paddies has been effective.

809. Rickard, W. H., and C. E. Cushing. 1982. Recovery of woody streamside vegetation after exclusion of livestock grazing. J. Range Manage. 35(3):360–361.

Response: VEG

Genus: *Populus, Salix*

Provides a summary of the effects of excluding cattle from a stretch of Rattlesnake Springs on the Department of Energy's Hanford site in southcentral Washington. In 1963, this small permanent stream was almost devoid of woody vegetation and an 800-acre exclosure was built. By 1980, it was an almost continous narrow corridor of willows (*Salix*). Discusses the ecological significance of this restoration project.

810. Richardson, B. 1988. Highway wetland mitigation—everyone can be a winner. Pages 149–153 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: ECON

Genus: None

Discusses plans to provide replacement bottomland hardwood wetlands as mitigation sites for construction of a four-lane divided highway in Pine Bluff, Arkansas. The three sites—a cultivated field, a pasture, and an overgrown hay field—will be excavated to provide fill material for highway embankment construction. The wetlands will provide a net increase in floodwater storage capacity. These sites will ultimately enhance wildlife use of the bottomland hardwoods by restoring the continuity of the bayou. The mitigation sites will be cost-effective due to acquisition of property outside of right-of-way limits, thus eliminating the need to build costly access roads.

811. Richardson, C. J., and J. H. Davis. 1987. Natural and artificial wetland ecosystems: ecological opportunities and limitations. Pages 819–854 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Nyssa, Pinus, Taxodium, Thuja*, many

Analyzes data from natural and artificial wetlands to substantiate guidelines for selection and potential use of wetlands for wastewater treatment. Six natural systems were used to evaluate ecological processes and their efficiency for wastewater treatment. Marshes, ponds, ditches, and the root zone method were evaluated in terms of treatment approaches, design, and treatment capabilities and limitations. Stresses that the use of natural wetlands for treatment purposes could be disastrous because sufficient data are not available on long-term effects. Therefore, artificial wetlands have greater potential as treatment systems.

812. Riley, C. V. 1977. Ecosystem development on coal-mined lands, 1918–1975. Pages 303–346 *in* J. Cairns, Jr., K. L. Dickson, and E. E. Herricks, eds. Recovery and restoration of damaged ecosystems. University Press Virginia, Charlottesville.

Response: SOIL, CHEM, WQUAL, SUCCESS

Genus: *Carex, Drepanocarpus, Eleocharis, Juncus, Oedogonium, Pleurotaenium, Sagittaria, Scirpus, Sparganium, Spirogyra, Typha*, many

Describes ecosystem development on a site in southeastern Ohio that was surface-mined for coal in 1918. A 2-ha (5.5-acre) mine water impoundment was planted between 1949 and 1953. By 1956, the lake chemistry could support bluegills (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*). Water quality samples (1958–59) revealed wide ranges in pH and total solids. Vegetation and organic litter around the lake alter spoil chemistry and thus improve the chemistry of runoff entering the lake. By 1960, aquatic vegetation growth required chemical control to free the lake for recreation. Chain pickerel (*Esox niger*) and redear sunfish (*Lepomis microlophus*) were stocked at that time. Sampling up to 1975 indicated increasing numbers and diversity of fauna.

813. Riner, M. I. 1976. A study on method, techniques and growth characteristics for transplanted portions of eelgrass, (*Zostera marina*). M.S. thesis, Adelphi University, Oakdale, N.Y. 107 pp.

Response: VEG

Genus: *Zostera*

Investigates the feasibility of transplanting common eelgrass (*Zostera marina*) in Great South Bay, New York. A well-established *Zostera* bed near West Fire Island was used as a control area and as a source for transplants. A second study site consisting of 14 ha (35 acres) of dredge spoil material surrounding Sand Island was used for the experimental transplants. Transplanted plugs were placed 1 m apart at 1.25 m below mean low water. Plugs, miniplugs, and individual shoots were planted; survival after 2 months was 100% for plugs, 71% for miniplugs, and 36% for individual shoots. Compares morphology, growth rates, and plant production of the control and experimental sites.

814. Ripl, W. 1976. Biochemical oxidation of polluted lake sediment with nitrate—a new lake restoration method. Ambio 5(3):132–135.

Response: VEG, WQUAL, ECON

Genus: *Chara, Nitella*

Describes the restoration of sewage-polluted Lake Lillesjon in southern Sweden near Varnamo. The sediment was periodically anoxic and was treated by a combination of an acid iron-chloride solution, lime slurry, and an oxidizing agent. More than 1.8 ha of dense vegetation was removed (the lake's area is 4.2 ha) and the bottom was colonized by *Chara* and

Nitella. Discusses both short-term and long-term restoration effects.

815. Ripl, W. 1981. Lake restoration methods developed and used in Sweden. Pages 495–500 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, EPA 440/5-81-010.

Response: CHEM, WQUAL, ECON

Genus: *Anabaena*

Discusses lake restoration research conducted by the Institute of Limnology, University of Lund, Sweden. Swedish lakes have been damaged by excessive eutrophication, acidification, and lowering of water levels. In many eutrophic lakes, phosphorus reduction either by diversion or treatment of effluents did not improve water quality and oxygen conditions as expected. Lake Trummen did improve permanently following removal of the upper nutrient-rich sediment by suction dredging. Other techniques include: an apparatus for injecting chemicals into lake sediments to convert humic acids to sodium humates with ionic exchange properties, for the reduction of acidity; water level management for lakes overgrown with weeds; a limno device for aeration; and systems combining wastewater treatment and biomanipulation.

816. Ristich, S. S., S. W. Fredrick, and E. H. Buckley. 1976. Transplantation of *Typha* and the distribution of vegetation and algae in a reclaimed estuarine marsh. Bull. Torrey Bot. Club 103(4):157–164.

Response: VEG

Genus: *Bidens, Dryopteris, Elodea, Hibiscus, Impatiens, Lophotocarpus, Lythrum, Lythrum, Myriophyllum, Peltandra, Phragmites, Polygonum, Potamogeton, Sagittaria, Scirpus, Typha*, many

Describes the results of a 2-year study of an artificial tidal freshwater marsh near Annsville Creek and the Hudson River, Peekskill, New York. Narrowleaf cattail (*Typha angustifolia*) was successfully transplanted; optimum planting time was May or June. Sampling was conducted regularly at five stations in and around the reclaimed marsh. The reclaimed area was invaded rapidly by 40 species of vascular plants and 63 genera of algae. Floating seeds, plant fragments, and buried seeds were the major sources of plant invasion.

817. Robb, A. E., Jr., and K. E. Ohlsson. 1982. Mine-related stream alteration practices for protection and enhancement of fish and wildlife. U.S. Fish Wildl. Serv., FWS/OBS-82/57. 157 pp.

Response: FISH

Genus: None

Provides information on mine-related stream alterations and alternative methods for protecting and enhancing fish and wildlife habitat. Discusses stream protection measures. Stream habitat enhancement techniques include descriptions of various devices to improve the streambed, reduce erosion, and provide fish habitat (e.g., artificial riffles and pools, in-stream cover devices).

818. Robel, R. J. 1961. Water depth and turbidity in relation to growth of sago pondweed. J. Wildl. Manage. 25:436–438.

Response: VEG, HYDRO, WQUAL

Genus: *Potamogeton*, many

Presents results of a study on relations between submerged vegetation production, water depth, and turbidity of diked marshes on the delta of Bear River, 24 km (15 miles) west of Brigham City, Utah. This site provides excellent waterfowl habitat. As water depth (maximum 50.8 cm [20 in.]) increased, turbidity decreased and vegetation production increased. Inundation of the marsh to at least 22.8 cm (9 in.) was recommended for the greatest amount of waterfowl food production.

819. Robel, R. J. 1962. Changes in submerged vegetation following a change in water level. J. Wildl. Manage. 26:221–224.

Response: VEG

Genus: *Potamogeton, Scirpus*, many

Discusses changes in aquatic vegetation of marshes on the delta of the Bear River at the northern end of Great Salt Lake, Utah, following a 7.6-cm (3-in.) rise in water level. Submerged vegetation production increased 32% in shallower areas (15–40.6 cm [6–16 in.]) and decreased 35% in deeper areas (43–81 cm [17–32 in.]). When considering the additional acreage flooded by the rise in water level, estimated crop production increased 10% during the first year of inundation. Other changes also noted were an increase in the amount of food around and near duck-nesting areas and a more luxuriant growth of alkali bulrush (*Scirpus maritimus*).

820. Roberts, C., and J. Graves. 1978. Sand and gravel mining and reclamation to benefit wildlife. Colorado State University, Department of Natural Resources, Fort Collins, Colo. 55 pp.

Response: WFOWL, SHOREB, VEG, HYDRO, SOIL, SUCCESS

Genus: Many

Provides an overview of sand and gravel mine reclamation guidelines that emphasize wildlife habitat as the postmine land use, and applications of these guidelines and specific techniques to a mining plan for the Three Bell Ranch near Timnath, Colorado, on the Cache la Poudre River. Reclamation guidelines include pond shape, orientation, and access; bank treatment; islands; revegetation; water depth control; and user access. An eight-phase "mining sequence" is presented for application of guidelines to proposed mining projects. These phases involve stripping and stockpiling of topsoil and subsoil for use on reclaimed mined areas. Plant species selection lists are presented along with information on transplanting, timing of seeding, and plant growth media.

821. Robertson, D., R. Garcia, and K. Piwowar. 1987. Comparison of wetland habitat in undisturbed and reclaimed phosphate surface-mined wetlands. Pages 180–193 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: INVERT, VEG, SUCCESS

Genus: *Acer, Azolla, Eleocharis, Fraxinus, Gordonia, Hydrocotyle, Lemna, Liquidambar, Magnolia, Myrica, Panicum, Paspalum, Pontederia, Quercus, Salix, Scirpus, Taxodium, Typha, Ulmus*

Compares macroinvertebrate populations of wetlands reclaimed from two intermittent first order tributaries of the South Prong Alafia River in the phosphate mining region of westcentral Florida. Stream channels eliminated by mining were reclaimed by grading the site; transplanting peat, topsoil, and plants; seeding berms with grasses; planting additional tree seedlings; and creating shallow depressions. Macroinvertebrate species richness was nearly twice as high in older

(15–27 months old) reclaimed areas compared to a 1-month-old reclaimed area and the undisturbed channel.

822. Robertson, D. J. 1988. Project documents recovery of reclaimed stream, forest community (Florida). Restor. Manage. Notes 2(2):80.

Response: INVERT, VEG

Genus: None

Describes a research project at Sink Branch, a perennial sandhill stream in central Florida. The site consists of a narrow, 1-ha ribbon of riparian land along a diverted section of the stream. Native hydric and mesic tree species were planted. The potential for reestablishing forested riparian wetlands on an area formerly mined for phosphate was examined by Mobil Chemical Company and the Florida Institute of Phosphate Research.

823. Robertson, D. J. 1984. Sink Branch—stream relocation and forested wetland reclamation by the Florida phosphate industry. Pages 135–151 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: CHEM, INVERT, WQUAL, VEG

Genus: *Acer, Cornus, Fraxinus, Liquidambar, Magnolia, Pinus, Quercus, Taxodium, Ulmus*

In 1979, 304 m of the Sink Branch Channel was diverted from its original course to an excavated channel on reclaimed mine land. Trees and aquatic emergents were planted. In 1983, aquatic macroinvertebrates were sampled in both the reclaimed channel and in an undisturbed upstream section. Of the 93 species collected, 37 were found at both sites, 18 at the control site only, and 38 at the reclaimed channel only. Macroinvertebrate density was similar between the two sites. Nutrient levels in water leaving the reclaimed section were slightly lower than those upstream of the reclaimed section. Nine species of trees were planted (at about 1,535 trees per ha) in the vicinity of the stream. Survival rates differed by species (American elm, [*Ulmus americana*] 94%; baldcypress, [*Taxodium distichum*] 91%, sweet bay [*Magnolia virginiana*] 6%; and dogwood [*Cornus*] 6%).

824. Robertson, S. B. 1988. Hydrology of Arctic wetlands. Pages 262–269 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of of State Wetland Managers, Berne, N.Y.

Response: HYDRO

Genus: None

Describes Arctic wetlands in terms of temperature, precipitation, river and stream hydrology, soil hydrology, and geomorphology. Concludes that in the Arctic, minimization or avoidance of adverse affects on wetlands are preferred to mitigation. Any attempts to create wetlands in the Arctic are likely to produce consequences that are different from what was orginally planned, largely because of the influence of ice and permafrost.

825. Robilliard, G. A., and P. E. Porter. 1976. Transplantation of eelgrass (*Zostera marina*) in San Diego Bay. San Diego, Calif., Nav. Undersea Cent. Rep. NUC TN 1701. 36 pp.

Response: VEG, SOIL

Genus: *Zostera*

Describes an eelgrass (*Zostera*) transplanting project used as mitigation for construction of the U.S. Navy ammunition pier along North Island in San Diego Bay, California. Approximately 65 m^2 (700 $feet^2$) of eelgrass were transplanted from the proposed dredge site to another suitable site in the bay. Three plug sizes were planted at various depths and spacings. A total of 440 man-hours was required to complete the transplant. Cost (including personnel, equipment, and materials) was approximately \$25/m^2 (\$25/$feet^2$). Monitoring transplanted sites was recommended on a regular basis for at least 1 year and periodically over the subsequent 2- to 3-year period. Includes 12 specific recommendations concerning the transplant technique.

826. Roesser, J. C., Jr. 1988. Blue River reclamation project, Breckenridge, Colorado. Pages 94–101 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American west. Society of Wetland Scientists, Rocky Mountain Chapter, Denver, Colo.

Response: ECON, HYDRO, WQUAL

Genus: Many

Describes restoration of a portion of the Blue River (Breckenridge, Colorado) that had been destroyed by dredging for extraction of precious metals. More than 300,000 tons of rocks and cobble have been removed form the site to allow for 915 m (3,000 feet) of reconstructed river channel. Site elevation is 2928 m (9,600 feet). Determinations of high flow conditions and prediction of groundwater levels during critical periods of the year were part of the hydrologic analysis used in this restoration project. Drop structures and other channel alterations were designed to eliminate sources of sediment overloading. Plant species selection for 10 different site types was done after soil analyses and examination of natural vegetation in nearby wetland areas. Begun in 1984, the project is scheduled for completion in 1989.

827. Rorslett, B. 1978. Some ecological implications of freshwater systems restoration. Pages 339–350 *in* M. W. Holdgate and M. J. Woodman, eds. The breakdown and restoration of ecosystems. Plenum Press, New York.

Response: SHOREB, VEG, HUSE, CHEM, WQUAL, WFOWL

Genus: *Acorus, Anabaena, Ceratophyllum, Elodea, Glyceria, Nuphar, Nymphaea, Phragmites, Typha*

Presents an overview of ecological implications of restoring eutrophic lakes in Scandinavia and discusses attempts to restore Lake Ostensjovatn, Oslo, Norway. Ostensjovatn is a shallow, vegetation-rich lake subjected to increased nutrient loading from wastewater. Public recreational use of the lake is high. Digging of channels, planting grass along littoral zones, adjusting water level, and harvesting vegetation were used to try to restore water quality. However, the procedures resulted in lower ecosystem diversity, avian botulism poisoning, oxygen deficiency, and fish kills. Discusses the choice between natural resources or recreation use in restoring lakes.

828. Ross, D., C. Kocur, and W. Jurgens. 1985. Wetlands creation techniques for heavy construction equipment. Pages 210–220 *in* F. J. Webb, ed. Proceedings of the Twelfth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, ECON

Genus: *Baccharis, Bacopa, Cyperus, Eclipta, Eleocharis, Eupatorium, Hydrochloa, Hydrocotyle, Hypericum, Juncus, Ludwigia, Nymphoides, Oryza, Panicum, Paspalum, Pluchea, Polygonum, Pontederia, Ptilimnium, Sagittaria, Typha*

Describes wetland creation techniques that employ heavy construction equipment. A preliminary report of the results of the first 6 months of this experimental project is presented. Four wetlands totaling 40 ha were created adjacent to a natural slough in Desota County, Florida. Heavy equipment was used to apply three mulching treatments: a-horizon soil from a nearby marsh dominated by St. Johns wort; deep organic soils from a nearby pickerelweed (*Pontederia cordata*) marsh; and no mulch, but a light seeding with rice. Vegetative composition of mulched areas after 6 months was more indicative of site conditions (e.g., water depth) than of mulch source. The mulched areas supported diverse vegetation that did not resemble the wetlands from which the mulch was taken. The unmulched areas supported sparse vegetation.

829. Ross, W. M. 1972. Methods of establishing natural and artificial stands of *Scirpus olneyi*. M.S. thesis, Louisiana State University, Baton Rouge. 99 pp.

Response: VEG

Genus: *Scirpus*

Determines methods for establishing Olney bulrush (*Scirpus olneyi*) and to identify factors affecting survival and growth of the plant. Plants were collected at Lake Pontchartrain, Louisiana; field studies were conducted at Rockefeller Refuge, Grand Chenier, Louisiana, and greenhouse studies were performed at Ben Hur Experiment Station near Baton Rouge. *Scirpus olneyi* survival and growth depends on maintenance of water levels at 5–10 cm (2–4 in.) above soil surface and maintenance of proper salinity levels. Of three planting methods tested, "till-only" provided the best site preparation, followed by a combination of tilling and burning.

830. Rosseland, B. O., and O. K. Skogheim. 1984. Attempts to reduce effects of acidification on fishes in Norway by different mitigation techniques. Fisheries 9(1):10–16.

Response: FISH, WQUAL

Genus: None

Discusses preliminary results of a 5-year Norwegian liming project (initiated in 1979). Describes mitigation techniques, including shellsand filters, lime slurry, powdered limestone, and soda, and effects on fish. Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) were used as test organisms. Substrate manipulation, limestone–shellsand wells, continuous dosing systems, and lake liming are included. Different methods are used depending on water quality, hydrology, and fish species or life stages.

831. Rossiter, J. A., and R. D. Crawford. 1981. Evaluation of constructed ponds as a means of replacing natural wetland habitat affected by highway projects in North Dakota. Univ. N. Dak. Dep. Biol. FHWA-ND-RD-(2)-79A. 169 pp.

Response: INVERT, WFOWL, NGBIRDS, SHOREB, VEG, SOIL, CHEM, SUCCESS

Genus: *Alisma, Carex, Chara, Eleocharis, Enteromorpha, Juncus, Lemna, Myriophyllum, Potamogeton, Ruppia, Sagittaria, Scirpus, Sparganium, Typha, Utricularia*

Describes a survey of 18 artificial wetlands constructed as part of highway projects in Pembena, Pierce, and Barnes Counties, North Dakota. The survey focused on use by waterfowl and abundance and types of vegetation and macroinvertebrates. All wetlands were constructed between 1975 and 1977 and studied during 1979–80. Includes Lumby Lake, a natural basin wetland near Manvel, North Dakota, in Grand Forks County. Provides detailed descriptions and comparisons; appendixes list bird species, vegetation, macroinvertebrates, and soil analysis results.

832. Rossiter, J. A., and R. D. Crawford. 1984. Evaluation of artificial wetlands in North Dakota: recommendations for future design and construction. Transp. Res. Rec. 948:21–25.

Response: WFOWL, VEG, WQUAL, ECON

Genus: Many

Provides an overview of artificial wetlands in the prairie pothole region of North Dakota. Recommendations for the design and construction of such wetlands are based on field studies and habitat requirements of waterfowl. Discusses design features such as size, shape, depth, bank gradient, vegetation, soils, water quality, and hydrology. Recommendations include: a series of wetlands of different sizes is preferable to one large wetland, multisided wetlands of varying depths are preferred by breeding waterfowl, bank gradients should not exceed a 10:1–20:1 slope, nesting islands should be constructed toward the center of the wetland, adjacent uplands should be seeded to provide cover and reduce erosion, wetlands may require sealing (with bentonite), and topsoil removed during excavation should be respread to provide adequate substrate for aquatic plants.

833. Rozsa, R. 1983. Tidal flow reduction factor in salt marsh restoration, tide gate developed, publication planned (Connecticut). Restor. Manage. Notes 1(4):26.

Response: None

Genus: *Phragmites*

Discusses displacement of natural salt marsh vegetation in Connecticut by aggressive common reed (*Phragmites australis*) and development of a self-regulating tide gate to restore tidal flows. Habitat modification induced by filling and especially by reduced tidal flushing are the main factors encouraging the displacement of salt marsh vegetation by *Phragmites*. Salinity levels are reduced, water table drops, and wetland soil dries, allowing *Phragmites* to invade and out-compete natural salt marsh vegetation. A self-regulating tide gate was developed to permit normal tidal flooding and flushing. The amount of water that enters the wetland is controlled by a combination of floats so that low-lying residential properties are not flooded. A feasibility study has been undertaken to determine methods of restoring degraded tidal wetlands.

834. Ruesch, K. J. 1983. A survey of wetland reclamation projects in the Florida phosphate industry. Florida Institute of Phosphate Research, Bartow. 59 pp.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, HYDRO, CHEM, WQUAL, SUCCESS

Genus: Many

Provides an overview of 35 wetland reclamation projects on phosphate mined land in Florida. Provides: size, location, goals, revegetation methods, plant survival, monitoring, and evaluation of techniques (successful or unsuccessful) for each project. Summarizes opinions of a variety of professionals and citizens regarding existing projects, criteria for judging project success, and suggestions for long-term monitoring.

835. Rushton, B. T. 1983. Examples of natural wetland succession as a reclamation alternative. Pages 148–169 *in* D. J. Robertson, ed. Reclamation and the phosphate industry: proceedings of the symposium. Florida Institute of Phosphate Research, Bartow.

Response: VEG, HYDRO, SOIL, CHEM

Genus: *Acer, Ampelopsis, Baccharis, Celtis, Cephalanthus, Fraxinus, Gordonia, Ilex, Liquidambar, Ludwigia, Magnolia, Myrica, Nyssa, Persea, Polygonum, Quercus, Rubus, Sabal, Salix, Sambucus, Taxodium, Typha, Ulmus, Viburnum*

Discusses natural succession on clay settling ponds in central Florida's phosphate region to provide a basis for designing reclamation alternatives. The ponds are rapidly colonized by willow (*Salix*) shrubs. Baldcypress (*Taxodium distichum*) or gum (*Nyssa*) grow in the lowest and wettest sites. If detritus is accumulated, succession may move toward bays or mixed hardwood swamps.

836. Rushton, B. T. 1984. Natural wetland regeneration in clay settling ponds. Pages 152–167 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, SUCCESS

Genus: *Acer, Baccharis, Myrica, Quercus, Salix*

Natural succession was evaluated on six clay settling ponds on phosphate strip-mining areas in Hillsborough and Polk Counties, Florida. Ponds varied in age from 2 to 60 years. Litter and woody species biomass increased over the first 30 years. Leaf area index increased from 1.1 to 3.3 during the first 12 years, but was only 3.6 after 60 years. Bottomland hardwoods were found in ponds more than 25 years old where flooding was limited and a nearby seed source was available. Oaks (*Quercus*) dominated the driest sites, red maple the more frequently flooded sites, and willow (*Salix*) the wettest sites.

837. Ruwaldt, J. J., Jr., L. D. Flake, and J. M. Gates. 1979. Waterfowl pair use of natural and man-made wetlands in South Dakota. J. Wildl. Manage. 43(2):375–383.

Response: WFOWL

Genus: *Scirpus, Typha*

Examines use of natural ponds and lakes, streams, stock ponds, and dugouts by pairs of waterfowl in South Dakota during May-June. Prairie ponds and lakes comprised 75% of the total area of wetlands, stock ponds 14%, and dugouts 1%. Semipermanent wetlands and stock ponds contained proportionally more pairs of most species than other wetland habitats. Lack of water in ephemeral, temporary, and seasonal wetlands during a drought year seemingly decreased use of the remaining more permanent wetlands (natural or man-made) by teal, northern pintail, and northern shoveler. Dabbling ducks, particularly mallard and wigeon, heavily used stock ponds both years; diving ducks selected natural wetlands almost exclusively.

838. Ryan, J. B., D. N. Riemer, and S. J. Toth. 1972. Effects of fertilization on aquatic plants, water, and bottom sediment. Weed Sci. 20(5):482–486.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Elodea, Myriophyllum, Potamogeton*

Describes field studies at Rutgers University Soils and Crops Research Center, Adelphia, New Jersey, to determine effects of fertilization on Eurasian water milfoil (*Myriophyllum spicatum*), *Elodea canadensis canadensis*, and heartleaf pondweed (*Potamogeton pulcher*). The bottom sediment was analyzed for cation exchange capacity, organic matter, total nitrogen, and available phosphorus after various fertilizer treatments. Water analysis included average concentrations of NH_4, NO_3, phosphorus, and potassium following fertilizer treatments.

839. Sacco, J. N., F. L. Booker, and E. D. Seneca. 1988. Comparison of the macrofaunal communities of a human-initiated salt marsh at two and fifteen years of age. Pages 282–285 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: INVERT, SUCCESS

Genus: *Spartina*

Compares macrofauna of the Snow's Cut marsh, Cape Fear River estuary, North Carolina, 2 and 15 years after the unvegetated dredge spoil island was planted with smooth cordgrass (*Spartina alterniflora*). After 2 years, the area resembled a natural marsh in both vegetative cover and dry matter production. After 12 years, the marsh vegetation was composed of mixed species in the upper elevation zones and was dominated by *S. alterniflora* in the lower elevation zones. Periodic sampling of the macrofauna through the fifteenth year revealed that the marsh supported 10.6 times more organisms than it did at 2 years of age. At 2 years of age, 91% of the macrofauna consisted of 2 species of amphipods, 1 species of mysid shrimp, and one species of dipteran larvae. After 15 years, the macrofauna consisted of oligochaetes (56%), polychaetes (36%), isopods (2%), tanaids (2%), and dipterans (1%), similar to macrofaunal communities of natural marshes.

840. Salisbury, E. 1970. The pioneer vegetation of exposed muds and its biological features. Philos. Trans. R. Soc. London 259(829):207–255.

Response: VEG, SOIL

Genus: *Bidens, Chenopodium, Cyperus, Eleocharis, Juncus, Ludwigia, Lythrum, Polygonum, Ranunculus, Riccia, Rorippa, Rumex, Scirpus*, many

Describes the characteristic pioneer vegetation of exposed mud in Britain. Discusses about 50 species of vegetation. Plants generally fruit in late summer or fall corresponding to the season of greatest evaporation and suitable habitat conditions, and propagules are generally small. The most frequent means of distant dispersal is probably adhesion to the feet and fethers of waterbirds. Summarizes the results of germination experiments on 38 plant species. Most species require light to germinate, are highly specialized for colonization of bare mud, and are intolerant of competition.

841. Sandrik, S. R., and R. F. Crabill. 1983. Natural systems reclamation at the Amax Chemical Corporation Big Four Mine. Pages 227–231 *in* D. J. Robertson, ed. Reclamation and the phosphate industry, proceedings of the symposium. Florida Institute of Phosphate Research, Bartow.

Response: MAMMALS, WFOWL, SHOREB, SUCCESS

Genus: *Acer, Gordonia, Liquidambar, Magnolia, Myrica, Panicum, Pinus, Pontederia, Taxodium, Typha*

Discusses general reclamation of phosphate-mined lands at the Big Four Mine in westcentral Florida, including a .8-ha (2-acre) tree planting test plot, a 12.5-ha (31-acre) floodplain hardwood forest, a 8.5-ha (21-acre) marsh, a 9-ha (22-acre) tributary floodplain forest, and a sand pine (*Pinus clausa*)

scrub forest. Red maples, (*Acer rubrum*) wax myrtles (*Myrica*), and bay species naturally reseeded disturbed sites from adjacent floodplain forests. Survival of potted or bare-root trees varied with species planted. Cattail (*Typha*) invasion on unvegetated wetland sites was rapid and created undesireable monoeultures. Transplanting organic mulch from other marshes provided a diverse seed and plant source and a quick start for marsh revegetation.

842. Sandusky, J. E. 1978. The potential for management of waterfowl nesting habitat on reclaimed mined land. Pages 325–327 *in* D. E. Samuel, J. R. Stauffer, and C. H. Hocutt, eds. Proceedings symposium on surface mining and fish–wildlife needs in the eastern United States. U.S. Fish Wildl. Serv., FWS/OBS-78/81.

Response: WFOWL

Genus: *Ceratophyllum, Dathonia, Erianthus, Panicum, Sagittaria, Setaria, Typha*

Discusses waterfowl use of 291 ha of southern Illinois surface mined land. Track-mounted bulldozers were used to level ridges and fill in valleys of a pit area so that slopes did not exceed 30%. An 88-ha lake with a maximum depth of more than 21 m was created, as well as 30 small ponds with depths of less than 2 ha each. The area was limed, fertilized, and sown with a grass-legume mixture and wheat. The variety of pond size provided nesting and brood rearing habitat for blue-winged teal (*Anas discors*), mallard (*Anas platyrhynchos*), and wood duck (*Aix sponsa*) the year following reclamation. Surrounding grasslands provided nest sites for blue-winged teal and, to a lesser extent, mallard.

843. Sanville, W. D., A. R. Gahler, J. A. Searcy, and C. F. Powers. 1976. Studies on lake restoration by phosphorus inactivation. U.S. Environ. Prot. Agency, Corvallis, Oreg., EPA-600/3-76-041. 53 pp.

Response: VEG, CHEM, WQUAL

Genus: *Anabaena, Ankistrodesmus, Aphanizomenon, Kirchneriella, Planktosphaeria, Scenedesmus*

Discusses treatment of Cline's Pond, a 0.4-ha farm pond, 32 km north of Corvallis, Oregon, with sodium aluminate for evaluation of a nutrient inactivation technique to control excessive eutrophication. Interpretation of the results was based on a comparison of limnological data collected after nutrient inactivation with data obtained 2 years before treatment. Dissolved oxygen, transparency, and pH suggested some improvement in water quality. Algae seemed to change from predominantly blue-green in color to green with an indication of a reduced algal standing crop.

844. Sapa, A. J. 1979. Restoration of wildlife habitat to offset project losses, Garrison Diversion Unit, North Dakota. Pages 318–321 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. RM-65.

Response: FISH, WFOWL

Genus: None

Provides a brief overview of proposed plans to mitigate the loss of wildlife habitat incurred by the construction of the Bureau of Reclamation's Garrison Diversion Unit in central–eastern North Dakota. The restoration plan includes filling of drainage ditches (in anticipation of natural revegetation), grass seeding, prairie wetland restoration with natural runoff as the water supply, land acquisition, establishment of smaller tracts of wetland dispersed over a large area, and wetland complexes interspersed with areas of upland habitat. Discusses local issues and political factors.

845. Sargent, W. B., and P. R. Carlson, Jr. 1987. The utility of Breder traps for sampling mangrove and high marsh fish assemblages. Pages 194–205 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: FISH, ECON

Genus: *Avicennia, Batis, Rhizophora, Salicornia*

Compares the use of Breder rectangular plastic fish traps to the use of throw nets and pull nets (modified scines) for sampling mangrove and high marsh fish assemblages within the Indian River Lagoon, 3 km north of Fort Pierce, Florida. Breder traps were efficient in even the densest vegetation while causing only minimal habitat disturbance. Statistical validity through replication was provided at reasonable cost and effort. A complete sampling scheme requires use of several gear types. Traps were a highly efficient method for sampling cyprinodontids and poeciliids in these habitats. Conclude that Breder traps are useful tools in functional assessment of natural and created wetland communities.

846. Saucier, R. T., C. C. Calhoun, Jr., R. M. Engler, T. R. Patin, and H. K. Smith. 1978. Synthesis of research results, dredged material research program: executive overview and detailed summary. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. DS-78-22. 189 pp.

Response: NGBIRDS, SHOREB, VEG, SOIL, CHEM, WQUAL

Genus: *Carex, Cyperus, Deschampsia, Distichlis, Festuca, Halodule, Panicum, Scirpus, Spartina, Triglochin*

Synthesizes results of comprehensive nationwide research programs performed by the U.S. Army Corps of Engineers Dredged Material Research Program (DMRP). The 250 studies of this program were conducted to develop methods for predicting environmental effects before project implementation. Results of laboratory studies were tested under field conditions. The most significant overall conclusion drawn from the DMRP was that no single disposal alternative is suitable for a geographic region or group of projects; each project must be evaluated individually. Summarizes 21 research tasks. Presents detailed accounts of the DMRP administrative aspects and goals.

847. Savage, T. 1972. Florida mangroves as shoreline stabilizers. Fla. Dep. Nat. Resour. Prof. Pap. Ser. 19. 46 pp.

Response: VEG, SOIL, ECON

Genus: *Avicennia, Laguncularia, Rhizophora*

Assesses the use of native mangrove species for shoreline stabilization and protection. Field and laboratory tests were conducted near Tampa Bay, Florida. Results indicated that black mangrove (*Avicennia germinans*) is probably the most suitable for use in a statewide shoreline rehabilitation program. Distribution, tolerance to adverse substrate conditions, inundation, nature of root systems, and growth rates were evaluated for black mangrove, red mangrove (*Rhizophora mangle*), and white mangrove (*Laguncularia racemosa*).

848. Savage, T. 1978. The 1972 experimental mangrove planting—an update with comments on continued research needs. Pages 43–71 *in* D. P. Cole, ed. Proceedings Fifth Annual Conference

on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Avicennia, Laguncularia, Rhizophora*

Provides a summary of observations of several mangrove plots along the westcentral Florida coast to examine the use of native mangroves for shoreline stabilization and protection. Compares growth progress by photographs, measuring leaf growth rates, hypocotyl thickness, and number of prop roots. Compares the amount of prop roots and leaf growth in plants on the northern exposed areas to plants on the eastern protected areas. Discusses general ecology and biology of mangroves, along with research needs.

849. Scharf, W. C. 1978. Colonial birds nesting on man-made and natural sites in the U.S. Great Lakes. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-10. 328 pp.

Response: WFOWL, NGBIRDS, SHOREB, SOIL

Genus: Many

Analyzes the use of natural and man-made sites by colonial nesting birds in the Great Lakes region. Habitats and nesting populations were determined by the use of aerial census, ground nest observations, and vegetation and soil analyses. Summarizes the number of nesting sites by species and the associated substrate and vegetation. Presents site specific information on colonies and vegetation sampling transects. Includes importance values of plants by transect and bird species. Includes recommendations on the management of spoil islands to aid plant succession and subsequent nesting use.

850. Scheider, W., and T. G. Brydges. 1984. Whole-lake neutralization experiments in Ontario: a review. Fisheries 9(1):17–18.

Response: FISH, WQUAL

Genus: None

Describes whole-lake neutralization efforts in several lakes near Sudbury, Ontario, Canada. Four acidic, metal-contaminated lakes were treated with calcium carbonate and calcium hydroxide; two of them also were fertilized with phosphorus 1–2 years later. Describes effects of neutralization, in terms of ph, metal concentrations, secehi transparency, depth of thermocline, and hypolimnetic temperature.

851. Schindler, D. W. 1974. Eutrophication and recovery in experimental lakes: implications for lake management. Science 184:897–899.

Response: VEG, WQUAL, CHEM

Genus: *Anabaena, Synedra, Tabellaria*

Discusses the effects of adding combinations of phosphorus, nitrogen, and carbon to several small lakes in northwestern Ontario, Canada. Phosphate and nitrate caused rapid eutrophication. A similar result was obtained with phosphate, ammonia, and sucrose, but recovery was almost immediate when phosphate additions were discontinued. Basins receiving only nitrogen and carbon remained at prefertilization conditions, whereas those receiving equal amounts of nitrate and sucrose quickly became highly eutrophic when phosphorous also was added. These results suggest that cultural eutrophication problems of the Great Lakes might be solved simply and swiftly by the use of phosphorus control measures, particularly the ban of detergent phosphates.

852. Schreiber, R. W., and E. A. Shreiber. 1978. Colonial bird use and plant succession on dredged material islands in Florida. Vol. I. Sea and wading bird colonies. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-78-14. 127 pp.

Response: WFOWL, SHOREB, VEG

Genus: None

Provides an overview of the use of dredged material islands in Florida by colonial nesting birds. Study areas included all waterways maintained by the U.S. Army Corps of Engineers, focusing on islands in or near Tampa Bay, Indian River, Citrus County-cross Florida barge canal, new Port Richey, and Fort Meyers. Twenty-six species of birds nest on these dredged spoil islands; many other birds use these islands for feeding and roosting. Recommendations include: restriction of human use of nesting and roosting areas, mammalian predator control, designation of prime sites as sanctuaries, erosion control on existing islands, and creation of new dredged material islands. Discusses habitat needs of various species of birds.

853. Schultze, R. F. 1984. Riparian system restoration by private landowners: an example of coordinated interagency assistance. Pages 965–967 *in* R. E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkley, Calif. Water Resour. Rep. 55.

Response: ECON

Genus: *Pinus, Populus, Salix*

Summarizes programs involving public and private cost-sharing and cooperation in restoring riparian resources on Willow Creek, Modoc County, northeastern California. Accelerated ersosion occurred in the late 1800's and 1900's due to heavy livestock grazing and timber harvesting. The California Soil Conservation Service and private individuals shared the costs ($200,000) of constructing grade control structures and a bridge apron, stabilizing current grade structures, shaping and protecting current rock riprap, reestablishing fish passages over the structures, revegetating with herbaceous and woody species, and future stocking of trout.

854. Schwartzmeier, J. 1977. Opening statement on wetland restoration. Pages 129–131 *in* C. B. Dewitt and E. Soloway, eds. Wetlands ecology, values, and impacts. Proceedings of Waukesha conference on wetlands. University of Wisconsin, Institute of Environ. Studies, Madison.

Response: VEG, SUCCESS

Genus: None

Provides an overview of wetland restoration activities in Waukesha County, Wisconsin. Some major points include: potential restoration sites are considered in terms of their connective corridor relations to other habitat areas; wetlands change over time—most shallow marshes have become "closed" habitats; and if average midsummer water levels are attained at a restoration–creation site, plant succession changes will occur fairly rapidly. Describes research needs.

855. Seehorn, M. E. 1985. Fish habitat improvement handbook. U.S. For. Serv. Tech. Publ. R8-TP7. 21 pp.

Response: FISH, HYDRO, ECON

Genus: None

Provides design specifications and applications for 16 fish habitat improvement techniques. The primary objective of the designs is to improve instream conditions by creating deeper water and overhead cover. Includes the purpose, design, placement, advantages, disadvantages, and costs for channel block, boulder placement, cover logs, tree cover, bank crib, log and

brush shelter, four types of deflectors, channel constrictor, cross log and revetment, wedge and k dams, gabions, and fish barriers.

856. Segal, D. S., P. J. Latham, and G. R. Best. 1987. Delineating a wetland boundary using vegetative, soil and hydrologie characteristics: a Florida cypress dome example. Wetlands 7:51–58.

Response: VEG, SOIL, CHEM

Genus: *Ilex, Lyonia, Nyssa, Pinus, Serenoa, Sphagnum, Taxodium, Vaccinium*

Describes a multiple parameter approach to delineating wetland boundaries of more obscure vegetation patterns such as Florida cypress domes. Soil and hydrologic parameters of a cypress dome near Gainesville, Florida, were integrated with vegetation characteristics. Edaphic factors found to be useful indicators of hydrologic conditions included percent organic matter in the a horizon and degree of mottling in the argillie horizon. Tree buttressing and lichen line formation also were reliable indicators of inundation. The wetland boundary delineated by these soil factors closely corresponded with the vegetation boundary determined both visually and by vegetation analysis.

857. Segelquist, C. A., G. T. Auble, and L. S. Ischinger. 1987. Soil-plant correlation studies for selected wetlands of the United States. Pages 7–10 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: None

Genus: Many

Describes a series of studies conducted by the U.S. Fish and Wildlife service to determine the relation between wetland plants and hydrie soils. Includes sampling design, vegetation sampling, and data analysis. Species dominance by wetland indicator classes (e.g., obligate wetland, facultative wetland) is determined for each vegetation stratum. The basic unit of study is a broadly defined wetland complex including uplands and all transition zones, and is relatively undisturbed by human activity.

858. Sempek, J. E., and C. W. Johnson. 1987. Wetlands enhancement at the Ogden Nature Center in Ogden, Utah. Pages 161–165 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American west: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, N.C.

Response: WFOWL, VEG, HUSE, SUCCESS

Genus: Many

Describes the design criteria, management guidelines, and reclamation of a eutrophic wetland 3 km (2 miles) west of Ogden, Utah. Avian indicator species were used to develop the wetland habitat model. Wetland vegetative zonation ranged from wet low prairie to deep emergent marsh and submerged or floating aquatics. Management guidelines include water level manipulations. Ponds and adjacent upland habitat are part of the overall plan.

859. Seneca, E. D. 1969. Germination responses to temperature and salinity of four dune grasses from the outer banks of North Carolina. Ecology 50(1):45–53.

Response: VEG

Genus: *Ammophila, Panicum, Spartina, Uniola*

Discusses germination responses to temperature and salinity of four dune grasses from the barrier islands off the coast of North Carolina. *Ammophila breviligulata*, shoredune panicum (*Panicum amarulum*), and marshhay cordgrass (*Spartina patens*) seeds germinated under certain alternating warm (65–95° F) temperatures without cold treatment. *Uniola paniculata* germination required cold (43° F) treatment for 30 days. This treatment also increased germination in all species. Based on germination response, *S. patens* is the most salt tolerant (upper limit of 4.0% NaCl), followed by *P. amarulum* (2.0% NaCl), *U. paniculata* (1.5% NaCl), and *A. breviligulata* (1.0% NaCl).

860. Seneca, E. D. 1974. Germination and seedling response of Atlantic and Gulf coast populations of *Spartina alterniflora*. Am. J. Bot. 61(9):947–956.

Response: VEG

Genus: *Spartina*

Discusses germination response to thermoperiod and seedling response to photoperiod-thermoperiod treatments for 12 populations of smooth cordgrass (*Spartina alterniflora*) from the Atlantic and Gulf coasts. Controlled environment and field seedling experiments indicated that southern populations flowered later, exhibited longer growing periods, and were less sensitive to photoperiod than northern populations. New England, mid-Atlantic, south Atlantic, and Gulf coast populations differed in height, color, flowering time, length of growing period, and morphology through two growing seasons in the field study.

861. Seneca, E. D. 1980. Techniques for creating salt marshes along the east coast. Pages 1–5 *in* J.C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG, SOIL, ECON, SUCCESS

Genus: *Spartina*

Describes the transplanting and seeding of smooth cordgrass(*Spartina alterniflora*) for salt marsh establishment at several sites along the coast of North Carolina. Direct seeding was feasible only in the upper half of the intertidal zone. At least two full growing seasons (17 months in North Carolina) are required for development of effective substrate stabilization. *Spartina* marshes established where salinities are low (5–10 ppt) will be invaded by other species. After 3–4 years, *Spartina* will no longer be dominant. Upper zones of such areas are inundated less frequently and invading species eventually out-compete *Spartina*.

862. Seneca, E. D. 1974. Stabilization of coastal dredge spoil with *Spartina alterniflora*. Pages 525–529 *in* R. J. Reimold and W. H. Queen, eds. Ecology of halophytes. Academic Press, New York.

Response: VEG, SOIL

Genus: *Spartina*

Describes experimental results of planting smooth cordgrass (*Spartina alterniflora*) on dredge spoil along the coast of North Carolina to stabilize the spoil and create salt marshes. Seeding requires less cost and labor than transplanting; however, transplants have a higher survival rate over a wider intertidal elevation range. Thus, transplants at .9- × .9-m (3- × 3-feet) spacing were used. After two growing seasons, an effective substrate-binding network of roots and rhizomes had developed. The zone for optimal growth was just below mean high water.

Describes supplemental studies in the laboratory, greenhouse, and controlled growth chambers.

863. Seneca, E. D., S. W. Broome, and W. W. Woodhouse. 1985. Comparison of *Spartina alterniflora* Loisel. Transplants from different locations in a man-initiated marsh in North Carolina. Wetlands 5:181–190.

Response: VEG

Genus: *Spartina*

Summarizes results of a study comparing transplant success for smooth cordgrass (*Spartina alterniflora*) taken from Beaufort, Oregon Inlet, Ocracoke Island, and Snow's Cut, North Carolina. Plants were hand-planted on dredged material in the Cape Fear River estuary near Snow's Cut. Tall and short height forms of *S. alterniflora* were taken from Beaufort; intermediate forms were taken from the other three locations. Over a 5-year period, the Beaufort tall forms at higher elevations (shorter inundation periods) decreased in height; short forms at the same location remained unchanged. At lower elevations, the tall forms remained the same and short forms increased in height. Transplants of intermediate height are recommended for stabilization and marsh creation purposes.

864. Seneca, E. D., S. W. Broome, W. W. Woodhouse, L. M. Cammen, and J. T. Lyon. 1976. Establishing *Spartina alterniflora* marsh in North Carolina. Environ. Conserv. 3(3):185–188.

Response: VEG, SOIL, CHEM, ECON, SUCCESS

Genus: *Spartina*

Summarizes a study of the stabilization of dredge material using smooth cordgrass (*Spartina alterniflora*) to prevent erosion and to replace salt marsh systems lost through dredging operations. Experimental sites were located along the North Carolina coast. Seeding required fewer man-hours, but was successful only in the upper intertidal zone and in protected areas. Transplanting was more expensive, but revegetation efforts were successful in exposed sites and at mean sea level. Aboveground production of *S. alterniflora* was 1,200 to 1,300 g/m^2/year in the 3–5 years. Belowground production was maximum after 2 years at 900 g/m^2/year and decreased thereafter. Based on sediment carbon content measurements, a newly planted marsh might take 4–25 years to resemble a natural marsh.

865. Seneca, E. D., W. W. Woodhouse, Jr., and S. W. Broome. 1976. Dune stabilization with *Panicum amarum* along the North Carolina coast. U.S. Army Corps Eng., Fort Belvoir, Virginia, Misc. Rep. 76–3. 42 pp.

Response: VEG, SOIL

Genus: *Ammophila, Panicum, Uniola*, many

Discusses techniques for propagating, handling, processing, and planting shoredune panicum (*Panicum amarum*) for dune stabilization along the North Carolina coast. Experimental plantings with emphasis on shoredune panicum, American beachgrass (*Ammophila breviligulata*), and sea oats were conducted at Duck and Drum inlets, North Carolina. On a sandy site with little sand movement, about 300 m inland, *Panicum* contributed more of the estimated cover through two growing seasons than either of the other two grasses. More than 2 years at a foredune site, *Panicum* accumulated only one-fourth the sand accumulated by beachgrass or mixed-species plantings. The principal values of *Panicum* are in stabilizing sandy coastal areas. Mixed plantings are best for building and stabilizing coastal foredunes in North Carolina.

866. Seneca, E. D., W. W. Woodhouse, and S. W. Broome. 1975. Salt-water marsh creation. Pages 427–437 *in* L.E. Cronin, ed., Estuarine research. Vol. II. Geology and engineering. Academic Press, New York.

Response: VEG

Genus: *Spartina*

Describes salt-water marsh creation, using smooth cordgrass (*Spartina alterniflora*), at Snow's Cut, North Carolina. Discusses tidal inundation, salinity, elevation gradients, and plant invaders. An additional experiment involved the colleetion of seeds from *S. alterniflora* in locations from New England to Texas. Seeds were stored for 3 months in estuarine water and then planted; morphological and physiological differences were apparent.

867. Shapiro, J. 1979. The need for more biology in lake restoration. Pages 161–167 *in* Lake restoration: proceedings of a national conference. U.S. Environ. Prot. Agency Rep. EPA-440/5-79-001.

Response: FISH, INVERT, CHEM, WQUAL, VEG

Genus: None

Presents an overview of the biological processes involved in the phosphorus loading of lakes, including fish density, summer chlorophyll, and zooplankton abundance in relation to total phosphorus. The symptoms of eutrophication are frequently worsened by the biological imbalance that follows and, in these instances, restoration must involve biological reconstruction.

868. Shapiro, J., V. Lamarra, and M. Lynch. 1975. Biomanipulation: an ecosystem approach to lake restoration. Pages 85–96 *in* P. L. Brezonik and J. L. Fox, eds., Proceedings of a symposium on water quality management through biological control. Univ. Fla. Rep. ENV. 07-75-1.

Response: FISH, INVERT, VEG, CHEM, WQUAL

Genus: *Anabaena, Aphanizomenon, Chlamydomonas, Mallomonas, Microcystis, Stephanodiscus*

Discusses the eutrophication process of lakes and presents preliminary results of several experiments to biomanipulate ecosystem parameters of a lake in St. Paul, Minnesota. Results indicated that adding zooplanktivores (yellow perch [*Perca flavescens*]) in enclosures to the system increased rate of photosynthesis. Orthophosphate concentrations were much higher in enclosures lacking yellow perch. Discusses the possibility of using various biomanipulation techniques (e.g., zooplankton and fish stocking, innoculating a lake with algae) to restore lake systems.

869. Sharp, W. C. 1982. Best of beach vegetation. U.S. Soil Conservation Service, Broomall, Pa. 24 pp.

Response: VEG

Genus: *Ammophila, Carex, Elymus, Ilex, Iva, Juniperus, Myrica, Panicum, Parthenocissus, Pinus, Prunus, Rosa, Spartina, Uniola*, many

Discusses dune building and management concepts for the coastal United States and along the shores of the Great Lakes. Descriptions of 8 herbaceous dune species and 11 shrubs and trees include recommended propagation techniques, wildlife use, and adaptation to various regions and environments. Techniques include the use of fences to create or protect dunes and the addition of fertilizers to promote growth of plants.

870. Sharp, W. C., C. R. Belcher, and J. Oyler. 1976. Vegetation for tidal shoreline stabilization in the mid-Atlantic States. U.S. Soil Conservation Service, Broomall, Pa. 19 pp.

Response: VEG

Genus: *Ammophila, Spartina*

Discusses planting of vegetation to stablize tidal shorelines in the mid-Atlantic States. Discusses three species most useful for shoreline stabilization: smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*S. patens*), and American beachgrass (*Ammophila breviligulata*). Presents guidelines for evaluating vegetative treatment potential for individual sites and techniques for establishing and managing plantings.

871. Sharp, W. C., and J. Vaden. 1970. Ten year report on sloping techniques used to stabilize eroding tidal river banks. Shore and Beach 38:31–35.

Response: VEG, SUCCESS

Genus: *Ammophila, Panicum, Spartina*

Summarizes the results of shoreline stabilization through vegetative establishment at five locations along the Rappahannock River, Dymers Creek, and Potomac River in Virginia. The sloping and planting technique was useful for erosion control at sites suitable for planting smooth cordgrass (*Spartina alterniflora*) and marshhay cordgrass (*S. patens*), with littoral drift for sand accumulation, and not severely exposed to normal storm paths. Fertilization was required to maintain cover. Cordgrass was best adapted to beach stabilization; dune panic grass was of limited value. American beachgrass (*Ammophila breviligulata*) was preferred for sand trapping.

872. Shisler, J. K., and D. Charette. 1986. Evaluation of artificial salt marshes in New Jersey. Natl. Wetl. Newsl. 8(3):4–5.

Response: INVERT, VEG, SOIL, CHEM, SUCCESS

Genus: *Baccharis, Iva, Phragmites, Scirpus, Spartina*

Describes a recently completed study of artificial salt marshes in New Jersey. Eight marshes, each with an adjacent natural salt marsh, were selected for qualitative evaluation. Measures three variables at each marsh: vegetational species, sediment (sand, dredged material, and original marsh peat) characteristics, and macroinvertebrate populations. Compares statistical values to natural marsh values. High marsh creation projects using marshhay cordgrass (*Spartina patens*) were less successful than low marsh projects using smooth cordgrass (*S. alterniflora*).

873. Short, F. T. 1987. Effects of sediment nutrients on seagrasses: literature review and mesocosm experiment. Aquat. Bot. 27:41–57.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Syringodium, Zostera*

Presents an overview of the effects of sediment nutrients on seagrasses and discusses a mesocosm experiment that showed the effects of various nutrients on growth of common eelgrass (*Zostera marina*) collected from Great Bay, New Hampshire. Seagrass growth, abundance, and morphology are strongly linked to available nutrient resources of the sediment. In north temperate climates and in habitats with terrigenous sediments, nitrogen limitation occurs in both intertidal and subtidal beds. Tropical seagrasses and those grown in carbonate sediments seem to experience phosphorus limitations. Mesocosm experiments are particularly useful for isolating one environmental factor from the complexities of plant and environmental interaction.

874. Shuey, A. G., and L. J. Swanson, Jr. 1979. Creation of freshwater marshes in west central Florida. Pages 57–76 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, WQUAL

Genus: *Andropogon, Axonopus, Azolla, Bacopa, Carex, Centella, Cephalanthus, Conyza, Cynodon, Cyperus, Digitaria, Diodia, Echinochloa, Eleocharis, Eragrostis, Erechtites, Eryngium, Eupatorium, Fimbristylis, Hedyotis, Hydrochloa, Hydrocotyle, Hypericum, Juncus, Leersia, Lindernia, Lippia, Ludwigia, Lycopus, Nymphoides, Panicum, Paspalum, Phaseolus, Pluchea, Polygonum, Pontederia, Proserpinaca, Psilocarya, Rhexia, Rhynchospora, Rumex, Sacciolepis, Sagittaria, Scleria, Scoparia, Solidago, Spartina, Typha, Utricularia, Woodwardia, Xyris*, many

Describes methods for restoring freshwater marsh vegetation. Study sites were at Four Corners mine in southeast Hillsborough and northeast Manatee Counties, Florida. Testing consisted of natural recolonization, selective planting, and (3) mulching with organic matter from a nearby natural marsh. Water samples were analyzed (in both artificial and in nearby natural marshes) for pH, dissolved oxygen, biological oxygen demand, ammonia, organic nitrogen, ortho-phosphate, and turbidity. After 1 year, 62 plant species were found on the mulched site, 34 on areas selectively planted, and 27 on natural recolonization (control) areas.

875. Sikkema, D. A., and P. C. Rosendahl. 1981. Prediction and assessment of the hydrologic conditions following the restoration of flow within an altered riverine system. Wetlands 1:105–109.

Response: HYDRO

Genus: None

Describes the restoration of a portion of the Turner River in the Big Cypress National Preserve, Florida. River flow was restored by placing a plug and culvert system at the intersection of the river's headwaters and the Turner Canal (constructed in the 1960's). Examines hydrologic conditions following this action. Yearly occurrence of flow within the river was estimated to increase from 38 to 88% of the time. During 1 year, the estimated mean stage increase for the river was about .3 m (1 foot).

876. Silker, T. H. 1948. Planting of water-tolerant trees along margins of fluctuating-level reservoirs. Iowa State J. Sci. 22:431–447.

Response: VEG

Genus: *Chamaecyparis, Fraxinus, Liquidambar, Nyssa, Platanus, Quercus, Taxodium*

Discusses results of a study on the establishment of reservoir-margin tree plantings on the lower Tennessee River in Kentucky and Tennessee. Data on survival, height, and adaptation of trees to changing water tables and to soil and groundcover conditions were obtained for 5- to 12-year-old plantings. Includes recommendations for plantings of these species in both the 0.3- to 4.6-m (1- to 15-feet) above normal pool level (infrequently flooded) and the upper drawdown zone (intermittently covered by 0.3–0.9 m [1-3 feet] of water).

877. Silverman, G. S. 1983. Seasonal freshwater wetlands development and potential for urban runoff treatment. Ph.D. dissertation, University of California, Los Angeles. 191 pp.

Response: HUSE, HYDRO, CHEM, WQUAL, ECON

Genus: None

Analyzes the potential for developing wetlands in San Francisco Bay to reduce the pollutant load from urban stormwater runoff. A demonstration marsh was used as a prototype wetlands system. Information from this marsh indicated that wastewater processing efficiencies varied considerably as vegetation became established and storm flows were considered. Describes physical mechanisms such as sedimentation, adsorption, filtration, biological degradation, and uptake. More research is needed on the environmental fate of pollutants. Discusses financial and regulatory processes needed to accomplish marsh construction.

878. Singh, K. P., V. Kothandaraman, D. F. Sefton, and R. P. Clarke. 1984. Economic returns and incentives of lake rehabilitation: Illinois case studies. Pages 405–411 *in* Proceedings, Third Annual Conference of the North American Lake Management Society: lake and reservoir management. U.S. Environ. Prot. Agency, EPA 440/5/84-001.

Response: HUSE, CHEM, WQUAL, ECON

Genus: Many

Describes studies conducted on three eutrophic impoundments in Illinois: Lake Le-aqua-na, Stephenson County; Johnson Sauk Trail Lake, Henry County; and Lake of the woods, Champaign-Urbana-Rantoul standard metropolitan statistical area. Includes descriptions of practical and economically viable methods for improving water quality and enhancing recreational uses. Includes methods for shore stabilization, aeration-destratification, harvest of aquatic macrophytes, and application of herbicides for algal control.

879. Skinner, M. M. 1971. Free meander pattern in intermontane rivers. Ph.D. dissertation, University of Colorado, Boulder. 125 pp.

Response: HYDRO, SOIL

Genus: None

Describes the use of aerial photography to determine river pattern data from freely meandering stretches of 11 rivers in the rocky mountain region of Colorado, Wyoming, and Montana. Demonstrates statistical relations between mean radius of curvature and average daily discharge and between tortuosity ratio and stream slope. Presents recommendations for using various types of photography to determine preconditions and for monitoring of river pattern alterations or relocations.

880. Skinner, Q. D., M. A. Smith, J. L. Dodd, and J. D. Rodgers. 1985. Reclamation of riparian zones and water law: first in time-first in right. Pages 374–378 *in* R. R. Johnson, et al., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses. U.S. For. Serv. Gen. Tech. Rep. RM-120.

Response: HYDRO

Genus: None

Describes the application of water law concepts to reclamation of riparian zones in Wyoming. Discusses reclamation in terms of increasing groundwater storage, creating desirable aquatic habitat, controlling nonpoint source pollution, and increasing forage and species diversity (plants and animals) through water storage in riparian areas. Goals of two major riparian research programs in Wyoming were to store water for prolonged use downstream, control nonpoint source pollution, develop reclamation strategies for degraded streams, and advance state-of-the-art methods for range ecosystem management. Describes applications of these goals to the reclamation of a cold desert steppe stream.

881. Slavin, P., and J. K. Shisler. 1983. Avian utilization of a tidally restored salt hay farm. Biol. Conserv. 26:271–285.

Response: WFOWL, SHOREB, VEG, NGBIRDS

Genus: *Aster, Baccharis, Distichlis, Iva, Phragmites, Pluchea, Salicornia, Solidago, Spartina*

Determines changes in vegetation and bird use of a salt hay farm in Delaware Bay near Heisterville, New Jersey. Three study plots in a 215-ha study area were selected for analysis: a salt hay farm of marshhay cordgrass (*Spartina patens*); a salt hay farm restored to tidal inundation with surface water and occasional exposed mud (1% was vegetated); and a restored salt hay farm with cycles of tidal inundation, some bare areas, surface water, and 15% *S. patens* cover. The vegetation was surveyed through the use of aerial photos. Birds were surveyed by vehicular transects. Compares bird populations (number of individuals and number of species) on all three plots.

882. Small, M. M. 1978. Artificial wetlands as non-point source wastewater treatment systems. Pages 171–181 *in* M. A. Drew, ed. Environmental quality through wetlands utilization. Coordinating counc. on the restoration of the Kissimmee River valley and Taylor Creek-Nubbin Slough basin, Tallahassee, Fla.

Response: CHEM, WQUAL

Genus: None

Describes a nonpoint source wastewater treatment system that consists of a created wetland and seems to be applicable for farm wastewater drains in Taylor Creek, Kissimmee River basin, Florida. Based on experimentation with various modifications of a meadow–marsh–pond design to remove inorganic nitrogen and phosphorus, a marsh–pond combination was designed for use at individual farms to remove some water by evaporation, a lot of nitrogen by denitrification, and the major portion of available phosphate by the harvest and removal of indigenous aquatic weeds from the basin. This system would eliminate much of the annual dump of phosphorus into Lake Okeechobee. Principal contaminant reductions relate amount of raw sewage with input and output values of BOD total nitrogen, and so forth.

883. Smart, R. M., and J. W. Barko. 1978. Influence of sediment salinity and nutrients on the physiological ecology of selected salt marsh plants. Estuarine Coastal Mar. Sci. 7:487–495.

Response: VEG, SOIL, CHEM

Genus: *Distichlis, Spartina*

Investigates the influence of salinity and nutrients on the physiological ecology of smooth cordgrass (*Spartina alterniflora*), *S. foliosa*, marshhay cordgrass (*S. patens*), and seashore saltgrass (*Distichlis spicata*) grown in a laboratory tidal simulation system. Growth of *S. alterniflora* and *D. spicata* was much greater on fine-textured sediments than on sand and also greater on clay than on silty clay. Maximum growth of *S. foliosa* and *S. patens* also was on clay, with no significant differences in growth on sand and silty clay. The plants are known to be salt secreting and capable of ion exclusion, which in some instances resulted in increased sediment salinity. Discusses the importance of salinity to plant growth in relation to other environmental factors.

884. Smart, R. M., and J. W. Barko. 1985. Laboratory culture of submersed freshwater macrophytes on natural sediments. Aquat. Bot. 21:251–263.

Response: VEG, SOIL, CHEM

Genus: *Hydrilla, Myriophyllum, Potamogeton*

Describes the laboratory culture of various submersed macrophytes. The use of natural sediments in these cultures as the source of nitrogen, phosphorus, and other nutrients was successful and prevented large occurrences of algal blooms. Reviews growth requirements of submersed macrophytes and the effectiveness of sediments as a nutrient source. Describes chemical composition and formulation of culture solutions, along with various types of sediment substrate.

885. Smirnov, A. P., and S. M. Kirov. 1985. Composition of soil air in a reclaimed highmoor bog. Sov. Soil Sci. 18(2):58–63.

Response: HYDRO, SOIL, CHEM

Genus: None

Examines the composition of soil air in a drained shrub-sphagnum peat bog in Tosnenskoye Forest Preserve, Leningrad Oblast, Russia. Measures soil temperature and groundwater levels. Air at depths of 10, 25, and 40 cm was analyzed. Levels of carbon dioxide concentrations in drained peat beds may be 10–20 times higher than those in slightly drained or undrained areas. Discusses seasonal dynamics of carbon dioxide concentrations as a function of moisture and temperature. The high carbon dioxide content of soil air in drained bogs may contribute to the absence of pine roots at depths greater than 10–15 cm.

886. Smith, B. H., and J. D. Dunder. 1984. Bone Draw: riparian rehabilitation for development of a seasonal sport fishery. Pages 117–124 *in* D. L. Archer, ed. Proceedings of the Bonneville Chapter of the American Fisheries Society. Bonneville Chapter of the American Fisheries Society, Salt Lake City, Utah.

Response: FISH

Genus: None

Discusses rehabilitation of Bone Draw, an ephemeral tributary of the Big Sandy River, southwest of Eden, Wyoming; a portion of the stream is perennial. Riparian pastures were fenced to control livestock grazing and thus enhance vegetative streambank stabilization. Instream habitat development consisted of gabion and log drop overpour structures. Artificial redds were installed and 5,000 rainbow trout (*Oncorhynchus mykiss*) sac fry were placed in the stream. As the amount of trout spawning activity increased over the 2–5 years after stream rehabilitation, more river run gravel was added to the stream, in addition to an artificial spawning box device (illustrated in text). Fish abundance has increased substantially on the study site.

887. Smith, B. M., and E. P. Hill. 1979. Waterfowl use of strip-mine ponds in Alabama. Proc. Ann. Conf. Southeast. Assoc. Fish Wildl. Agencies 33:1–10.

Response: INVERT, WFOWL, VEG

Genus: *Carex, Cephalanthus, Chara, Eleocharis, Juncus, Myriophyllum, Najas, Potamogeton, Scirpus, Typha, Utricularia*

Discusses waterfowl use of 23 coal strip-mine ponds in northwestern Alabama. Ponds were 5, 15, or 25 years old. Vegetation, cover, waterfowl food production, and waterfowl use increased with pond age. Species most frequently observed on the ponds were wood duck (*Aix sponsa*), ring-necked duck (*Aythya collaris*), and pied-billed grebe (*Podilymbus podiceps*). Lack of shoal water limited food resources, and lack of cover on younger ponds limited watefowl use. Ponds 1.5 ha or larger seemed to be used more heavily by waterfowl than smaller ponds. Discusses suggestions for enhancing waterfowl use of reclaimed strip mines, including: constructing ponds with increased shoreline length of irregular shape, gently sloping pond bottoms, and increased shoal areas; replacing topsoil (a better substrate for rooted vegetation); and establishing wood duck nesting boxes near ponds.

888. Smith, D. C. 1981. Shore erosion control demonstrations in Florida. Pages 87–98 *in* R. H. Stovall, ed., Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Avicennia, Casuarina, Coccoloba, Elaeagnus, Laguncularia, Paspalum, Pinus, Quercus, Rhizophora, Spartina*

This study was part of a demonstration program under the Shoreline Erosion Control Demonstration Act of 1974. Success of wetland species establishment was monitored at Stuart and Jensen Beach causeways and Basin Bayou State Recreation Area in Florida. Cordgrass (*Spartina*) was expected to flourish where roots were established. Red mangrove (*Rhizophora mangle*) should be at least 0.6 m (2 feet) tall to withstand wave action and sea vegetation overtopping. *Paspalum* was established easily and spread rapidly.

889. Smith, D. D. 1983. A practical evaluative procedure for the design of coastal wetland restoration projects. Pages 1477–1487 *in* Proceedings coastal zone '83. American Society Civil Engineers, New York.

Response: SUCCESS

Genus: None

Presents a practical, multistep evaluative procedure that aid assessment of biological benefits, technical feasibility, and cost of alternative designs to select the optimum wetland restoration design for coastal areas. The 10 major steps of the procedure are: select a restoration site, define biological objectives and constraints, specify biological design criteria, develop preliminary alternative engineering designs, assess feasibility and costs of alternative designs, conduct biological review of alternative designs, revise engineering designs based on biological review, conduct iterative biological and engineering reviews of revised designs, select a preferred alternative, and develop a habitat restoration plan.

890. Smith, D. D., T. E. Firee, C. T. Mitchell, and M. L. Whitt. 1975. Feasibility of using dredge spoil to generate a wildlife reserve and salt marsh in San Diego Bay, California. Pages 180–187 *in* Ocean 75 Record, San Diego, Calif.

Response: ECON

Genus: None

Summarizes the approach used for a multi-disciplinary feasibility study of using dredge spoil to ereate a wildlife reserve and salt marsh in San Diego, California. The study involved extensive interaction among regulatory agencies and environmental groups to assess the proposal of using about 764,600 m^3 (1 million cubic yards) of unpolluted dredge material sediment from a small boat basin to build a 36- to 40.5-ha (90- to 100-acre) island-like wildlife reserve and associated salt marsh. The feasibility study indicated that the project would be environmentally beneficial, compatible with existing local multiple land-water use, and feasible from an engineering point of view.

Using hydraulic dredging and confined disposal, the project would cost $1.5 million.

891. Smith, H. K. 1978. An introduction to habitat development on dredged material. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. DS-78-19. 40 pp.

Response: VEG

Genus: None

Reviews results concerning habitat development on dredged material. Four general habitats are suitable for development: marsh, upland, island, and aquatic. Emphasis is placed on habitat site selection. Each habitat is evaluated using factors such as dredged material type, engineering costs, and environmental effects. Discusses favorable wildlife habitat conditions and procedural guidelines.

892. Smith, H. K. 1980. Coastal habitat development in the dredged material research program. Pages 117–125 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: SHOREB, VEG, ECON

Genus: *Peltandra, Pontederia, Sagittaria, Spartina*

Describes the development of coastal habitat as part of the U.S. Army Corps of Engineers dredged material research program objectives. Includes habitat development field study locations and describes studies. Discusses the coastal habitat development program in five sections: effects of dredged material on marsh and upland habitat, marsh development, terrestrial habitat development, aquatic habitat development, and island habitat development.

893. Smith, H. K. 1978. Habitat creation with dredged material. World Dredging Mar. Constr. 14:14–19.

Response: SHELLF, MAMMALS, NGBIRDS, SHOREB, VEG, ECON

Genus: *Andropogon, Borrichia, Carex, Croton, Cynodon, Dactylis, Deschampsia, Distichlis, Festuca, Halodule, Iva, Juncus, Lolium, Myrica, Panicum, Peltandra, Phleum, Phragmites, Pinus, Pontederia, Quercus, Rhus, Ruppia, Sagittaria, Salicornia, Scirpus, Spartina, Syringodium, Tamarix, Thalassia, Trifolium, Zostera*, many

Evaluates wetland, inland, and terrestrial habitat development as a dredged material disposal alternative and summarizes feasibility studies from 11 sites. Discusses the development of the following marsh types: marsh, terrestrial, marsh–terrestrial, seagrass, and island. Describes size, cubic yards of material used or removed, plant responses, and general habitat improvements for each development site.

894. Smith, H. K. 1976. Habitat development on dredged material. Pages 856–865 *in* P. A. Krenkel, J. Harrison, and J. C. Burdick, III, eds. Proceedings of the specialty conference on dredging and its environmental effects. American Society of Civil Engineers, New York.

Response: None

Genus: None

Discusses the operational contraints and social, governmental, legal, and physical factors that affect habitat development on dredged material sites of the coastal United States. Includes a brief overview of nine dredged material research program sites of the U.S. Army Waterways Experiment Station. Habitat development is particularly sensitive to operational delays (e.g., caused by unavailability of equipment or equipment failure) due to restricted planting season (onset of growing season). Social factors include concerns about replacing one resource with another (e.g., a fishing area with a marsh) and possible health hazards from polluted dredged material. Governmental and legal factors include limited contruction and disposal areas and ownership of newly created sites.

895. Smith, L. M., and J. A. Kadlec. 1983. Seed banks and their role during drawdown of a North American marsh. J. Appl. Ecol. 20:673–684.

Response: VEG

Genus: *Distichlis, Eleocharis, Polypogon, Rumex, Salicornia, Scirpus, Typha*, many

Describes and compares size and species composition of seed banks among five vegetation types: cattail (*Typha*), tule bulrush (*Scirpus acutus*), alkali bulrush (*S. maritimus*), seashore salt-grass (*Distichlis spicata*), common reed (*Phragmites australis*), and open water. The study site was Ogden Bay waterfowl management area near Ogden, Utah. For each type, 25 soil samples were exposed to moist soil and submerged conditions in a greenhouse. Discusses soil conductivity and moisture, marsh seed banks, and marsh management. Used in conjunction with soil data, seed bank information can be used in management decision making (e.g., timing and degree of drawdowns).

896. Smith, R. D., and J. H. Sather. 1985. The Des Plaines River wetlands demonstration project. Vol. IV. Research plan. Wetlands Research, Inc., Chicago, Ill.

Response: FISH, INVERT, MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT, VEG, HUSE, HYDRO, CHEM, WQUAL, ECON, SUCCESS

Genus: Many

Describes the research program for the Des Plaines River wetlands demonstration project, a plan to restore wetlands on a 182-ha (450-acre) site along 4.5 km (2.8 miles) of the upper Des Plaines River, Lake County, Illinois. The watershed is 80% agricultural and 20% urban. The research program calls for: collection of environmental (hydrologic, climatologic, etc.) data; development of surface and groundwater hydrologic budgets; development of water quality budgets and descriptions of research methods; effects of the project on fluvial processes; evaluation of techniques for restoring native plant communities; evaluation of physical and chemical properties of soils and their effects on vegetation; description of the role of microorganisms; monitoring of aquatic macroinvertebrates and selected terrestrial insects, reptiles, and amphibians; research dealing with fisheries, migratory and breeding bird populations, and mammals; and research related to public use.

897. Smith, V. H., and J. Shapiro. 1981. A retrospective look at the effects of phosphorus removal in lakes. Pages 73–77 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environmental Protection Agency, Portland, Me., EPA 440/5-81-010.

Response: VEG, CHEM, WQUAL

Genus: None

Examines 16 north temperate lakes that have undergone restoration and show reductions in chlorophyll a, which accompany phosphorus removal. The exact response of each lake to phosphorus removal was unique. Suggest that these differences in response result to a large extent from changes in the

ratio of total nitrogen to total phosphorus accompanying restoration. Presents and tests a variable chlorophyll yield model, which depends explicitly on the total nitrogen:total phosphorus ratio using data from Lake Norrviken (Sweden). The new model seems to greatly reduce chlorophyll predietion error in lakes undergoing restoration.

898. Snyder, B. D., and G. L. Potter. 1981. The eritical links between baseline studies and development of revegetation and wildlife restoration plans. Pages 507–510 *in* E. H. Graves, ed. Proceedings 1981 symposium on surface mining hydrology, sedimentology, and reclamation. University of Kentucky, OES Publication, Lexington.

Response: SUCCESS

Genus: None

Discusses condueting premining baseline vegetation and wildlife studies for summary evaluations of outstanding ecological resources, assessing projeet-related effects and designing revegetation and wildlife habitat restoration projects. Recommendations are suggested for alleviating some common deficiencies that often occur during the process of synthesizing baseline data into an integrated natural resource restoration program.

899. Snyder, B. D., and J. L. Snyder. 1984. Feasibility of using oil shale wastewater for waterfowl wetlands. U.S. Fish Wildl. Serv., FWS/OBS-84/01. 290 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON, WFOWL

Genus: *Distichlis, Potamogeton, Ruppia, Scirpus, Typha*

Presents the results of a researeh study that evaluated the use of oil shale wastewater for waterfowl wetlands in the Washakie, Green River, Uintah, and Piceance basins of the Rocky Mountains. Characterizes physical and chemical properties of wastewater. Discusses ecological principles, wetland types, and waterfowl dynamics. Discusses design, engineering, institutional, legal, and wastewater treatment feasibility and costs. List eight recommendations for future projects. Appendixes include information on chemical composition of oil shale wastewater, effects of chemical constituents on major wetland biotic components, sclected state water quality standards, and wetland design criteria.

900. Snyder, C. D., and E. C. Aharrah. 1984. The influence of the *Typha* community on mine drainage. Pages 149–153 *in* D. H. Graves, ed. Proceedings 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publication, Lexington.

Response: VEG, CHEM

Genus: *Alternanthera, Carex, Eichhornia, Elodea, Equisetum, Justicia, Scirpus, Typha*

Discusses the influence of cattails (*Typha*) on the water quality of coal-mined sites in Clarion County, Pennsylvania. The concentrations of iron and manganese and pH increased as water flowed through two two-pond systems containing cattails. Water quality remained constant or deteriorated in nonvegetated ponds. Cattails from mined sites accumulated more iron and manganese in the roots–rhizomes than cattails from nonmined sites. Suggest that cattails may provide an environment for bacteria or algae that function as oxidizers and are agents in the removal of metallic ions.

901. Snyder, C. T. 1982. Restoration as a method for dealing with unauthorized wetlands alterations: the Mississippi experience. Pages 54–68 *in* F. J. Webb, ed. Proceedings of the Ninth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Juncus, Spartina*

Examines the legal, regulatory, social, and economie problems associated with the required restoration of coastal Mississippi wetlands damaged by unauthorized landform alterations. Restoration success depends on the ability and willingness of the violator to comply with regulations and implement restoration plans effectively. Describes several instances: waterfront lot development, private residential canals, and residential shoreline modification. Discusses the eircumstances surrounding each case along with the reasons for the success or failure of each restoration effort.

902. Snyder, R. M. 1978. Revegetation on erosion prone estuarine beaches. Pages 162–176 *in* D. P. Cole, ed. Proceedings of the Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, HUSE

Genus: *Rhizophora, Spartina*

The use of commereially available filter fabrie to prevent erosion was effective in the revegetation of an estuarine shoreline of the Loxahatehee river, Palm Beaeh County, Florida. Smooth cordgrass (*Spartina alterniflora*) and red mangrove (*Rhizophora mangle*) were planted at a minimum density of one 15.24-cm (6-inch) clump on 1.2- to 1.8 m (4- to 6-foot) centers. Lightweight filter fabrie (consisting of nylon fibers woven into a base fabrie of polypropylene strands) was placed with its upper edge above the highest spring tide and stabilized with vines and rubble to dissipate wave aetion and provide protection for red mangrove (*Rhizophora*) seedlings.

903. Snyder, R. M. 1986. Wetland rehabilitation—the holistic approach. Pages 10–18 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Assoeiation of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: Many

Describes an approach to wetland rehabilitation planning that considers nonlinear mechanics as an insight into plant community response. Equations incorporating exitation, inertia, damping, and restoring forces are applied to wetland systems. Diseusses system interaction and response curves. The holistic approaeh is then applied to the Admiral's Cove project in Palm Beach County, Florida. Elevation considerations, hydrodynamic circulation, groundwater influences, and plant material and hydrie soils from natural areas were the main components of this wetland rehabilitation effort.

904. Snyder, R. M., L. J. Greenfield, D. Schackelford, and S. Beeman. 1983. Wetland vegetation and agronomy—preliminary report. Pages 196–200 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Rhizophora, Spartina*

This paper is a preliminary report on the growth of smooth cordgrass (*Spartina alterniflora*) and mangrove species along revegetated canal banks in northern Palm Beach County, Florida. More than 20.25 ha (50 acres) of fringe salt marsh

were created. General observations regarding plant growth influences are groundwater level variations may lead to invasion by freshwater plant species at upper elevations; soil characteristics affect plant growth; and new growth may be shaded (and subsequently suppressed) by lush growth and dieback. The presence of cordgrass (*Spartina*) facilitates natural invasion and growth of mangrove seedlings. Large numbers of red mangrove (*Rhizophora mangle*) and white mangrove (*Laguncularia racemosa*), and some black mangroves (*Avicennia germinans*) have invaded planted areas.

905. Soileau, D. M. 1968. Vegetative reinvasion of experimentally treated plots in a brackish marsh. M. S. thesis, Louisiana State University, Baton Rouge. 75 pp.

Response: VEG, CHEM, WQUAL

Genus: *Distichlis, Scirpus, Spartina*, many

Describes the effectiveness of using tilling, burning, chemical application, or a combination of treatments in retarding the growth of marshhay cordgrass (*Spartina patens*) and seashore saltgrass (*Distichlis spicata*) and promoting the invasion of saltmarsh bulrush (*Scirpus robustus*) on a coastal marsh, Rockefeller Wildlife refuge, Louisiana. Burning and tilling reduced the growth of marshhay cordgrass and seashore saltgrass; a combination of the two methods was more effective. Saltmarsh bulrush successfully reinvaded the plots. Use of chemicals was more effective in eliminating undesirable species, but retarded growth of the saltmarsh bulrush.

906. Soots, R. F., Jr., and M. C. Landin. 1978. Development and management of avian habitat on dredged material islands. U.S. Army Eng. Waterways Exp. Stn, Vicksburg, Miss., Tech. Rep. DS-78-18. 134 pp.

Response: WFOWL, NGBIRDS, SHOREB, VEG, SUCCESS

Genus: Many

Summarizes findings from seven regional studies to determine dredged material island use by colonizing waterbirds. Development and management of the islands include five objectives: record use of islands by nesting birds, document succession of vegetation, compare vegetation on diked and undiked islands, compare vegetation and bird use on natural and man-made sites, and study year-round and migratory use of dredged material islands. The majority of birds on the islands were tree nesting species. Habitat needs indicate the importance of management of existing islands. Identifies eight habitat types for nesting. Reviews breeding biology and nesting substrate characteristics. Discusses techniques, management plans, and problems.

907. Soots, R. F., and J. F. Parnell. 1975. Introduction to the nature of dredge islands and their wildlife in North Carolina and recommendations for management. Pages 1–34 *in* J. F. Parnell and R. F. Soots, eds. Proceedings of a conference on management of dredge islands in North Carolina estuaries. Univ. ND.C. Sea Grant Coll. Prog. Publ. UNC-SG-75-01.

Response: NGBIRDS, SHOREB, VEG

Genus: *Ammophila, Atriplex, Baccharis, Cakile, Cenchrus, Distichlis, Erigeron, Euphorbia, Heterotheca, Iva, Myrica, Oenothera, Panicum, Phragmites, Scirpus, Spartina, Strophostyles, Triplasis*

Discusses succession of plants and associated bird species on dredge material islands of the North Carolina coast. Recommendations for management of these islands for nesting birds include avoid deposition of dredge spoil from early April–July (nesting season), decrease slope of dome to create better nesting sites, cut down or bulldoze trees or shrubs beneath deposition site on older islands because seabirds do not seem to use the dead trees and shrubs that project above the deposit, plant vegetation to stabilize islands, and manage for a particular succession level (e.g., sparse grass cover for terns, dense grass cover for gulls, and woody vegetation for herons). Isolation of islands from predators and human use is an important management consideration.

908. Soots, R. F., and J. F. Parnell. 1975. Ecological succession of breeding birds in relation to plant succession on dredge islands in North Carolina estuaries. Univ. ND.C. Sea Grant Coll. Prog. Publ. UNC-SG-75-27. 91 pp.

Response: SHOREB, VEG

Genus: *Atriplex, Cakile, Cenchrus, Distichlis, Erigeron, Euphorbia, Fimbristylis, Phragmites, Scirpus, Spartina, Strophostyles, Triplasis*, many

Describes the use of dredged material islands by nesting birds. Correlations between nesting birds and seral stages of plant succession on the islands were also made. Eleven islands along the coast of North Carolina, from the South Carolina border to the New River inlet, were selected for this study. They varied from 0 to 40 years in age. A succession of breeding birds was associated with vegetation changes.

909. Sorensen, J. 1982. Towards an overall strategy in designing wetland restorations. Pages 85–96 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: SUCCESS

Genus: None

Presents strategies for designing wetland restoration projects and includes a process diagram. The following are major planning considerations: defining the wetland planning area; reviewing state-wide and regional factors such as migratory birds, relative scarcity-abundance of the wetland resource, overall mix of fish and wildlife habitat, and establishment of baseline environmental data; determining extent of wetland degradation, historical evolution, and ownership; assessing existing resource values and effects; designing the restoration site plan; and monitoring, implementing, and evaluating the project.

910. Sorensen, J., and S. Gates. 1983. New directions in restoration of coastal wetlands. Coastal zone '83 2:1427–1443.

Response: SUCCESS

Genus: None

Describes three major aspects of wetland restoration planning: obtaining a regional perspective, cooperative arrangements with the private sector, and effects of site modification on design plans. Examples are taken from coastal wetlands near Los Angeles, California. The design of wetland restoration plans includes assessment of existing resources, evaluation of wildlife behavior, determination of habitat types, assessment of physical constraints, and consideration of buffers. Suggests the following to overcome the problem of insufficient data: provide a margin of safety in the design plan, use performance standards, and include a comprehensive monitoring program.

911. Southern Tier Consulting. 1987. Wetland demonstration project. New York State Department of Transportation, Albany. Contract D250336-CPIN5119-01. 321 pp.

Response: VEG, SUCCESS

Genus: *Alisma, Asclepias, Carex, Cicuta, Dulichium, Glyceria, Iris, Juncus, Nuphar, Polygonum, Ranunculus, Rumex, Scirpus, Sparganium*

Describes a demonstration project to determine effective methods of wetland construction for mitigation of wetlands lost to construction of New York State route 17, Cattaraugus County. Results of the project were applied to the construction of 31.6 ha (78 acres) of wetlands (to replace 17.4 ha [43 acres] lost). The demonstration project included three replications of each of several sets of environmental-planting treatments (2 water depths, 3 soil substrates, 14 planting treatments consisting of 16 plant species, and 5 planting techniques). Describes the measurement of biomass, cover, density, and diversity after two growing seasons.

912. Southward, A. J., and E. C. Southward. 1978. Recolonization of rocky shores in Cornwall after use of toxic dispersants to clean up the Torrey Canyon spill. J. Fish. Res. Board Can. 35(6):682–706.

Response: INVERT, VEG

Genus: *Fucus*

Describes the 10-year recovery of intertidal rocky shore communities near Cornwall, Great Britain, from the release of crude oil from the Torrey Canyon. A general progression is outlined as follows: colonization by green algae, then brown algae, with loss of surviving barnacles. Limpets and other grazers followed; brown algae were eventually removed. Final phases were reductions in limpet populations and resettlement of barnacles. Describes the effects of dispersants applied to oiled areas. Wave-beaten rocks that had been lightly oiled and were treated with light dispersant applications recovered most readily (over a 5- to 8-year period).

913. Spangler, F. L., W. E. Sloey, and C. W. Fetter, Jr. 1976. Artificial and natural marshes as wastewater treatment systems in Wisconsin. Pages 215–240 *in* D. L Tilton, R. H. Kadlec, and C. J. Richardson, eds. Freshwater wetlands and sewage effluent disposal. University of Michigan, Ann Arbor.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Iris, Scirpus*

Discusses water quality improvement capabilities of artificial marshes constructed for wastewater treatment at Seymour, Outagamie County, Wisconsin. Marshes were constructed by lining excavations with 20 mil PVC, placing gravel on the bottom, and planting softstem bulrush (*Scirpus validus*), hardstem bulrush (*S. acutus*), and river bulrush (*S. fluviatilis*) and wild iris. River bulrush was less effective than the other species at reducing BOD, coliforms, and total phosphorus. Harvesting of plants was not a feasible phosphorus removal technique nor did it influence treatment efficiency. Most of the phosphorus taken out of the wastewater went into the gravel and most of the purification processes also seemed to be carried out in the substrate system.

914. Spence, D. H. N. 1982. The zonation of plants in freshwater lakes. Pages 37–125 *in* A. Macfadyen and E. D. Ford, eds. Advances in ecological research. Vol. 12. Academic Press, New York.

Response: VEG, HYDRO, SOIL, WQUAL

Genus: *Betula, Carex, Ceratophyllum, Cladophora, Fontinalis, Fraxinus, Lemna, Nymphaea, Nyssa, Phragmites, Populus, Potamogeton, Salix, Sphagnum*, many

Reviews the factors controlling the zonation of freshwater plants in lakes. Defines the overall depth distributions of various groups of macrophytes. Presents specific examples of vegetation zonation in a range of lakes, primarily european. Vertical environmental variables include underwater light (attenuation, spectral intensity) and density gradient, thermal stratification, and pressure. Vertical and horizontal variables include turbulent and molecular motion. Discusses plant responses and adaptations to habitat variables. Presents an hypothesis that the shape and size of the lake basin determine the overall depth of the wave-mixed zone, whereas factors controlling the underwater light climate primarily determine depth of the macrophyte zone.

915. Spencer, D. F. 1987. Tuber size and planting depth influence growth of *Potamogeton pectinatus* L. Am. Midl. Nat. 118(1):77–84.

Response: VEG

Genus: *Potamogeton*

Discusses the influence of tuber size and planting depth on the growth of sago pondweed (*Potamogeton pectinatus*) collected from three irrigation canals in Solano County, Central California, and later grown in greenhouses. Tubers were present to depths of 15–23 cm in sediment cores collected from the canals. Mean individual tuber weight increased with depth in the sediment. In greenhouse studies, initial growth rates of plants grown from small tubers (1–10 mg), planted at 10 cm or less, were reduced relative to those grown from larger tubers (31–100 mg). Tubers of all weight classes had reduced growth when planted at 20 cm. Results indicated that planting depth and tuber size may be as important as environmental factors in regulating aquatic macrophyte population growth.

916. Spencer, D. F., H. Y. Yeung, and R. W. Greene. 1983. Alterations in the zooplankton community of a fly ash treated lake. Hydrobiologia 107(2):123–130.

Response: INVERT, CHEM, WQUAL

Genus: None

Describes the response of the zooplankton community to additions of fly ash and lime in shallow, productive Lake Charles east near Angola, Steuben County, Indiana. Lime and fly ash were added to precipitate phosphates and seal lake sediments. One year after treatment, the zooplankton community was similar to what it was before treatment. Describes water quality, species richness, diversity, and total biomass of the zooplankton community and relative composition of the phytoplankton community (blue-green algae, flagellates, green algae, and diatoms).

917. Srivastava, O. N. 1981. Planktonic changes after restoration of a perennial pond at Chotanagpur, India. Verh. Internatl. Verein. Limnol. 21(2):1196–1199.

Response: INVERT, CHEM, WQUAL

Genus: *Anabaena, Cosmarium, Microcystis, Oscillatoria, Spirulina*

Discusses restoration of a wastewater polluted pond at Chotanagpur, India. Inflow of wastewater was diverted in 1974, but high productivity of the pond gave rise to massive blooms of cyanophytes during 1975–76. Pond restoration during 1976–77 consisted of water flushing and dry sediment removal. The pond was filled with rain water following restoration. Phosphate and nitrate concentrations were appreciably reduced during 1978–79 and ammonium concentrations

nearly disseemed. Transparency increased more than 6-fold. The pH level dropped from a high of greater than 10.0 to a high of less than 8.0. Phytoplankton produetion declined nearly 20-fold following restoration. Quick improvements in strongly polluted ponds are possible using sediment removal and flushing techniques.

918. Stalter, R. 1973. Transplantation of salt marsh vegetation ii., Georgetown, South Carolina. Castanea 38:132–139.

Response: VEG, SOIL, CHEM

Genus: *Baccharis, Borrichia, Distichlis, Iva, Limonium, Salicornia, Spartina*

Survival and growth rates of transplanted marsh plants were studied to determine the effects of inundation, salinity, and conductivity when species were moved to atypical habitat. Four vegetative zones were chosen at Georgetown, South Carolina. Thirty plants of cordgrass (*Spartina*), saltgrass (*Distichlis*), sumpweed (*Iva*), *Baccharis*, glasswort (*Salicornia*), sea-oxeye (*Borrichia*), and (*Limonium*) were transplanted to other vegetation zones. Soil samples were taken at 10-day intervals at low tide. Salinity varied from 33,500 ppm in the upper high marsh to 322 ppm in the lower low marsh. Mortality rates of all species were high. Results indicate that smooth cordgrass (*Spartina alterniflora*) tolerated the widest range of salinity, highest conductivity, and largest inundation period. Two forms of *S. alterniflora* may be present: a short form occupying upper low marsh and a tall form occupying lower low marsh.

919. Stalter, R. 1976. Factors affecting vegetational zonation on coastal dunes, Georgetown, Co., South Carolina. Pages 58–73 *in* R. R. Lewis and D. P. Cole, eds. Proceedings of the Third Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM

Genus: *Amaranthus, Baccharis, Cakile, Cenchrus, Diodia, Erigeron, Euphorbia, Heterotheca, Hydrocotyle, Iva, Juniperus, Myrica, Oenothera, Opuntia, Panicum, Physalis, Rhus, Rubus, Smilax, Spartina, Strophostyles, Triplasis, Uniola*

Describes experimental procedures for testing the tolerance of sand dune plants to salt spray and salt water inundation. Fifteen plant species on each of 12 sites received periodic salt treatments from september to october 1970. *Iva imbricata* and marshhay cordgrass (*Spartina patens*) were unaffected by salt treatments. *Uniola paniculata* and *Erigeron canadensis* were not affected by salt spray treatments, but *U. paniculata* declined after several weeks' treatment with saltwater and combinations of saltwater and salt spray. No *E. canadensis* survived more than 2 weeks under these two treatments. Wind-borne salt spray is an important determinant of vegetation zonation in coastal dune communities.

920. Stalter, R. 1976. The zonation of vegetation of southeastern salt marshes. Pages 24–35 *in* R. R. Lewis and D. P. Cole, eds. Proceedings of the Third Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, CHEM

Genus: *Baccharis, Batis, Borrichia, Distichlis, Iva, Juncus, Limonium, Salicornia, Scirpus, Sesuvium, Spartina, Suaeda,* many

Describes vegetation zonation in salt marshes of the southeastern United States. Plant tolerance to tidal action, flooding, and soil salt content varies; as a result, specific plants occupy certain zones, which are described by species association and elevation. The upper high marsh (low soil salt, infrequent flooding) is dominated by groundsel baccharis (*Baccharis halimifolia*), bigleaf sumpweed (*Iva frutescens*), marshhay cordgrass (*Spartina patens*), and switchgrass panicum (*Panicum virgatum*). Lower high marsh (moderate soil salt, infrequent flooding) contains bushy sea-oxeye (*Borrichia frutescens*), *Limonium carolinianum*, *L. nashii*, seashore saltgrass (*Distichlis spicata*), and others. The upper low marsh (moderate to high soil salt, more frequent flooding) is dominated by dwarf smooth cordgrass (*Spartina alterniflora*). The lower low marsh is flooded twice daily by tides and is dominated by tall *S. alterniflora*. Discusses brackish marsh vegetation.

921. Stalter, R., and W. T. Batson. 1969. Transplantation of salt marsh vegetation, Georgetown, South Carolina. Ecology 50(6):1087–1089.

Response: VEG, SOIL, CHEM

Genus: *Borrichia, Iva, Limonium, Salicornia, Spartina*

This experiment was conducted to determine the tolerance, survival, and growth rate of salt marsh plant species under various tidal marsh conditions on the Baruch plantation at Georgetown, South Carolina. Describes four vegetation zones: high high marsh flooded 20 minutes/day, low high marsh flooded 1 hour/day, high low marsh flooded several hours per day, and low low marsh flooded 14 hours/day. Thirty plants of each dominant species in each zone were transplanted as plugs in the other zones. Several species can tolerate conditions not found in their usual zones. Presents a table comparing percent survival, transplant height, contiguous vegetation height, and transplant response for six species in the four zones.

922. Starnes, L. B. 1985. Aquatic community response to techniques utilized to reclaim eastern U.S. Coal surface mine-effected streams. Pages 193–222 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: FISH, INVERT, VEG, HYDRO, SOIL, CHEM, SUCCESS

Genus: None

Addresses surface coal mining effects of sedimentation and acid mine drainage on aquatic systems. Geology, topography, and mining techniques affect recovery rates for affected aquatic communities. Describes studies from Tennessee, Virginia, Pennsylvania, and West Virgainia, with the focus on response of the aquatic community to various restoration activities, including stream channel reconstruction, revegetation, limestone barriers, bank cover, deflectors, cascades, and rock boulders for habitat diversity. The greatest degree of ecological recovery occurred when the restoration approach treated drainage and vegetation problems and was based on careful assessment of site-specific characteristics.

923. Starnes, L. B., J. B. Maddox, and T. G. Zarger. 1978. Effects of remedial reclamation treatments on terrestrial and aquatic ecosystems—a progress report. Pages 276–286 *in* D. E. Samuel, J. R. Stauffer, and C. H. Hocutt, eds. Proceedings of a symposium: surface mining and fish-wildlife needs in the eastern United States. U.S. Fish Wildl. Serv., FWS/OBS-78/81.

Response: FISH, INVERT, VEG, CHEM, WQUAL

Genus: None

Describes the effects of remedial treatments applied to 162 ha of surface mined lands within the Ollis Creek watershed, north of Caryville, Tennessee. Treatments, applied over 3 years, included liming, disking, seeding grasses and legumes, and planting trees and shrubs. Percent herbaceous groundcover and number of woody stems per hectare increased significantly. Improvement in water quality (decreases in acidity, turbidity, sulfates, some metals) seemed to be associated with improved groundcover from the remedial treatments. Aquatic invertebrates were slowly responding to treatments after 2 years of monitoring. Fish populations were still limited to streams that were direct tributaries to downstream reservoirs.

924. Stebbings, R. E. 1970. Recovery of salt marsh in Brittany sixteen months after heavy pollution by oil. Environ. Pollut. 1:163–167.

Response: VEG

Genus: *Agropyron, Armeria, Aster, Beta, Festuca, Glaux, Halimione, Juncus, Plantago, Puccinellia, Salicornia, Scirpus, Spergularia, Suaeda, Triglochin*

Assesses changes in vegetation 16 months after an oil spill, which heavily contaminated a salt marsh in the Cotes Du Nord Province of northwestern France. Oil was 2–5 cm deep over the marsh with frequent deep pools to 10 cm. Oil was still evident 16 months later with many pools 2–3 cm deep. Oil also had penetrated about 3 cm into litter and soil. The salt marsh was able to withstand the contamination with slight floral composition changes. However, the oil was at sea for 14–18 days before entering the marsh and lost most of its toxic factions. Oil did seem to prevent gaseous interchange between soil and air, yielding reducing conditions that led to chlorotic symptoms in plants. Salt marshes can be important sites for trapping and holding oil off coastal waters while biodegradation and other breakdown processes occur.

925. Stefan, H. G., and M. J. Hanson. 1981. Predicting dredging depths to minimize internal nutrient recycling in shallow lakes. Pages 79–85 *in* Restoration of lakes and inland waters. International symposium on inland waters and lake restoration. U.S. Environ. Prot. Agency, Portland, Maine. EPA 440/5-81-010.

Response: VEG, CHEM, WQUAL

Genus: None

Develops a method to predict vertical temperature structures and multiple turnover events in shallow lakes in response to wind forces and heat transfer from the atmosphere. The model is useful for determining proper dredging depths to reduce summer fertilization of the photic zone by phosphorous recycled from the lake bed and thus reduce nuisance blooms of algae. The method was verified against field measurements and weather data for the Fairmont Lakes in southern Maine. Presents examples of the use of this model for determining required dredging depths.

926. Steiner, G. R., J. T. Watson, D. A. Hammer, and D. F. Harker, Jr. 1987. Municipal wastewater treatment with artificial wetlands—a TVA/Kentucky demonstration. Pages 923–932 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: HYDRO, SOIL, CHEM, WQUAL, ECON

Genus: *Carex, Phragmites, Scirpus, Typha*

Demonstrates the benefits of using artificial wetlands to treat municipal wastewater by reviewing the success of three artificial wetland designs in southwestern Kentucky. Uses the following systems: a gravel marsh and surface flow marsh at a cost of $200,000; a root-zone method at a cost of $135,000; and a marsh–pond–meadow at a cost of $172,000. Monitoring will be conducted for the following 3 or 4 years. Design parameters included plant species, slopes, flow rates, and substrate types. Native soils were used, but were altered to suit each design method.

927. Steinke, T. J. 1986. Hydrologic manipulation and restoring wetland values: Pine Creek, Fairfield, Connecticut. Pages 377–383 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Association of State Wetland Managers, Berne, N.Y.

Response: FISH, INVERT, VEG

Genus: *Distichlis, Spartina*

Describes initial efforts to restore degraded tidal wetlands in Fairfield, Connecticut, by breaching a dike. After 5 years, the marsh seemed to be restored to salt hay and cordgrass (*Spartina*), with large populations of several invertebrate species. Original populations of breeding fish, birds, and diamondback terrapins have not been restored, however. Their habitat requirements include upland areas adjacent to the marsh; these areas may have to be rehabilitated before the estuarine system can be considered fully restored.

928. Steller, D. L. 1976. Factors affecting the survival of transplanted *Thalassia testudium*. Pages 3–22 *in* R. R. Lewis and D. P. Cole, eds. Proceedings of the Third Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Thalassia*

Turtlegrass (*Thalassia testudinum*) was transplanted at 10 sites around Marco Island, Collier County, Florida. *Thalassia* was taken from a single bed at Coconut Island in the Marco River. The 10 sites exhibited a range of temperature, depth, current, and sediment conditions. Percent survival of *Thalassia* was influenced most by minimum temperature and depth; survival increased with higher minimum temperatures and greater depth. The deepest site was .8 m (2.62 feet) below mlw, but there was no indication that *Thalassia* could not be planted in deeper water. The planting of rhizomes with intact apical meristems was not recommended for further use because it was time consuming and destructive to the environment.

929. Stengel, E., W. Carduck, and C. Jebsen. 1987. Evidence for denitrification in artificial wetlands. Pages 543–550 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: VEG, CHEM, WQUAL

Genus: *Cyperus, Phragmites*

Investigated two artificial wetland systems to determine their ability to remove nitrates from ground- and tap water by assimilative uptake in biomass and dissimilative reduction to nitrous oxide and nitrogen by bacteria. Artificial wetland units consisted of a flat basin 0.6 m × 16 m filled with gravel and planted with reeds (*Phragmites*) or flatsedge (*Cyperus*). Occurrence of high nitrous oxide levels after addition of acetylene

enriched water gave a strong indication of the denitrification process. Measured rates of nitrate removal exceeded normal range of nitrogen uptake in macrophytes during the summer.

930. Stephen, M. F. 1983. Mangrove restoration in Naples, Florida. Pages 201–206 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: INVERT, VEG, SHELLF, FISH, SHOREB, ECON

Genus: *Avicennia, Rhizophora*

A 6.1-ha (15-acre) spoil site that formerly was a wetland on Naples Bay, Florida was the site for restoration activities, including the planting of red mangrove (*Rhizophora mangle*) propagules. After 6 months, propagule survival was 97%. Most propagules were 45 to 53 cm in height. Where several permanent ponds were created unintentionally, oyster communities began to grow and habitat was provided for algae, small fish, and wading birds. Black mangroves (*Avicennia germinans*) began to grow along the site perimeter.

931. Stoecker, R. E. 1982. Creating small islands for wildlife visual enhancement. Pages 48–50 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG

Genus: *Agropyron, Sporobolus*

Describes the reclamation of gravel pits at white rocks, 8 km (5 miles) east of Boulder, Colorado. Before mining in 1972, a reclamation plan was developed, which included construction of two main lakes and six small lakes on the 61-ha (150-acre) property. Bird and small mammal populations have been monitored since 1972. Monitoring led to recognition of the importance of islands as part of the created habitat; plans were adjusted accordingly. The original plan for a 9-ha (22-acre) lake included one large island; the new plan provides for 50 small islands and 2 large ones, for a total increase in shoreline length of 40%. Describes island construction plans.

932. Stoecker, R. E. 1978. The importance of shoreline length to improving wildlife habitat at gravel ponds. Pages 172–176 *in* W. D. Graul and S. J. Bissell, tech. coords. Lowland river and stream habitat in Colorado: symposium. University of Northern Colorado, Greeley.

Response: MAMMALS, NGBIRDS

Genus: None

Describes the effects of shoreline length on wildlife habitat at white rocks, a gravel-mined area near Boulder, Colorado, during its fifth year of reclamation. Data were collected through bird counts, casts regurgitated by raptors, and live trapping of small mammals. Voles were the most important prey (meadow vole [*Microtus pennsylvanicus*] and prairie vole [*M. ochrogaster*]), and were much more abundant in the 1-m zone surrounding the pond margin. Songbird richness was greater near the shore than in the original pasture habitat. Discusses the importance of islands.

933. Strawn, K. 1961. Factors influencing the zonation of submerged monocotyledons at Cedar Key, Florida. J. Wildl. Manage. 25(2):178–189.

Response: VEG, HYDRO

Genus: *Diplanthera, Halophila, Ruppia, Syringodium, Thalassia*

Discusses factors influencing the zonation of five submerged monocotyledons on grass flats at Cedar Key, Florida. Zonation is determined by tidal level and is modified by tide pools and by water draining across the grass flats during low tide. Shallow water and the winter environment are less severe on species with flexible leaves than on species with stiff leaves. Dredging and filling can be used to restore grass flats to areas where they have been destroyed and to enlarge existing grass flats, but the success of the restoration depends on a thorough knowledge of the ecology of the grass flat at a particular restoration site.

934. Street, M. 1982. Management of artificial wetlands for waterfowl—a novel technique to increase the availability of invertebrate food items. Trans. Int. Congr. Game Biol. 14:159–174.

Response: INVERT, SOIL

Genus: None

Discusses experimental treatment of a gravel quarry lake complex near Great Linford, England, by the addition of barley straw (*Hordeum* sp.) to provide a major nutrient supply for aquatic invertebrates. The objective was to significantly increase the standing crop of macroinvertebrates that are important food sources for waterfowl during summer. Initially, the existing chironomid larval populations of the sandy substrate were adversely affected by the addition of 0.45–1.45 kg/m^2 of straw in early march. However, after the straw began to decay, the invertebrate fauna was considerably richer on treated sites. The straw also added a substrate for colonization by detritivores and diversity and biomass of invertebrates increased within the straw itself. Discusses the use of this treatment in relation to production of waterfowl foods.

935. Street, M. 1982. The Great Linford project: waterfowl research in a gravel pit wildlife reserve. Pages 170–180 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: INVERT, WFOWL, VEG

Genus: *Carex*

Describes the restoration and management of the Great Linford gravel quarry near Newport Pagnell, North Bucks, Great Britain. Management focuses on creation and maintenance of productive habitat for waterfowl. Research on duckling survival revealed a need for areas of water with high biological productivity; this was provided by: using emergent plant species (e.g., *Carex riparia*) with large submerged surface per unit area, which contain the largest, most diverse invertebrate populations; and adding barley straw at 1 kg/m^2 to recently dug gravel pit water to stimulate invertebrate production. Describes a computerized model that simulates waterfowl population responses to various changes in habitat.

936. Summers, P. B., Jr. 1981. An ecological assessment of 21 sediment ponds, Ollis Creek mine, Campbell County, Tennessee, 1981. M.S. thesis, Tennessee Technological University, Cookeville. 242 pp.

Response: FISH, INVERT, SOIL, CHEM, WQUAL

Genus: *Callitriche, Eleocharis, Glyceria, Juncus, Leersia, Lindernia, Ludwigia, Potamogeton, Sagittaria, Scirpus, Typha, Vallisneria*

Compares water quality, macroinvertebrate communities, fish populations, and vegetation of 21 sediment ponds of the Ollis Creek Mine, Campbell County, Tennessee. The sediment ponds were basically the same age. Community structure descriptors for benthic macroinvertebrates in the higher pH

ponds indicated an accelerated rate of recovery compared to the acidic ponds. Carbon may have been a limiting factor for recovery in acidic ponds. Many ponds had excessive plant growth, which contributed to overcrowding and stunting of forage fishes. Many of the problems associated with these sediment ponds may be eliminated with higher water quality and pond engineering standards, coupled with the removal of toxic spoils and highwalls.

937. Suurballe, N. C. 1988. Hydrologic regime of a floodplain wetland in Massachusetts. Pages 73–81 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Illinois. Association of State Wetland Managers, Berne, N.Y.

Response: None

Genus: None

Describes the results of a study to determine the water balance of a wetland stream system in the head waters of Natty Pond Brook in central Massachusetts. Describes seasonal influences of a wetland under various hydrological conditions. This information is intended to improve predictions of water quality along stream reaches in wetlands. Presents and discusses input–output data.

938. Svedarsky, W. D. 1982. The Red River Valley Natural History area: wildlife management and environmental education in an abandoned gravel pit in northwest Minnesota. Pages 132–140 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, HUSE, SUCCESS

Genus: *Alisma, Carex, Cornus, Lemna, Potamogeton, Salix, Scirpus, Sium, Typha*

Describes a 34.4-ha (85-acre) natural history area near Crookston, Minnesota: 14.2 ha (35 acres) were mined for gravel about 80 years ago. Willow (*Salix*) swamps and marshes have been developing since that time. Lists inventories of birds and mammals recorded at the site. Depicts successional changes in both vegetation and breeding bird species for gravel pits above or below the water table. Discusses considerations in planning for wildlife habitat on gravel mined lands, along with planning for environmental education uses.

939. Swanson L. J., and A. G. Shuey. 1980. Freshwater marsh reclamation in west central Florida. Pages 51–61 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: SHOREB, NGBIRDS, FISH, REPT, AMPHIB, MAMMALS, VEG

Genus: *Agalinis, Amphicarpum, Andropogon, Aristida, Axonopus, Centella, Cephalanthus, Cyperus, Digitaria, Drosera, Eleocharis, Elephantopus, Eragrostis, Erigeron, Gratiola, Hedyotis, Hydrochloa, Hydrocotyle, Hypericum, Hypericum, Hypoxis, Juncus, Lachnocaulon, Lindernia, Ludwigia, Nymphoides, Panicum, Paspalum, Pluchea, Polygala, Polygonum, Pontederia, Pterocaulon, Rhexia, Rhynchospora, Sabatia, Solidago, Typha, Utricularia, Viola, Xyris*, many

Wetlands were constructed near Alderman Creek, Hillsborough County, Florida, to compare various reclamation methods. Grading, backfilling, and contouring created three depressions. The first was the control; natural vegetation colonization resulted in 70 species after 2 years (although most of the site remained unvegetated). The second area was planted in maidencane (*Panicum hemotomon*), softrush (*Juncus effusus*), and pickerelweed (*Pontederia sp.*) from natural marshes. After 2 years, 76 plant species were present. The third area was covered with mulch from a natural marsh; dense vegetative cover developed rapidly. After 2 years, 95 plant species were present. Water depth was a critical factor in species composition and abundance. Success was greatest in areas that dried out periodically.

940. Swenson, E. A. 1988. Progress in the understanding of how to reestablish native riparian plants in New Mexico. Pages 144–150 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American West. Society of Wetland Scientists, Rocky Mountain Chapter, Denver, Colo.

Response: VEG

Genus: *Populus, Salix*

Describes the development of a dormant pole planting technique as part of the effort to reestablish native vegetation in non-montane floodplains of New Mexico. Provides detailed planting guidelines, especially relating to container grown plants and rhizomes that thrive in riparian zones. Describes understory vegetation. A 5-year research program has been initiated to make available a broad genetic base and wide selection of plants adapted to riparian conditions in New Mexico.

941. Swenson, E. A., and C. L. Mullins. 1985. Revegetating riparian trees in southwestern floodplains. Pages 135–138 *in* R. R. Johnson, et al., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses. U.S. For. Serv. Gen. Tech. Rep. Rm-120.

Response: VEG

Genus: *Populus, Salix*

Describes experimental plantings of Rio Grande cottonwood (*Populus fremontii*), narrowleaf cottonwood (*Populus angustifolia*), and gooding willow in riparian areas along the Rio Grande, south of Albuquerque, New Mexico. Dormant poles (cut and planted in December or January) and greenwood poles (cut and planted in March) were equally represented in plots where the water table was 2.1–4 m (7–12 feet) deep. Planting holes were predrilled to the known depth of the water table during the growing season. Survival rates of dormant poles after about 1 year varied from 60–77%; rates were lower for poles planted .6–1.2 m (2–4 feet) above the water table and for greenwood poles.

942. Szafoni, R. E. 1982. Wildlife considerations in the development of riparian communities. Pages 59–66 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: None

Genus: Many

Describes the establishment of riparian vegetation in gravel mine areas. Management strategies include shoreline development, island size, and planting consisting of two basic phases: initial establishment of groundcover and establishment of woody plants. Specific guidelines for the development of riparian zones for wildlife habitat take into consideration other concerns such as erosion control, water quality, recreational access, and aesthetics.

943. Talak, A., Jr. 1977. The recovery of stream benthie inseet communities following coal strip mining in the Cumberland mountains of Tennessee. M.S. thesis, University of Tennessee, Knoxville. 82 pp.

Response: INVERT

Genus: None

Investigates aquatic insects of 23 streams in the Cumberland mountains, Tennessee, to determine benthic insect recovery in streams polluted by runoff from contour coal strip mines. Simultaneous samples were taken in streams of similar flow and substrate characteristics in various stages following mining activity (up to 22 years) or unpolluted (control streams). The number of individuals, number of taxa, and species diversity index decreased after cessation of mining, reaching a minimum after 4–6 years. Values then began to increase and returned to predisturbance levels after 22 years. However, the community structure was altered, probably because of siltation and not acid mine drainage. Periphyton grazers and herbivorous plecopterans were most affected by siltation.

944. Tanner, G. W. 1979. Growth of *Spartina alterniflora* within native and transplant-established stands on the upper-Texas gulf coast. Ph.D. dissertation. Texas A&M University, College Station. 149 pp.

Response: VEG, HYDRO

Genus: *Spartina*

Compares growth of smooth cordgrass (*Spartina alterniflora*) within native and transplant-established stands in a natural salt marsh complex of the Bolivar Peninsula, Galveston County, Texas. Culm density within the established cordgrass (*Spartina*) stands was not as strongly associated with substrate elevation as the natural stands; however, culm height and aboveground biomass tended to decrease as elevation increased and was greatest at the lowest elevation. Root rhizome to shoot ratios increased as elevation increased. Fertilizer treatments significantly affected culm survival, vegetative reproduction, and end of growing season biomass.

945. Tanner G. W., and J. D. Dodd. 1985. Effects of phenological stage of *Spartina alterniflora* transplant culms on stand development. Wetlands 4:57–74.

Response: VEG, SOIL

Genus: *Spartina*

Smooth cordgrass (*Spartina alterniflora*) culm growth and phenological type were evaluated; various transplanting and fertilization methods were used. Two study plots were established on barren mudflats of different substrate textures north of Houston, Texas, on the Bolivar Peninsula. Inorganic nitrogen, P_20, K_20, and a commercial root dip were applied to the culms. The root dip was detrimental to culm growth and the fertilizer did not enhance culm growth. The root to rhizome ratio was approximately 1.0 after the second year, with little differences among various substrates and fertilizer treatments. The most growth was exhibited by transplants selected from rapidly growing, naturally established stands of *S. alterniflora*.

946. Tarquin, P. A. 1983. Stream channel reconstruction: the problem of designing lower order streams. Pages 41–46 *in* D. H. Graves and R. W. De Vore, eds. Proceedings 1983 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: VEG, HYDRO

Genus: None

Deseribes the reconstruetion of streams at the Black Thunder mine, eastern Powder River basin, 45 miles southeast of Gillette, Wyoming. Emphasized the importance of restoring a disturbed watershed compatible with the regional hydrologic regime. The following are critical factors in such restoration effforts: allowing a stream to cut its own pilot channel; controlling flow velocity by manipulating channel length, width, and roughness; effective revegetation and mulching; establishing adequate radius of curvature on meander bends; and ensuring that actual construction conforms to design variables. Discusses design of lower order streams.

947. Taylor J. L., C. H. Saloman, and K. W. Prest, Jr. 1973. Harvest and regrowth of turtlegrass (*Thalassia testudium*) in Tampa Bay, Florida. Fish. Bull. 71(1):145–148.

Response: VEG

Genus: *Thalassia*

Compares leaf growth and new leaf production in plots of cut and uncut turtlegrass (*Thalassia testudium*) in lower Boca Ciega Bay, St. Petersburg, Florida. Turtlegrass leaves were harvested 10 cm above bay bottom in August and October 1968 and July and September 1969. Leaves harvested in the growing season had an equivalent or greater rate of regrowth and reached the height of uncut plants in about 2 months. Harvesting had no apparent influence on production of new leaves.

948. Tchobanoglous, G., R. Stowell, R. Ludwig, J. Colt, and A. Knight. 1979. The use of aquatic plants and animals for the treatment of wastewater: an overview. Pages 35–55 *in* R. K. Bastian and S. C. Reed, eds. Aquaculture systems for wastewater treatment: seminar proceedings and engineering assessment. U.S. Environmental Protection Agency, Washington, D.C.

Response: None

Genus: *Alternanthera, Azolla, Ceratophyllum, Eichhornia, Lemna, Ludwigia, Myriophyllum, Phragmites, Potamogeton, Scirpus, Typha*

Presents an overview of the use of aquatic plants and animals for wastewater treatment. General concepts discussed include type and composition of contaminants in wastewater, contaminant removal mechanisms, and potential aquatic plants and animals for use in wastewater treatment. Presents a conceptual model for the use of aquatic systems for treating wastewater. Discusses design, effects, reliability, resource recovery, health risks, and costs of aquatic systems. The major stimulus for further research into the fundamentals, design, and management of aquatic systems for wastewater treatment is the potential for reducing the construction, operation, and maintenance costs associated with conventional wastewater treatment systems.

949. Teas, H. J. 1980. Mangrove swamp creation. Pages 63–90 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the creation of mangrove swamps in three parts: description of ecological factors in mangrove establishment—tidal depth and flushing, salinity, wave and current action, root mat and soil stabilization, nutrients, parasites, diseases, and public access; review of mangrove planting experiments, in-

cluding description of differences among mangrove species; and evaluation of state-of-the-art mangrove swamp creation techniques (e.g., rapid stabilization of soil by planting smooth cordgrass [*Spartina alterniflora*] with mangroves).

950. Teas, H. J. 1980. Restoration of mangrove ecosystems Pages 95–107 *in* R. C. Carey, P. S. Markovits, and J. B. Kirkwood, eds. Proceedings of the U.S. Fish and Wildlife Service workshop on coastal ecosystems of the southeastern United States. U.S. Fish Wildl. Serv., FWS/OBS-80/59.

Response: VEG

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the restoration of mangrove ecosystems. Discusses substrate, food chain, biomass, community stability, and associated animal species diversity. Recommends the following for restoration: to develop a better root mat, plant black mangroves (*Avicennia germinans*) or white mangroves (*Laguncularia racemosa*) along with red mangroves (*Rhizophora mangle*); use topsoil or other organic soil along with slow release fertilizer pellets; place plantings close together to ensure early coverage by leaf canopy; after 1–2 years, add brush and leaves to plantings (source of reduced carbon); and aid establishment of community biota by adding litter, mud, branches, snails, etc., from a nearby well-established mangrove community.

951. Teas, H. J. 1977. Ecology and restoration of mangrove shorelines in Florida. Environ. Conserv. 4(1):51–58.

Response: VEG, ECON

Genus: *Avicennia, Laguncularia, Rhizophora*

Describes the ecology of mangroves their productivity, and their role in shoreline protection and as habitat for various organisms. Discusses a number of mangrove planting experiments in Florida, including those using seeds, propagules, small trees, or large trees. Factors to be taken into account for successful establishment are plant size, plant source, shoreline energy, prevalence of root parasites, tidal depth at planting site, substrate type, salinity, and vandalism. Includes planting costs for red mangrove (*Rhizophora mangle*) propagules, black mangrove (*Avicennia germinans*) or white mangrove (*Laguncularia racemosa*) seedlings, and various types of 3-year-old mangrove trees.

952. Teas, H. J., and W. Jurgens. 1978. Aerial planting of *Rhizophora* mangrove propagules in Florida. Pages 1–25 *in* D. P. Cole, ed. Proceedings of the Fifth Annual Conference on Restoration of Coastal Vegetation in Florida. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Rhizophora*

Experiments were conducted to explore the feasibility of planting red mangrove (*Rhizophora mangle*) from the air. With the use of helicopters, drops were made over Sandy Key, Everglades National Park, on a low-energy shoreline with exposed seagrass beds and mud banks at low tide and with scattered mangroves along the shore. Attempts were made to drop propagules using weights, rigid fins, nonrigid fins, and type H missles. The type H missle, constructed of paper bag, sand, and staples, was the most successful. The propagules held up well in flight and the bag disintegrated rapidly after landing in wet substrate. The success rate of drops was 18 or 19 out of 20 when the aircraft was moving at 64 km/h (60 mph). This method was successful for establishing mangroves in isolated sites and has potential for other genera with similar propagules.

953. Ternyik, W. E. 1980. Salt marsh ereation in the Pacific Northwest: criteria, planting techniques and costs. Pages 25–27 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG, ECON

Genus: *Carex, Deschampsia, Eleocharis, Juncus, Scirpus*

Summarizes salt marsh creation work initiated at Miller Sands, an island complex on the lower Columbia River, Oregon. This pilot test program included plant selection, collection, planting, and growth over one growing season (June-November 1975). The sprigging method was used and all plants were topped to a uniform height before planting. Root cuttings generally included a section of rhizomes containing one to three stems. Records the spacing, planting depth, and culms per planting stock in table form for all six species planted. Some of the test plots were fertilized. Ammonia-based fertilizers may cause problems for fishery productivity.

954. Ternyik, W. E. 1978. Habitat development field investigations, Miller Sands marsh and upland habitat development site, Columbia River, Oregon: Appendix D: propagation of vascular plants on dredged material. U.S. Army Waterways Exp. Stn., Vicksburg, Miss. Tech. Rep. D-77-38. 42 pp.

Response: VEG

Genus: *Agropyron, Agrostis, Alisma, Ammophila, Carex, Deschampsia, Eleocharis, Festuca, Hordeum, Iris, Juncus, Phalaris, Sagittaria, Scirpus, Trifolium, Vicia*, many

Discusses propagation experiments conducted at Miller Sands, an island complex in the lower Columbia River, Oregon. The complex derives from dredge material and consists of a large vegetated island formed before 1940, an elongated barren sand spit formed since 1970, and a cove protected by the island and spit. Presents methodologies and costs for propagating nine seeded grass and legume species on the older, vegetated island; transplanting and fertilizing European beachgrass on the sandspit in conjunction with installation of sand fences; and transplanting and fertilizing eight intertidal species in the cove. Presents percent viability of seeds for some species.

955. Terry, O. W., H. F. Udell, and J. D. Zarudsky. 1974. Tidal marsh restoration at Hempstead, Long Island. Shore Beach 42(2):36–39.

Response: VEG, SOIL, CHEM

Genus: *Spartina*

Discusses a pilot marsh planting project on a dredged material site at Hempstead, Long Island, New York. Seed, seedlings, and plugs of smooth cordgrass (*Spartina alterniflora*) were planted. Seedlings had the highest survival (50%) after 13 months. Germination of seeds was successful, but the resulting seedlings eventually washed out or died. The spoil material was high in organic matter and the sediment was soft and loose. The material may containe a toxic substance that may have prevented growth of cordgrass (*Spartina*). The source of dredged spoil substrate was a more serious problem than the difficulty of planting *Spartina*.

956. Teskey, R. O., and T. M. Hinckley. 1977. Effect of water level changes on woody riparian and wetland communities, Vol. I:

plant and soil responses to flooding. U.S. Fish Wildl. Serv., FWS/OBS-77/58. 30 pp.

Response: VEG

Genus: Many

Describes the physiological effects of water level changes on the growth of various wetland trees and shrubs. Flooding that occurs during the dormant season and recedes before growth begins in the spring can increase the growth of tree species (especially on bottomlands). For most bottomland species, flooding retards germination, preventing establishment of seedlings during flooding periods when chances of their survival are reduced. Discusses responses of trees to soil conditions and the nature, timing, and duration of water level changes.

957. Tetreault, T. E. 1988. Wetland replacement: design, construction, and monitoring considerations. Pages 362–363 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: SUCCESS

Genus: None

Provides an overview of wetland replacement in terms of physical and funetional replication. Discusses suggested monitoring programs that may meet applicable regulatory requirements. Successful replacement of altered wetlands is contingent on an integrated analysis of hydrologic, soil-substrate, vegetative, and other site-specific factors. Once an understanding of these basic factors has been achieved, design variables are developed with the objective of physical and functional replacement or restoration of the wetland area.

958. Thayer, G. W., M. S. Fonseca, and W. J. Kenworthy. 1986. Wetland mitigation and restoration in the southeast United States and two lessons from seagrass mitigation. Pages 95–117 *in* The estuarine management practices symposium. Louisiana State University, Baton Rouge.

Response: VEG

Genus: *Halodule, Zostera*

Discusses the role of the National Marine Fisheries Service in wetland mitigation and restoration in the southeastern United States. Includes the following topics: environmental assessment activities, mitigation approaches, mitigation activities, and the need to follow up and determine effectiveness of mitigation-restoration efforts. Discusses two examples of mitigation projects that involved seagrass transplantation: construction of a marina in North Carolina and bridge construction in the Florida Keys. Restoration can only be effective by incorporating basic ecological data on wetland systems during decision processes.

959. Theis, T. L. 1979. Physical and chemical treatment of lake sediments. Pages 115–120 *in* Lake restoration: proceedings of a national conference, Minneapolis, Minnesota. U.S. Environ. Prot. Agency EPA 440/5-79-001.

Response: SOIL, CHEM

Genus: None

Describes the physical and chemical effectiveness of various techniques for treating sediments of eutrophic and hypereutrophic lakes to improve water quality. Considers the following to determine lake suitability for such treatment: physical and chemical properties of sediment, contribution of sediment to the phosphorus budget, lake morphology, need for supplemental chemicals, deleterious effects, aesthetics, and costs. Uses Stone lake in Michigan as an example.

960. Thom, R. M., E. O. Salon, C. A. Simenstad, J. R. Cordell, and D. K. Shreffler. 1987. Construction of a wetland system in the Puyallup River estuary, Washington. Pages 156–159 *in* K. M. Mutz and L. C. Lee, tech. coords. Wetland and riparian ecosystems of the American West: eighth annual meeting of the Society of Wetland Scientists. Society of Wetland Scientists, Wilmington, ND.C.

Response: FISH, WFOWL, NGBIRDS, SHOREB, VEG, SUCCESS

Genus: *Carex*

Describes construction of a 3.6-ha sedge (*Carex*) marsh for mitigation purposes in the Puyallup River Estuary, Puget Sound, Washington. Describes fish and bird species diversity and abundance. Development of the marsh as it reaches its "maximum sustainable performance" is expected to take from 3 to 10 years.

961. Thompson, B. A., and L. A. Deegan. 1983. The Atchafalaya River delta: a "new" fishery nursery, with recommendations for management. Pages 217–239 *in* F. J. Webb, ed. Proceedings of the Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, HYDRO, SOIL, WQUAL, CHEM

Genus: None

Describes a study to determine the fishery potential of the Atchafalaya delta and to examine management for enhancement of the fishery resource. At least 56 fish species inhabit the Atchafalya delta; estuarine-marine species are most numerous. Includes many valuable commercial and recreational species. Areas most protected from direct flow from the river during winter maintain the highest fish populations year-round. Suggests the following for design of spoil islands: select a small site (2–10 ha [5–25 acres]) to promote rapid ecological development, account for the diversity of water currents and elevation, determine the affect of substrate type on biological resources, and create optimal elevation for desired plants and other biota. Spoil island location and shape are important for maintenance of local fisheries.

962. Thompson, C. S. 1984. Stream relocation in surface mine areas—effects on fish and invertebrates. Pages 345–355 *in* D. H. Graves, ed. Proceedings of the 1984 symposium on surface mining, hydrology, sedimentology, and reclamation. University of Kentucky, OES Publications, Lexington.

Response: FISH, INVERT, SUCCESS

Genus: None

Examines fish and invertebrate populations of relocated streams in surface mine areas of Illinois and Indiana. Stream habitat reconstruction varied from no planned restoration to installation of riffles, pools, deflectors, and rock structures. Results indicate that the greater the amount of habitat diversity and development, the closer the correlation of fish and invertebrate species and diversity with undisturbed sections of the stream. Natural streams severely affected by agriculture or past mining operations benefited from the relocation process with additional habitat improvement. Lack of riparian habitat surrounding relocations had a detrimental effect on both fish and invertebrate recovery.

963. Thompson, C. S. 1985. Stream relocation on surface mined land. Pages 39–50 *in* L. B. Starnes, ed. Fish and wildlife rela-

tionships to mining: symposium proceedings. American Fisheries Society, Milwaukee, Wisc. Spec. Publ.

Response: INVERT

Genus: None

Discusses restoration of a relocated tributary of Honey Creek at the Amax Chinook Coal Mine, Vigo County, Indiana. The stream relocation is 3,657 m long and drains approximately 596 ha. Restoration consisted of constructing meanders every 61–152 m, grading banks, creating pools, and installing instream habitat structures for fish. Downdrain structures were constructed of rock riprap or corrugated buried pipe to protect instream structures and revegeted areas from side drainage erosion. Initial observations indicated that the habitat is developing as planned. Larval forms of more mobile invertebrates began recolonizing the stream before opening the relocated stream to normal flow. Trees were planted for two seasons after groundcover establishment and monitoring continued for 5 years.

964. Thompson, C. S. 1985. Stream relocations under OSM regulations: benefits to fish and invertebrates. Pages 305–316 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School Forestry Resources, University Park.

Response: FISH, INVERT

Genus: None

Discusses methods and materials used in the reconstruction of channelized streams on surface mined land. Study sites were on tributaries of Otter Creek in Illinois and Honey Creek in Indiana. Otter Creek was reclaimed using shale and small gravel from spoil, minimal bank revegetation, and one small meander. The Honey Creek tributary restoration included construction of a meander, three large permanant pools, two man-made riffles, several rock wing deflectors, log structures, and random boulder placement. Fish and benthos were sampled from permanently established 100-m stretches of stream channel. Describes invertebrate and fish taxa from upstream, relocated, and downstream sites.

965. Thompson, C. S. 1984. Experimental practices in surface coal mining: creating wetland habitat. Natl. Wetl. Newsl. (March-April):15–16.

Response: WFOWL, SHOREB, CHEM, WQUAL, ECON

Genus: *Cyperus, Echinochloa, Leersia, Panicum, Phalaris, Polygonum, Scirpus, Spartina*, many

Describes the experimental practices portion of the Surface Mining Control and Reclamation Act, which was created to encourage advances in mining and reclamation practices and postmining land uses. The Amax Coal Company applied for a permit for the conversion of a coal slurry pond to wetland habitat. Lime and fertilizer were applied to the sites in fall; highly acidic areas were covered with 1.2 m (4 feet) of soil after liming. The pond was seeded and after several months the pH returned to acceptable levels. In spring, wetland species were planted according to zones of available moisture. The resultant 16.2-ha (40-acre) wetland was being used by waterfowl and wading birds 1 year later. The company estimated that this method cut reclamation costs by 80%.

966. Thompson, D. H., and M. C. Landin. 1978. An aerial survey of waterbird colonies along the upper Mississippi river and their relationship to dredged material deposits. U.S. Army Eng. Waterways Exp. Stn, Vicksburg, Miss., Tech. Rep. D-78-13. 103 pp.

Response: NGBIRDS, SHOREB

Genus: Many

Synthesizes information from aerial surveys of breeding waterbird colonies associated with dredged material sites on 1,040 km of the upper Mississippi river between Alton, Illinois, and St. Paul, Minnesota. None of the 328 dredged material sites were used by birds because of unsuitable vegetation and disturbance by recreationists and river traffic. Preferred characteristics for colony sites included mature deciduous forests downstream from dams, proximity to water and feeding areas, junctions of tributaries to the Mississippi river, the east side of the navigation channel, and protection from human disturbance and wind.

967. Thorhaug, A. 1980. Environmental management of a highly effected, urbanized tropical estuary: rehabilitation and restoration. Helgol. Meeresunters. 33:614–623.

Response: VEG, CHEM, WQUAL

Genus: *Halodule, Thalassia*

Describes seagrass restoration in Biscayne Bay, Florida, to increase recovery of the ecosystem from severe pollution effects and to restore important fish nurseries. Revegetation using turtlegrass (*Thalassia*) was successful; after 4 years, moderate densities of growth were measured at 2,030 blades/m^2. *Thalassia* seeds were planted at 0.3-m (1-foot) intervals and shoalweed (*Halodule*) plugs were planted at 1-m (3-feet) intervals. In the restored *Thalassia* beds, animal communities returned to expected density and diversity after about 4 years.

968. Thorhaug, A. 1980. Restored major plant communities in the U.S. Pages 113–124 *in* J. Cairns, Jr., ed. The recovery process in damaged ecosystems. Ann Arbor Scientific Publications, Ann Arbor, Mich.

Response: VEG

Genus: *Halodule, Spartina, Syringodium, Thalassia, Zostera*

Describes recovery patterns of restored plant communities throughout the United States and summarizes the issues addressed in "Restoration of major plant communities in the U.S.A., " a symposium held at Tulane University, New Orleans, Louisiana, June 1976. Some restoration examples include seagrass communities, mangroves and marsh grasses. Political and legal issues are part of the process of planning and implementing a restoration project. Presents a list of general principles for restoration, along with a table that depicts recovery results for restoration efforts and compares them to natural recovery rates.

969. Thorhaug, A. 1979. Mitigation of estuarine fisheries nurseries: seagrass restoration. Pages 667–669 *in* G. A. Swanson, tech. coord. The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitat. U.S. For. Serv. Gen. Tech. Rep. Rm-65.

Response: FISH, VEG, ECON, SUCCESS

Genus: *Thalassia*

Discusses the results of a new method of seeding turtlegrass (*Thalassia testudium*) in large-scale restoration projects near Biscayne Bay, Florida. Restoration areas were previously denuded by various pollution effluents and dredging and filling. Within 4–5 years after planting, these areas exhibited rapid regrowth of vegetation and recolonization by fish and other aquatic organisms. Animal populations from restored and

control areas were similar. The new seeding method was more cost effective than plugging.

970. Thorhaug, A. 1985. Large-scale seagrass restoration in a damaged estuary. Mar. Pollut. Bull. 16(2):55–62.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Halodule, Syringodium, Thalassia*

In 1982, a large-scale seagrass restoration project was started in areas of Biscayne Bay, Florida, previously subjected to major dredging effects. Test plots were planted with turtlegrass (*Thalassia*), shoalweed (*Halodule*), and *Syringodium* sprigs and seeds. Blade length, mean number of short-shoots, and rhizome length were measured between 9 and 18.6 months. *Thalassia* sprigs had the highest overall survival at 70.8%; *Halodule* was next at 47%; however, *Syringodium* had a survival rate of less than 30% except at 1 site. The plot with sandy-organic sediment and high light penetration had high survival rates for all species.

971. Thorhaug, A. 1979. The flowering and fruiting of restored *Thalassia* beds: a preliminary note. Aquat. Bot. 6(2):189–192.

Response: VEG

Genus: *Thalassia*

Reports the results of turtlegrass (*Thalassia testudium*) plantings near Biscayne Bay, Florida. Previously denuded by thermal effluents, the area now supports fully restored *Thalassia* beds. Seeded in 1973, the plants flowered in April 1977 and fruited in August 1977. In spring 1977, restored *Thalassia* beds averaged 2,030 blades per square meter, compared to 2,295 blades per square meter in control areas. Describes the success of this planing project in terms of lateral spreading over an area, and long-term restoration conditions closely approximating those of control *Thalassia* beds.

972. Thorhaug, A. 1980. Seagrasses in the Gulf of Mexico, Florida and Caribbean, including restoration and mitigation of seagrasses. Pages 161–178 *in* R.D.C. Carey, P. S. Markovits, and J. B. Kirkwood, eds. Proceedings of the U.S. Fish and Wildlife Service workshop on coastal ecosystems of the southeastern United States. U.S. Fish Wildl. Serv., FWS/OBS-80/59.

Response: VEG, SUCCESS

Genus: *Halodule, Halophila, Ruppia, Syringodium, Thalassia*

Describes the distribution, growth, and ecology of several seagrasses of the Gulf of Mexico and the Caribbean. Describes several planting methods and subsequent success rates. Provides an overview of seagrass mitigation and restoration techniques, along with government-agency involvement and guidelines. Recommendations include restore several species simultaneously; restore fastest growing species first, to stabilize sediment; restore species that would return slowly by natural means; and allow invasion by fast-growing species. Economic considerations require compromise between size of area planted and plant species selected.

973. Thorhaug, A. 1976. Transplantation techniques for the seagrass *Thalassia testudinum*. Univ. Miami Sea Grant Program, Miami, Fla. 6 pp.

Response: VEG, SOIL, WQUAL

Genus: *Halodule, Thalassia*

Reviews two methods for establishing turtlegrass (*Thalassia testudinum*) throughout the Gulf of Mexico, southeast Florida coast, and the Caribbean. The seeding method used various growth hormones and seeds were planted at intervals of 200 seeds per square meter. Reported increased *Thalassia* growth using this method if a secondary seagrass, Wright shoalweed (*Halodule wrightii*), had previously begun to colonize the area. The other method involves plugging and using of growth hormones. Plugs were placed in 30 cm of soil during winter. Gives turbidity, light penetration, and salinity tolerances for *Thalassia* are given.

974. Thorhaug, A. 1983. Habitat restoration after pipeline construction in a tropical estuary: seagrasses. Mar. Pollut. Bull. 14(11):422–425.

Response: VEG

Genus: *Halodule, Thalassia*

After construction of a water transmission pipeline through the Florida Keys in 1981, a revegetation effort was begun to restore the area. Shoalweed (*Halodule*) shoots were planted in severely disturbed substrate in the pipeline corridor. After 10 months of monitoring, the percent cover of *Halodule* in the pipeline trench was 31.1% with a density of about 400–2,600 blades per square meter. After 10 months, 1,261 of 50,000 *Thalassia* seedlings planted adjacent to the pipeline corridor were counted on the disturbed area.

975. Thorhaug, A. 1986. Review of seagrass restoration efforts. Biology 15(2):110–118.

Response: VEG, ECON, SUCCESS

Genus: *Cymodocea, Enhalus, Halodule, Halophila, Posidonia, Ruppia, Syringodium, Thalassia, Zostera*

Reviews the history of seagrass restoration efforts in southern Florida and the Caribbean. Presents recovery rates based on planting methods and requirements. Planting costs varied from $3,000 to $12,596/ha, depending on labor used. Policy recommendations for seagrass restoration include protecting seagrasses from further effects, incorporating mitigation and restoration plans in development projects, restoring climax species to increase successional rates, upgrading existing seagrass beds with climax species planting, and recognizing that each species of seagrass has different characteristics for sediment binding, productivity, and relation to animal communities.

976. Thorhaug, A. 1979. Growth of *Thalassia* restored by seedlings in a multiply-effected estuary. Pages 263–278 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL, WQUAL

Genus: *Halodule, Syringodium, Thalassia*

Describes a study of turtlegrass (*Thalassia testudinum*) seedling growth on two sites in south Biscayne Bay, Florida. About 41,000 seedlings were planted on site one along a large dredge and fill causeway. About 37,000 seedlings were planted on site two, a filled area multiply effected by an oil terminal, sewage outfall, urban runoff, major port activity, high tidal currents, and periodically high turbidity. After 6 months, blade growth was greater at site one; this was probably related to sediment or vegetation type in the planted area. Plants in highly turbid waters had shorter leaf blades. Growth of plants at both sites is compared to previous *Thalassia* restroration efforts at Turkey Point.

977. Thorhaug, A. 1980. Techniques for creating seagrass meadows in damaged areas along the east coast of the U.S.A. Pages

105–116 *in* J. C. Lewis and E. W. Bunce, eds. Rehabilitation and creation of selected coastal habitats: proceedings of a workshop. U.S. Fish Wildl. Serv., FWS/OBS-80/27.

Response: VEG, ECON

Genus: *Halodule, Posidonia, Syringodium, Thalassia, Zostera*

Provides an overview of techniques for seagrass meadow restoration along the east coast of the United States. Discusses government agency decisionmaking regarding seagrass restoration, needs for seagrass restoration, history of seagrass restoration, techniques and case studies, and economic analysis. Several restoration plans include restoration of several species simultaneously; restoration of the fastest growing species first for substrate stabilization; restoration of only those native species that invade an area slowly, allowing fast growing species to invade naturally; and restoration of plants that meet a specific purpose, such as food or nursery stock.

978. Thorhaug, A. 1974. Transplantation of the seagrass *Thalassia testudinum*. Aquaculture 4:177–183.

Response: VEG

Genus: *Thalassia*

Describes several techniques for planting turtlegrass (*Thalassia testudinum*) at Turkey Point, Biscayne Bay, Florida. The site had been denuded of vegetation by previously discharged heated effluents. The sediment was bare peat. Seedlings were transplanted from other areas and were also raised in the laboratory in containers supplied with running sea water. After 9 months, 31.2% of the seedlings planted in the bay were missing, dead, or dormant. Planting by seed in the field was successful; germination was rapid and growth was vigorous. Rhizome growth was slow at first, but vigorous after 4 months. Cultivation of the laboratory specimens was less successful, due to infection.

979. Thorhaug, A., and C. B. Austin. 1976. Restoration of seagrass with economic analysis. Environ. Conserv. 3(4):259–266.

Response: VEG, ECON

Genus: *Halodule, Thalassia, Zostera*

Provides an overview of seagrass community restoration methods, including an economic analysis. Seedling growth of turtlegrass (*Thalassia testudinum*) was successful in low-energy areas with peat or consolidated sand sediment and where pioneers such as Wright shoalweed (*Halodule wrightii*) or slender syringodium (*Syringoduim filiforme*) started to recolonize. High-energy currents, wave action from boats, and shifting unconsolidated sediments incurred low survival rates. Turfing was the most promising method for large-scale transplantation of eelgrass (*Zostera marina*).

980. Thorhaug, A., and R. D. Stearns. 1972. A preliminary field and laboratory study of physiological aspects of growth and reproduction of *Thalassia testudinum*. Am. J. Bot. 1(59):670–671.

Response: VEG

Genus: *Thalassia*

Propagation studies of turtlegrass (*Thalassia testudinum*) were conducted in Biscayne Bay and Card Sound, southern Florida. Observations were made over a 2-year period in laboratory and field sites to determine the extent of sexual and asexual reproduction as well as the growth and success rate of colonizing seeds. *Thalassia* seeds responded well in unstressed (normal temperatures) conditions with adequate sediment depth for rhizome development.

981. Thornburg, A. 1977. Use of vegetation for stabilization of shorelines of the great lakes. Pages 39–54 *in* Proceedings of the workshop on the role of vegetation in stabilization of the great lakes shoreline. Great Lakes Basin Commission, Ann Arbor, Mich.

Response: VEG, SOIL

Genus: Many

Discusses techniques for site preparation and establishment of vegetation for stabilizing shorelines of the Great Lakes. Guidelines for selecting plant species include considerations of ecotype or cultivar (e.g., adapted to proper elevation, precipitation, temperature, and soil), single species versus mixtures, and introduced versus native species. Presents a species list of grasses, legumes, trees, and shrubs that commonly occur in, or are adapted to, various moisture regimes of the Great Lakes. Discusses site preparation guidelines of water control, lime, fertilizer, seedbed preparation, seeding, irrigation, mulching, and sodding.

982. Tolbert, V. R., and G. L. Vaughan. 1980. Strip mining as it relates to benthic insect communities and their recovery. W. Va. Acad. Sci. 51(3):168–181.

Response: INVERT, HYDRO, CHEM, WQUAL

Genus: None

Describes a study of effects of strip mining on benthic insect communities and recovery of those communities over time. Three disturbed streams (Bill's Branch, Green Branch, and Indian Fork) and one undisturbed stream (Lowe Branch) in Scott, Morgan, Anderson, and Campbell counties, Tennessee, were monitored for 4 years. In addition, eight streams recovering from mining effects and another undisturbed stream were monitored for 1 year. Benthic insects, pH, temperature, dissolved oxygen, percent leaf litter, and turbidity were monitored in all streams. Although benthic communities in disturbed streams can recover over time (20–25 years after mining), reclamation activities should result in shorter recovery time.

983. Townsend, C. R., and A. G. Hildrew. 1976. Field experiments on the drifting, colonization and continuous redistribution of stream benthos. J. Anim. Ecol. 45:759–772.

Response: INVERT

Genus: None

Evaluates the role of invertebrate drift in the colonization of new areas of stream bed, exposed both experimentally (introduced trays of substrate) and naturally (diverted section of the broadstone stream, southeastern United Kingdom). On the introduced substrate, drifting accounted for 82% of the colonization. Average naturally occurring density of stream benthos was achieved after 38 days in midsummer at flow rates often less than 5 cm/s. Colonization rate was correlated with water velocity. Colonization of the diverted stream suggested that the majority of invertebrates in the drift were derived locally. Discusses rates of drift and redistribution for various groups of invertebrates.

984. Tuovila, B. J., T. H. Johengen, P. A. Larock, J. B. Outland, D. H. Esry, and M. Franklin. 1987. An evaluation of the lake Jackson (Florida) filter system and artificial marsh on nutrient and particulate removal from stormwater runoff. Pages 271–278 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: WQUAL

Genus: *Pontederia, Scirpus, Typha*

Discusses a filter system and artificial marsh constructed for removal of suspended solids and nutrients from runoff into Lake Jackson, Florida. Stormwater enters a 163,000-m^3 detention pond, passes through a 1.8-ha intermittent underdrain filter, discharges into a triple box culvert, enters a diversion impoundment, and is channeled into a 2.5-ha marsh, which has an average depth of 0.5 m, except for a 2.5-m deep settling basin near the outfall. Results from the first year of monitoring indicated that the system was capable of removing a large fraction of both suspended solids and dissolved particulate nutrient material.

985. Tupa M, E. Olgeirson, and M. Stevens. 1988. Beaver Creek stream relocation and restoration, Beaver Creek ski area, Avon, Colorado. Pages 112–114 *in* K. M. Mutz, D. J. Cooper, M. L. Scott, and L. K. Miller, tech. coords. Restoration, creation, and management of wetland and riparian ecosystems in the American west. Society of Wetland Scientists, Rocky Mountain Chapter, Denver, Colo.

Response: VEG

Genus: *Alnus, Betula, Calamagrostis, Caltha, Cardamine, Carex, Eleocharis, Equisetum, Erigeron, Geranium, Geum, Juncus, Lonicera, Mertensia, Picea, Populus, Potentilla, Ribes, Rosa, Salix, Sorbus*

Describes the design objectives and general plan for relocating a section of Beaver Creek in Avon, Colorado. Access to the stream, creation of ponded areas, and restoration of native vegetation were important considerations. The project was constructed in 1985 and evaluated in 1988. Minor sedimentation had occurred in ponded areas, but plants were thriving. The replaced wetlands were in a mid-successional woodland scrub-shrub stage.

986. Turner L. J., and D. K. Fowler. 1981. Utilization of surface mine ponds in east Tennessee by breeding amphibians. U.S. Fish Wildl. Serv., FWS/OBS-81. 14 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, AMPHIB, REPT

Genus: *Scirpus, Typha*

Describes a survey of 24 sediment ponds at Allis Creek surface mine near Caryville, Campbell County, Tennessee. The survey focused on breeding amphibians (of which 12 species were found). Water quality (pH and hardness), vegetation, and other wildlife were also recorded. Breeding amphibians were found in 21 of the ponds, where average pH varied from 5.22 to 6.33. Two ponds were very acidic (pH 4.0) and hard (34–46 ppm $CaCO_3$), but supported many amphibians and aquatic organisms. Discusses potential of the ponds for fish stocking.

987. Turner, R. E. 1977. Intertidal vegetation and commmercial yields of penaeid shrimp. Trans. Am. Fish. Soc. 106(5):411–416.

Response: SHELLF

Genus: *Juncus, Spartina*

Examines the relation between the volume of commercial penaeid shrimp and area of intertidal vegetation at study sites along the Louisiana coast. Includes data from northwestern South America, Central America, Southeast Asia, and the southeast coast of Southern Africa. Data were obtained from estimates of catches from known shrimp harvest landings. Two species of shrimp, *Penaeus aztecus* and *P. duorarum*, account for more than 95% of the shrimp harvest in Louisiana. Describes a direct relation between abundance and type of penaeid shrimp and the area and type of intertidal vegetation.

988. Tydeman, C. 1982. Gravel pits as wildlife habitat in Great Britain. Pages 6–12 *in* W. D. Svedarsky and R. D. Crawford, eds. Wildlife values of gravel pits. Univ. Minn. Agric. Exp. Stn. Misc. Publ. 17-1982.

Response: WFOWL, NGBIRDS, SHOREB, VEG, HUSE

Genus: None

Provides an overview of the use of gravel pits as habitat for birds in Great Britain. Briefly discusses the social history and attitudes toward gravel pits, along with changing uses of the pits. Eleven sites in the Thames Valley were surveyed for breeding bird populations more than 2 years. Describes community structure, species diversity, and succession in gravel pit habitat. Species diversity varied with habitat structure, which in turn changed over time (with no management). Notes the conflict between using gravel pits for recreation to take pressure off natural wetlands and developing the habitat potential of gravel pits for wildlife.

989. U.S. Army Corps of Engineers. 1986. Beneficial uses of dredged material: engineering and design. U.S. Army Corps of Engineers, Washington, D.C. EM 1110-2-5026. 272 pp.

Response: SHOREB, VEG, HUSE, SOIL, CHEM, WQUAL

Genus: Many

Provides guidance for planning, designing, developing, and managing dredged material for beneficial uses, incorporating ecological concepts and engineering designs with biological, economical, and social feasibility. Uses include habitat development, aquaculture, parks and recreation, agriculture, strip-mine reclamation, shoreline stabilization, and construction and industry. Habitat development includes discussions of wetland, upland, island, and aquatic habitats. Information on collecting, handling, and planting 359 upland and 105 wetland species on dredged material sites is included in the appendixes.

990. U.S. Army Corps of Engineers. 1979. Kissimmee River, Florida Reconnaissance Report (stage i). U.S. Army Corps of Engineers, Jacksonville, Fla. 115 pp.

Response: VEG, FISH, SHELLF, WFOWL, HUSE, HYDRO, WQUAL

Genus: *Eichhornia, Pontederia, Scirpus*

Discusses a comprehensive plan for modifying the existing flood control system of the Kissimmee River basin, north of Lake Okeechobee, Florida, to improve water quality and enhance fish and wildlife resources. Construction of the flood control system has changed the formerly cyclical flooded and dry wetlands to wetlands with stabilized water levels and reduced plant and animal species diversity. Waterfowl numbers and sport fishing have dropped considerably since installation of flood control structures. The report includes a detailed description of the study area; a discussion of the existing flood control system; and a comprehensive overview of concerns, effects, and options for modifying the existing system.

991. U.S. Army Corps of Engineers Waterways Experiment Station. 1986. Bird and mammal use of main stem levee borrow pits along the lower Mississippi River. U.S. Army Waterways Experiment Station., Vicksburg, Miss. 137 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB

Genus: *Acer, Cornus, Polygonum, Populus, Quercus, Salix, Taxodium, Ulmus*, many

Discusses bird and mammal use of 26 selected borrow pits along the main stem levee of the lower Mississippi River from 1981 to 1983. Summarizes information by 11 species groups and 6 nesting groups for birds. Analyses of selected groups of animals indicated which land-use features of borrow areas produce suitable wildlife habitat: land adjacent to pools and vegetated with mixed bottomland hardwoods and good understory coverage; moderate grazing or at least occasional mowing to maintain open areas; some flooding, but less than 1 month-year; depths great enough to maintain permanent water pools even at drought; at least 12 ha; more than 1.6 km from the river; and small islands of 0.4 km in pit.

992. U.S. Department of Agriculture. 1977. Cape American beachgrass. U.S. Soil Conserv. Serv., Prog. Aid Leafl. 1152.

Response: None

Genus: *Ammophila*

Discusses the use of cape American beachgrass (*Ammophila breviligulata*) to stabilize dunes and areas of shifting sand in coastal areas from Maine to North Carolina. The plant can also be used to stabilize sandy inland areas such as roadbanks, abandoned gravel pits, and other disturbed areas. Presents guidelines for planting the grass, maintaining the grass cover, and obtaining stock.

993. U.S. Department of Agriculture. 1975. A partial summary on soil conservation service plant materials activities for shoreline erosion control. U.S. Soil Conserv. Serv. Rep. 16 pp.

Response: VEG, SOIL

Genus: *Alopecurus, Ammophila, Carex, Panicum, Phalaris, Salix, Scirpus, Spartina*

Summarizes some of the Soil Conservation Service's activities using plants to stabilize coastal, riverine, and lake shorelines throughout the United States. Discussions of each region (northeast, south, midwest, west) include a brief summary of erosion problems, a few findings concerning plantings of various species, contributions of soil conservation service plant materials centers, and plans for future work.

994. U.S. Environmental Protection Agency. 1973. Measures for the restoration and enhancement of quality of freshwater lakes. U.S. Environmental Protection Agency, Washington, D.C. EPA-430/9-73-005. 238 pp.

Response: FISH, INVERT, VEG, HYDRO, SOIL, CHEM, WQUAL, ECON

Genus: *Alternanthera, Anabaena, Aphanizomenon, Eichhornia, Gloeotrichia, Myriophyllum, Oscillatoria, Pontederia, Potamogeton, Scirpus*, many

Presents information on methods, processes, and procedures to restore and enhance the water quality of lakes. Topics discussed include an overview of lake types, thermal regimes, and nutrient cycling; measures to restrict nutrient and sediment input; in-lake treatment and control measures; control and removal of hazardous substances; and possible lake protection management considerations. Summaries of case studies throughout the world are used to illustrate various techniques, including dredging, nutrient inactivation, covering of sediments, aeration, drawdown and harvesting, biological control, and chemical control of nuisance organisms. The appendix includes discussions of various sources of water quality problems in lakes and the effects of different contaminants on lake environments.

995. U.S. Federal Highway Administration. 1979. Restoration of fish habitat in relocated streams. U.S. Department of Transportation, Washington, D.C. FHWPA-IP-79-3. 63 pp.

Response: FISH, ECON

Genus: None

Provides guidelines for the design and construction of relocated channels and describes measures that lead to rapid recovery of new channels by natural processes, with particular emphasis on restoring fish habitat. Topics include flow in natural streams, fish habitat (resting, hiding, food producing, and reproduction areas), rehabilitation concepts, and habitat restoration measures and structures. Describes types of deflectors, check dams, bank protection, and instream placement of large boulders. Design recommendations emphasize aesthetics as well as habitat improvement. A case study of the Tenmile Creek stream relocation project in Summit County, Colorado, is used to illustrate design and construction principles.

996. U.S. Fish and Wildlife Service. 1983. Carrolls channel wetland restoration project, Columbia River, Cowlitz County, Washington. U.S. Fish and Wildlife Service, Portland, Oreg., Unpubl. Rep. 13 pp.

Response: VEG

Genus: *Bidens, Eleocharis, Equisetum, Leersia, Lilaeopsis, Lindernia, Paspalum, Phalaris, Polygonum, Sagittaria, Salix*, many

Discusses efforts to restore 243 ha of riparian wetland habitat along the Carrolls channel, Cowlitz County, Washington, which was inadvertantly filled with dredged material during emergency actions following the 1980 eruption of Mount St. Helens.

997. U.S. Fish and Wildlife Service. 1986. A status report: operation of an interagency agreement for replacing easement wetlands affected by highway projects in North Dakota. U.S. Fish and Wildlife Service, Bismark, N. Dak., Unpubl. Rep. 22 pp.

Response: None

Genus: None

Discusses a memorandum of understanding developed between the U.S. Fish and Wildlife Service and the North Dakota State Highway Department to establish a basis for replacing easement wetlands effected by highway construction in the State. Wetland habitats used for replacement included constructed wetlands, existing natural wetlands, and restored drained wetlands. The memorandum has been successful in replacing wetland habitat through easements. Fee title ownership increases the potential for gains from control of land use, more intensive management, and protection from erosion. The overall average land replacement of about 1 ha of fee land for each area of easement wetland compares favorably with other habitat-based systems presently in use in the State.

998. U.S. Fish and Wildlife Service. 1985. Evaluation of mitigation wetlands: U.S. Highway 83 between Bismark and Minot. U.S. Fish and Wildlife Service, Bismark, N. Dak., Unpubl. Rep. 10 pp.

Response: WFOWL, NGBIRDS, SHOREB, HYDRO

Genus: *Carex, Eleocharis, Lemna, Phalaris, Polygonum, Populus, Potamogeton, Sagittaria, Salix, Scirpus, Setaria, Typha*, many

Discusses the U.S. Fish and Wildlife Service's evaluation of the effectiveness of mitigation wetlands along U.S. Highway 83 in North Dakota. Water level and wildlife use were examined on

216 developed ponds classified as temporary (88), seasonal (83), and semipermanent to permanent (44). Waterfowl preferred semipermanent, long (30.5 m [100 feet]) ponds greater than 6 m (20 feet) in width with good cover. No apparent differences were noted between ponds created by excavation or impoundment or between ponds connected to or separated from natural basin wetlands. Pond vegetation was similar to that of natural wetlands.

999. U.S. Fish and Wildlife Service. 1984. Recovery plan for salt marsh bird's beak. U.S. Fish and Wildlife Service, Portland, Oreg. 92 pp.

Response: VEG

Genus: *Cordylanthus*

This report is the completed salt marsh bird's beak (*Cordylanthus maritimus*) recovery plan. Describes the taxonomy, appearance, and distribution of this endangered species. It is found only in scattered salt marshes along coastal southern California and northern Baja California. *C. maritimus* is a hemiparisitic plant, deriving water and possibly nutrients from haustorial root connections with other species. Describes objectives for recovery.

1000. U.S. General Accounting Office. 1988. Public rangelands: some riparian areas restored but widespread improvements will be slow. U.S. General Accounting Office, Washington, D.C., GAO/RCED-88-105. 85 pp.

Response: VEG, SUCCESS

Genus: None

Presents results of the U.S. General Accounting Office's (GAO) investigation into the status of riparian restoration on public lands in the West. The Office reviewed 22 riparian areas restored by the Bureau of Land Management or Forest Service. The overriding factor in achieving success was improving livestock management to give the native vegetation more opportunity to grow. Management consisted of restricted herding, temporary or permanent fencing, or a combination of both. Barriers to further success in restoring riparian habitat in the West include the reduction, over the past 8 years, in personnel, funding, and activites related to riparian improvements, and lack of agency, particularly Bureau of Land Management, support of field staff in making difficult riparian management decisions when faced with uncooperative ranchers.

1001. Uebelhoer, G. 1979. Problems associated with the successful recreation of wetlands in mined areas of Desoto and Manatee counties, Florida. Pages 102–126 *in* D. P. Cole, ed. Proceedings of the Sixth Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG, HYDRO, SOIL

Genus: Many

Provides an overview of existing wetlands on phosphate mine properties in Manatee and Desoto counties, Florida. Assesses interrelations between these wetland systems and soil, topography, and hydrology. Comprises studies of transect analyses (of vegetation, soil, and topography), streamflow gaging stations and piezometer installation, geomorphological studies, and assessment of the viability of using field litter as a seed source for native vegetation. This information will be applied to test reclamation-revegetation experiments for the reestablishment of wetland systems in the big slough drainage system. Describes Phase 1 efforts of this program.

1002. Uhler, F. M. 1956. New habitats for waterfowl. Trans. N. Am. Wildl. Conf. 21:453–469.

Response: WFOWL

Genus: *Carex, Cephalanthus, Cornus, Fagus, Glyceria, Ilex, Liquidambar, Nyssa, Polygonum, Proserpinaca, Quercus, Sagittaria, Sparganium*, many

Describes the creation and management of ponds and marshes for waterfowl at the Patuxent Research Refuge near Laurel, Maryland. Discusses construction of impoundments, treatment of turbid or stained water, the use of sewage lagoons for waterfowl habitat, shrub and wooded swamp management, meadows for waterfowl, nesting sites, and predation-disturbance problems.

1003. Ulrich, K. E., and Burton T. M. 1985. The establishment and management of emergent vegetation in sewage-fed artificial marshes and the effects of these marshes on water quality. Wetlands (4):205–220.

Response: VEG, SOIL, CHEM

Genus: *Phragmites, Sparganium, Spartina, Typha, Zizania*

Describes experiments on the establishment and growth of several freshwater emergent plant species in three artificial marshes at Michigan State University's Water Quality Management Facility. Species differed in their ability to flourish in the high-nutrient, clay-bottom marshes; *Sparganium eurycarpum* spread most rapidly, followed by common cattail (*Typha latifolia*) and narrowleaf cattail (*T. angustifolia*). Input-output budgets were constructed for total nitrogen, phosphorous, and potassium. A net removal of nitrogen occurred from flow-through waters, but the sediments of all three marshes did not serve as a sink for phosphorous during the 6-year monitoring period.

1004. Uttormark, P. D, and Hutchins M. L. 1978. Imput/output models as decision criteria for lake restoration. Univ. Wisc. Water Resour. Cent., Tech. Rep. Wis WRC 78–03. 61 pp.

Response: CHEM, WQUAL

Genus: None

Evaluates the applicability of four input-output models for designing lake restoration activities. Data from 25 lakes that experienced reductions in nutrient inflow were used in the models. Comparisons of measured and predicted responses were made, based on general descriptions of trophic status, secchi depth, and lake condition index. All four models yielded accurate predictions of general trophic state for at least 70% of the lakes. Input-output models were best applied to restorative techniques that curb nutrient influx and have limited application to techniques that disrupt internal nutrient cycling or accelerate nutrient outflow.

1005. Vadas, R. L., P. E. Garwood, and D. J. Healy. 1985. Ecological evaluation of an artificially created marsh at Harrington, Maine: final report. Maine Dep. Transp., Augusta, Tech. Pap. 85–5. 150 pp.

Response: VEG, SOIL, CHEM

Genus: *Puccinellia, Salicornia, Scirpus, Spartina*, many

Discusses creation of an experimental marsh as part of a bridge construction project at Harrington, Maine. Four subsections represented different methods for establishing salt marsh vegetation (deposit, plug, sod, and pond). Initially, the marsh developed slowly with large barren areas. Many of the plugs were damaged or removed by ice. The sod area recovered quickly, and after the first year, it was as productive as the

control areas. Growth and development was consistently best on elevated, dry areas and poorest in continually wet depressions (pannes).

1006. Valiela, I., J. M. Teal, and N. Y. Persson. 1976. Production and dynamics of experimentally enriched salt marsh vegetation: below ground biomass. Limnol. Oceanogr. 21:245–252.

Response: VEG

Genus: *Spartina*

Discusses the effects of fertilization on production of smooth cordgrass (*Spartina alterniflora*) and marshhay cordgrass (*S. patens*) in a salt marsh in Massachusetts. Fertilization did not affect initial root growth, but did cause a marked reduction in root biomass after the spring peak and a marked increase in aboveground production. Roots disappeared in autumn leaving rhizomes as the only part of the plants to overwinter. The lower dose of sewage sludge fertilizer (8.4 g/m^2/week) generated greater production than the higher dose (25.2 g/m^2/week).

1007. Van Arman, J., and R. Goodrick. 1980. Effects of water level increases on Kissimmee River vegetation. Pages 19–34 *in* D. P. Cole, ed. Proceedings of the Seventh Annual Conference on the Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Fla.

Response: VEG

Genus: *Alternanthera, Ambrosia, Andropogon, Aster, Bacopa, Centella, Cephalanthus, Cirsium, Cyperus, Eichhornia, Eleocharis, Eupatorium, Hibiscus, Hydrochloa, Hydrocotyle, Juncus, Leersia, Myrica, Oxalis, Panicum, Polygonum, Pontederia, Rhynchospora, Sagittaria, Urena*, many

Documents a study of the effects on marsh reflooding on 10 previously drained plots in the floodplain of the Kissimmee River, Florida. Changes in various vegetative communities were recorded from 1974 to 1978. Areas 12.2 m above mean sea level (msl) showed an increase in floating aquatic plants, whereas areas above the 12.2–contour showed increased coverage by emergents. Areas above 12.5 m msl showed a loss of understory vegetation and an increase in wax myrtle (*Myrica*). Describes other alterations in vegetative patterns.

1008. Van der Valk, A. G. 1981. Succession in wetlands: A Gleasonian approach. Ecology 62(3):688–696.

Response: VEG

Genus: *Bidens, Cirsium, Cyperus, Lemna, Najas, Nymphaea, Phragmites, Polygonum, Potamogeton, Scirpus, Sonchus, Sparganium, Typha*, many

Presents a qualitative model of succession in freshwater wetlands, based on life history features of plant species. Uses three important life history traits to characterize wetland species: life-span, propagule longevity, and propagule establishment requirements. Recognizes 12 basic life history types. Most of the information needed to apply the model can be obtained by examining a wetland's seed bank. The future state (presence in the form of propagules in the seed bank, presence as mature plants, or complete absence) of each species type can be predicted if environmental conditions change (e.g., drawdown and subsequent reflooding). Includes examples of succession in North American and African wetlands to illustrate application of the model.

1009. Van der Valk, A. G., and C. B. Davis. 1978. The role of seed banks in the vegetation dynamics of prairie glacial marshes. Ecology 59(2):322–335.

Response: VEG

Genus: *Bidens, Carex, Ceratophyllum, Cyperus, Lemna, Najas, Polygonum, Potamogeton, Rumex, Sagittaria, Scirpus, Sparganium, Spirodela, Typha*, many

Presents results of germination tests on marsh plant seeds of Eagle Lake and Goose Lake in northcentral Iowa. Seed bank tests consisted of a 1-month laboratory test of submerging soil samples or keeping samples moist to simulate exposed mud conditions. Emergent species (cattail [*Typha*], bulrush [*Scirpus*], burreed [*Sparganium*], and arrowhead [*Sagittaria*]) germinate on exposed mud flats or in very shallow water; submerged and free-floating species (duckweed [*Lemna*], ducksmeat [*Spirodela*], hornwort [*Ceratophyllum*], naiad [*Najas*], pondweed [*Potamogeton*]) have dormant seeds or turions that can survive on exposed mud flats for a year and germinate in standing water; and mud flat species (*Bidens, Cyperus, Polygonum*, and *Rumex*) are ephemerals whose seeds can only germinate on exposed mud flats when no standing water exists.

1010. Van Haveren, B. P., and W. L. Jackson. 1986. Concepts in stream riparian rehabilitation. Trans. N. Am. Wildl. Nat. Resour. Conf. 51:280–289.

Response: None

Genus: None

Presents an overview of the interrelations between riparian systems and the hydrologic and geomorphic processes operating in the associated stream channels. Riparian degradation is generally associated with either lateral instability or stream incision. These conditions must be identified and dealt with first in any proposed rehabilitation project. Treatment methods should work with, not against, the natural channel-adjustment processes. If the stream channel is evolving towards a new stage of dynamic equilibrium, and watershed condition is static or improving, riparian rehabilitation may simply involve no more than a passsive approach of "letting nature take its course."

1011. Vanbreedveld, J. F. 1975. Transplanting of seagrasses with emphasis on the importance of substrate. Florida Dep. Nat. Resour. Mar. Res. Publ. 17. 25 pp.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Halodule, Syringodium, Thalassia*

This study was undertaken to establish reliable methods of transplanting turtlegrass (*Thalassia testudinum*) and other seagrasses at various sites near Tampa Bay, Florida. Discusses techniques for successful restoration. The substrate was soft, dark mud of 30 cm depth in 61 cm of water at mean low tide. Root dip was used on some plants. *Thalassia* clumps of five each were anchored with construction rods; the survival rate was 100%. *Thalassia* did well in anaerobic soils; shoalweed (*Halodule*) did well in aerobic soil, and syringodium (*Syringodium*) did well in both soil types. Discusses water temperature, salinity, and growth measurements.

1012. Vance, H. A. 1988. Hydrology and hydraulic requirements of successful wetlands. Pages 283–286 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the National Wetland Symposium: wetland hydrology. 16–18 September 1987, Chicago, Illinois. Association of State Wetland Managers, Berne, N.Y.

Response: SUCCESS

Genus: None

Provides an overview of requirements for a successful wetland creation or restoration project, and brief summaries of three successful wetland projects that used the suggested approach. The following are key features of successful projects: clear objectives, an understanding of hydraulic and hydrologic components of the macro-system in which they exist, a clear definition of the hydraulic requirements of the micro-system, the ability to control both macro- and micro-systems, and professional management.

1013. Varnell, R. J. 1981. A water quality monitoring program for management and restoration of two Louisiana estuaries. Pages 39–57 *in* R. H. Stovall, ed. Proceedings of the Eighth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: FISH, INVERT, HYDRO, WQUAL, CHEM

Genus: None

Management plans were developed for the Breton Sound and Barataria Bay estuaries, Louisiana. Regulation of salinity gradients within the estuaries is important. Maximization of vegetative production should retard current trends of land loss from erosion and contribute to land building. This restoration project includes diversion of freshwater from the Mississippi river and routine water sampling of pH, turbidity, salinity, and fecal coliforms. Proposed use of an existing lake as a settling basin to assure adequate flow rates from the Mississippi to the estuaries would distribute nutrient-laden water throughout the adjacent marsh, moderate water temperature, allow sediment to settle, and filter out river water pollution before it reaches the estuaries.

1014. Vaubel, J. A., and G. R. Hoffman. 1975. A study of vegetation development in relation to age of river stabilization structures along a channelized segment of the Missouri river. University of South Dakota., Department of Biology, Vermillion. 76 pp.

Response: VEG, SOIL, CHEM

Genus: *Acer, Carya, Celtis, Cornus, Fraxinus, Gymnocladus, Juglans, Morus, Platanus, Populus, Quercus, Ribes, Salix, Symphoricarpos, Tilia, Ulmus*, many

Describes a study of vegetation succession and ecological processes in relation to river stabilization structures along the Missouri River in Nebraska, Iowa, and Missouri. Noted three stages in development: the pioneer stage, dominated by cottonwood-willow (*Populus-Salix*); the intermediate state consisting of cottonwood-maple (*Populus-Acer*); and the mature forest dominated by elm-ash (*Ulmus-Fraxinus*). Results of the study indicated that the mature floodplain forest community was more diverse than the pioneer stage. This method of relating vegetation successional stages to age of river channelization proved useful for developing a time scale for vegetation establishment and was accurate for ecological land management studies.

1015. Vaught, R., and J. Bowmaster. 1983. Missouri wetlands and their management. Missouri Department of Conservation, Jefferson City. 23 pp.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG

Genus: Many

Describes development, creation, and management of wetlands in Missouri. Discusses water level control, grading and topography, management benefits, wetland type, moist soil management, waterfowl nesting programs (and nest box construction), mammals, and invertebrates. A planting chart for 12 aquatic plants includes use by wildlife (e.g., food, cover), when to plant, propagation, where to plant (soil moisture and water depth), and quantity to plant per acre.

1016. Veneman, P. L. M. 1986. Science base for freshwater wetland mitigation in the northeastern United States: soils. Pages 115–121 *in* J. S. Larson and C. Neill, eds. Mitigating freshwater wetland alterations in the glaciated northeastern United States: an assessment of the science base. Univ. Mass., Environ. Inst. 87–1.

Response: SOIL, CHEM, SUCCESS

Genus: None

Provides a summary of the basic soils information necessary for determining a mitigation proposal's potential for success. The relative importance of soil characteristics for various wetland functions is given in table form. Describes minimum, detailed, and highly detailed data requirements. These include soil profile, soil survey data, fiber content, pore water analysis, seedbank capacity, soil organisms, clay mineralogical data, microbial assessment, heavy metal content, pesticides, gas-toxin analysis, soil temperature, and peat characteristics.

1017. Vincent, M. K. 1978. Habitat development field investigations, Rennie Island marsh development site, Grays Harbor, Washington; summary report. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss. Tech. Rep. D-78-11. 94 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Alnus, Cakile, Carex, Cotula, Juncus, Polypogon, Salicornia, Scirpus, Triglochin, Zostera*

A marsh habitat development project was undertaken at Rennie Island, Grays Harbor, Washington, to evaluate marsh development using fine-grained dredge material in a high-energy, high-tide environment. The original plans were to determine the feasibility of marsh development based on pertinent literature and physical, biological, and chemical assessment of the site. Earthen dikes were to be constructed to protect the development site. Because of the high-wave energy conditions, no cost-effective, feasible type of structure was found and the project was terminated. Includes some data on soil and water chemical content and vegetative composition.

1018. Virginia Institute of Marine Science. 1978. Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix D: environmental effects of marsh development with dredged material: botany, soils, aquatic biology, and wildlife. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Tech. Rep. D-77-23. 510 pp.

Response: FISH, INVERT, WFOWL, NGBIRDS, SHOREB, VEG, SOIL, CHEM

Genus: Many

Describes marsh island habitat constructed in the James River, Virginia, from fine-grained dredged material. Compared with nearby natural marshes, the artificial marsh produced a less diverse benthos (with greater biomass) and a similar abundance and biomass of a less diverse fish community. Differences in soil and physical characteristics were pronounced; the artificial area was comprised of a higher percentage of sand, which was highly susceptible to erosion. Reference site soils were higher in percent volatiles, organic carbon, soil nitrogen, and cation exchange capacity. Plant distribution at the artificial site seemed to be controlled by elevation and inundation pe-

riod rather than by differences in soil characteristics. Includes extensive species lists.

1019. Voigts, D. K. 1976. Aquatic invertebrate abundance in relation to changing marsh vegetation. Am. Midl. Nat. 95:312–322.

Response: INVERT, VEG

Genus: *Carex, Ceratophyllum, Lemna, Myriophyllum, Potamogeton, Scirpus, Typha, Utricularia*

Presents results of a study of aquatic invertebrates in relation to vegetative cover in four prairie marshes in northwestern Iowa near Ruthven. Invertebrates were sampled in various marsh habitats during June, the peak of laying and incubation for many waterbird species. The total number of invertebrates increased as the emergent vegetation was replaced by submerged vegetation, but maximum numbers occurred where beds of submerged vegetation were interspersed with stands of emergent vegetation. Describes the number of major invertebrate groups ([*Isopoda*], [*Amphipoda*], [*Chironomidae*], [*Physidae*], and [*Zooplankton*]) in emergent vegetation at drawdown stage and in open water with few submergents.

1020. Wadsworth, F. H. 1959. Growth and regeneration of white mangrove in Puerto Rico. Caribbean For. 20 (July–December) :59–71.

Response: VEG

Genus: *Avicennia, Conocarpus, Laguncularia, Rhizophora*

Discusses silviculture of mangroves (*Rhizophora*) in Puerto Rico, including three studies on growth and regeneration of white mangrove (*Laguncularia racemosa*) on the Atlantic and Caribbean coasts of Puerto Rico. Annual growth of mangroves was greater in thinned versus unthinned plots, growth rates of white mangroves and black mangroves (*Avicennia germinans*) were similar within plots. No serious wind throw losses were suffered as a result of thinnings. Thinnings did not induce effective natural regeneration of any tree or shrub species.

1021. Wakefield, R. B. 1966. The distribution of riparian vegetation in relation to water level. M.S. thesis, Washington State University, Pullman. 35 pp.

Response: VEG, HYDRO

Genus: *Agropyron, Celtis, Eriogonum, Rhus, Salix, Sporobolus*, many

Examines the effects of water level fluctuation on the distribution of riparian vegetation of the Snake River near Clarkston, Washington. Water level and stream discharge records were examined for the 17-year period preceding this study to determine daily means. Correlates frequencies of plant species on plot strips with contour intervals and exposes the substrate during the growing season. The lower terminus of a plant's distribution is the most significant frequency of occurrence for finding a correlation between plant distribution and water level. Effects of hydrological events on the distribution of streamside perennials vary with the species and should be evaluated in terms of the plants' life cycle and growing season.

1022. Wakeman, N. 1982. Development of regional wetland restoration goals: San Francisco Bay. Pages 32–37 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: VEG, WQUAL, SUCCESS

Genus: None

Provides an overview of San Francisco Bay wetlands in terms of present status and restoration goals. According to the Bay Conservation and Development Commission, the creation or restoration of freshwater marsh, brackish water marsh, habitat for rare or endangered species, and tidal marsh would enhance the bay's wildlife resources. Restoration of tidal flow to diked areas should increase the productivity of the bay. Careful planning, implementing, and monitoring (for at least 10 years) are essential for the achievement of restoration goals and objectives. Provides a suggested project checklist.

1023. Walker, R. 1988. Phosphate mining and wetlands creation: a company perspective. Pages 37–40 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: FISH, INVERT, VEG, CHEM, WQUAL

Genus: *Juncus, Spartina*

Discusses Agrico's Program of on-site and in-kind wetlands restoration on phosphate-mined lands in Florida and North Carolina. Restoration has involved excavation of ponds, planting wetland soils, and elevation grading. Overall, productivity of the created wetlands is nearly equivalent to that of natural systems. High pH of the marshes is declining and wildlife use of the wetlands is encouraging. Agrico is continuing their research on productivity, water quality, and wildlife use of the nearly 365 ha of created wetlands. Agrico also developed high flotation equipment to ditch and consolidate clays in waste ponds, which speeds reclamation of these areas.

1024. Walker, R. 1986. Corporate wetland creation effort (North Carolina). Restoration Manage. News 4(1):29.

Response: FISH, INVERT, SOIL, CHEM, WQUAL, SUCCESS

Genus: *Juncus, Spartina*

This experiment was conducted to create a salt marsh-open water fish nursery in creeks of the Pamlico Estuary, North Carolina. An intensive monitoring program of natural and man-initiated creeks included studying benthic invertebrates, fish, and use of phytoplankton. Approximately 60,000 cordgrass (*Spartina*) seedlings were planted along with rush (*Juncus*) on 2.4 ha of marsh. Abundance and diversity of the fish community in the created marsh were about equal to those in natural adjacent areas.

1025. Warburton, D. B., W. D. Klimstra, and J. R. Nawrot. 1985. Aquatic macrophyte propagation and planting practices for wetland development. Pages 139–152 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Proceedings of the wetlands and water management on mined lands conference. Pennsylvania State University, University Park.

Response: WFOWL, VEG, HYDRO, SOIL, CHEM

Genus: *Cyperus, Echinochloa, Polygonum, Scirpus, Secale, Spartina, Triticum*, many

Provides an overview of the development of coal mine slurry impoundments as wetland habitats through research demonstration efforts in Illinois. Discusses site assessment, planting stock selection, planting methods, and monitoring strategies. Plants that occur naturally on slurry ponds near the intended restoration site were found to be the most successful planting stock. Tables depict plant longevity, use as food and cover for waterfowl, recommended propagules, and physico-chemical conditions of natural habitat. Compares survival, stem height,

cluster diameter, and stem diameter between two sources of hardstem bulrush stock (*Scirpus acutus*): locally collected and commercial nursery. Compares hardstem bulrush to river bulrush (*Scirpus fluviatilis*) in terms of the same variables, with and without fertilizer treatments.

1026. Ward, E. 1942. Phragmites management. Trans. N. Am. Wildl. Conf. 7:294–298.

Response: VEG

Genus: *Phragmites, Scirpus, Typha*

Contains the observations of the growth and wildlife use of reed (*Phragmites*) over a 14-year period on the Delta Marsh, Manitoba, Canada. *Phragmites* is an aggressive plant that often crowds out more valuable wildlife food and cover plants. Dense stands of *Phragmites* are seldomly used by nesting ducks; however, phragmites edges and new thin growths are heavily used. *Phragmites* has the benefit of providing an effective barrier between farmland and wilderness marsh—preventing the intrusion of both man and cattle. The author discusses two methods of controlling phragmites that have had some success on the delta marsh: a 3-year mowing program and a spring or fall burning program.

1027. Ward, G. H. 1985. Marsh enhancement by Freshwater Diversion. J. Water Resour. Plan. Manage. 3(1):1–23.

Response: HYDRO

Genus: None

Describes the hydrological characteristics of the Nueces Delta, Texas, as part of a larger study to determine the feasibility of improving the ecological value of this coastal marsh area by construction of diversion works to increase marsh inundation by the river. Describes a numerical hydrodynamic model of the delta system: it predicts time evolution of flow and water level throughout the delta, simulating inundation and dewatering of floodplain and activation of intermittent channels. The response of the marsh to various flood events was computed for existing conditions as well as proposed combinations of weirs and diversion channels. The method described here, that combines statistical hydrology with a numerical hydrodynamic delta model, may be applied to other locations and situations.

1028. Warner, G. 1965. Relocating a river and rebuilding a fishery. Outdoor Calif. 26(12):14–15.

Response: FISH

Genus: None

Discusses habitat improvements on 4 km of relocated sections of the South Fork Yuba River, Placer County, California. Relocated sections were meandered as much as possible within the limited area available. Stream banks were sloped and stabilized with riprap. Deflectors were installed in the stream to create pool and riffle areas; they withstood two torrential rainfalls causing flood conditions and flows of 6,000 and 18,000 cfs in the river. Pools and riffles were created and the vast accumulation of silt was flushed out during these high-water periods. Trees were planted along streambanks to provide shade for fish and anglers.

1029. Warner, K., and I. R. Porter. 1960. Experimental improvement of a bulldozed trout stream in Northern Maine. Trans. Am. Fish. Soc. 89(1):59–63.

Response: FISH, HYDRO

Genus: None

Describes an experiment to improve brook trout habitat in Hudson Brook, northern Maine; the brook was bulldozed in 1950 for pulpwood stacking. Shade trees, bank cover, aquatic vegetation, and pools were destroyed. The brook was improved by installing single-wing deflectors, rock dams, and spring holes. Deflectors, constructed from bottom material, constricted the stream channel and created pools. Rock dams, built to impound pools and spring holes, were excavated and improved to increase their effectiveness in cooling stream water. After 2 years, most deflectors were still in place and working effeetively. None of the rock dams remained after wash-outs and three spring holes created 15.2- 76.2-cm deep pools where young-of-the-year trout were moderately abundant.

1030. Warren Spring Laboratory. 1963. The removal of oil from contaminated beaches. Warren Spring Laboratory, Department of Scientific and Industrial Research, Stevenage, Herts., England. Rep. Rr/Es/39. 6 pp.

Response: None

Genus: None

Provides a summary of methods for removing oil from contaminated beaches. Describes and evaluates removal by chemical and solvent treatments, physical removal of oil-contaminated material, burning, and cloaking or masking oil deposits. Includes limitations of these techniques and toxic effects on marine life.

1031. Water Resources Engineers. 1978. Hayward Marsh Restoration Project: hydraulic, soils, and cost considerations. Water Resources and Engineering, San Francisco, California. 32 pp.

Response: ECON

Genus: None

Summarizes hydrologic information and construction design for the Hayward Marsh Restoration Project, San Francisco, California. Describes levee specification, sedimentation, channel networks, and tidal fluctuations. Includes recommended grading specifications, along with descriptions of fill material. Provides costs, along with several cross-section illustrations.

1032. Waters, T. F. 1964. Recolonization of denuded stream bottom areas by drift. Trans. Am. Fish. Soc. 93(3):311–315.

Response: INVERT

Genus: None

Discusses stream invertebrate recolonization of an experimental substrate sampler placed in Valley Creek, eastcentral Minnesota. Drift rate, accumulated drift, and rate of recolonization were measured each season. The dominant organisms, a mayfly (*Baetis*) and an amphipod (*Gammarus*), exhibited high drift rates. During autumn and winter, repopulation generally took longer, up to 10 days for Baetis in winter. The failure of an organism to recolonize quickly may temporarily permit another organism to recolonize above original levels.

1033. Watson, J. T., F. D. Diodato, and M. Lauch. 1986. Design and performance of the artificial wetlands wastewater treatment plant at Iselin, Pennsylvania. Pages 263–270 *in* Reddy, K. R. and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: CHEM, WQUAL

Genus: *Lemna, Phalaris, Typha*

Discusses a low cost marsh–pond–meadow system for treatment of municipal wastewater at Iselin, Pennsylvania. The Iselin wetlands system consists of four main components: an aerated pond, a cattail (*Typha*) marsh, a stabilization pond, and

a reed canary grass meadow. Data from 31 months of operation indicate that the system is effective in meeting the National Pollutant Discharge Elimination Systems' discharge limitations for BOD, ammonia, nitrogen, and fecal coliforms. The system meets the U.S. Environmental Protection Agency's secondary treatment standards for total suspended solids more than 90% of the time. Reduction of phosphorus is higher during summer (90%) than winter (68%) because of plant dormancy and decay.

1034. Weaver, J. E., and L. F. Holloway. 1974. Community structure of fishes and macrocrustaceans in ponds of a Louisiana tidal marsh influenced by weirs. Contrib. Mar. Sci. 18:57–69.

Response: FISH, INVERT, SHELLF, CHEM, WQUAL, VEG

Genus: *Potamogeton, Ruppia*

This study was initiated to determine responses of fish, macrocrustaceans, and tidal marsh vegetation to weirs constructed in the 1950's in the Marsh Island Wildlife refuge near Vermillion Bay, Louisiana. Analyzes three pond sites: weired nonvegetated, weired vegetated, and unweired. Relatively high light transmittance and stable water levels contributed to the growth of extensive vegetation in the weired ponds. Gathered shrimp and fish data using surface and otter trawls. Examines ingested food materials in several fish species. Organic detritus, benthos, and zooplankton were major food sources in open-water areas, whereas vascular plant matter and associated fauna were more important in vegetated communities.

1035. Webb, J. W., Jr. 1977. Establishment of vegetation for shoreline stabilization in Galveston Bay, Texas. Ph.D. dissertation, Texas A&M University, College Station. 136 pp.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Arundo, Avicennia, Distichlis, Juncus, Phragmites, Scirpus, Spartina, Tamarix*

Compares the use of 13 salt marsh plant species for shoreline stabilization along the north shore of East Bay, Galveston, Texas. Wave-stilling devices constructed of hay bales and 14-gauge welded mesh wire or chicken wire did not withstand high-wave energies. Tires on cables attached to posts lost their effectiveness as they sank into the bay bottom. Giant reed, gulf cordgrass, and marshhay cordgrass (*Spartina patens*) were best adapted for areas above high tide. Smooth cordgrass (*S. alterniflora*) was best adapted to areas exposed to tidal action; survival was significantly greater behind wave-stilling areas. Black mangrove (*Avicennia germinans*), bulrushes (*Scirpus*), salt grass (*Distichlis*), salt cedar (*Tamarix*), needlegrass (*Stipa*), and common reed (*Phragmite australis*) generally exhibited poor survival.

1036. Webb, J. W. 1982. Salt marshes of the western Gulf of Mexico. Pages 89–109 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, SOIL

Genus: *Arundo, Avicennia, Batis, Colocasia, Distichlis, Eleocharis, Juncus, Phragmites, Rosa, Sagittaria, Salicornia, Scirpus, Spartina, Tamarix, Zizaniopsis*, many

Describes wetland restoration and creation efforts along the western gulf of Mexico. Describes productivity, habitat values, and habitat loss or modification, along with a review of 11 specific restoration-creation projects. These include Galveston Island—habitat rehabilitation, Galveston Bay—shoreline stabilization, Bolivar Peninsula—habitat development, Corpus Christi—stabilization of dredged material, Louisiana and Texas—pipeline revegetation, Texas City—dike marsh establishment, Clear lake—marsh mitigation for habitat loss, and Lake Pontchartrain—shoreline erosion demonstration project. Discusses natural revegetation of dredged material. Describes recommended techniques for species selection and wave protection, and identifies research needs.

1037. Webb, J. W., H. H. Allen, and S. O. Shirley. 1984. Marsh transplant establishment analysis along the northwest shoreline of Theodore Disposal Island, Mobile Bay, Alabama. Pages 184–200 *in* F. J. Webb, ed. Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Fla.

Response: VEG, SOIL

Genus: *Juncus, Spartina*

Examines factors correlated with the establishment of smooth cordgrass (*Spartina alterniflora*) and needlerush (*Juncus roemerianus*) planted on a spoil disposal island dike in Mobile Bay. Establishment was most successful in coves with less wave action. Plant cover establishment was affected by elevation, percent shoreline slope, direction and degree of wave exposure, fetch, and sand depth on straight shorelines. Greater plant cover was present in protected areas where sand depth was over 50 mm. Apparently, roots do not penetrate the underlying clay, but do require deeper sand for anchoring.

1038. Webb, J. W., and J. D. Dodd. 1978. Shoreline plant establishment and use of a wave-stilling device. U.S. Army Corps Eng., Fort Belvoir, Va, Misc. Rep. 78–1. 28 pp.

Response: VEG, SOIL, CHEM, ECON

Genus: *Arundo, Distichlis, Juncus, Spartina, Tamarix*

Anahuac National Wildlife Refuge in Galveston Bay, Texas, was the site for a 2-year study to determine plant suitability for shoreline stabilization. Objectives included field testing plants, refining knowledge on germination and planting technology, and compiling time requirements for specific operations. Out of 10 study blocks, 6 were fenced to keep rabbits out. Tiered tires on cables were initially used to protect the planting area, which had a 2% slope. Survival of cordgrass (*Spartina*) was 56.7% in the fenced area and 40.5% in the unfenced area, probably because of rabbit damage. Survival was lowest in the lower elevations, apparently because of wave action. Total cost for construction, sloping, and planting was $15.90/linear meter.

1039. Webb, J. W., and J. D. Dodd. 1976. Vegetation establishment and shoreline stabilization: Galveston Bay, Texas. U.S Army Corps Eng., Coastal Eng. Res. Cent., Fort Belvoir, Virginia, Tech. Pap. No. 76–13. 74 pp.

Response: VEG, SOIL, CHEM, WQUAL, ECON

Genus: *Avicennia, Distichlis, Juncus, Phragmites, Scirpus, Spartina, Tamarix*

The east bay of Galveston Bay, Texas, was the site of a revegetation project to stabilize an eroding shoreline. This area experiences high-energy wave action and requires structures to reduce wave effects and encourage vegetative growth. Wave-stilling devices of pipe, wire, netting, cable, and baled hay were used as well as tire and pipe structures. *Spartina* planted at 0.3-m intervals produced solid stands after 2 years. *Avicennia* was initially successful, but all plants died during the winter. Fertilizer applications did not produce significant

growth results. Detailed soil and bay water analyses are provided.

1040. Webb, J. W., J. D. Dodd, B. W. Cain, W. R. Leavens, L. R. Hossner, and C. Lindau et al. 1978. Habitat development field investigations; Bolivar Peninsula marsh and upland habitat development site, Galveston Bay, Texas. Appendix d: propagation of vascular plants and post propagation monitoring of botanical, soil, aquatic biota, and wildlife resources. U.S. Army Eng. Waterways Exp. Stn., Environ. Lab., Vicksburg, Mississippi, Tech. Rep. D-78-15. 772 pp.

Response: FISH, INVERT, MAMMALS, NGBIRDS, SHOREB, VEG, SOIL, CHEM, WQUAL

Genus: *Cynodon, Myrica, Panicum, Quercus, Rhus, Spartina*

Describes the establishment of marsh and upland communities on a dredged material disposal area on Bolivar Peninsula, Galveston Bay, Texas. *Spartina alterniflora* and *S. patens* were planted at various elevations with various fertilizer treatments; results are discussed. Plants thrived only where protected from waves by a sandbag dike. Bird species composition at the marsh changed as the marsh developed; censuses were conducted biweekly. Mammals, fish, and benthic invertebrates were also described in the experimental area. Physical and chemical characteristics of the substrate and water quality data are provided.

1041. Webb, J. W., B. H. Koerth, J. D, Dodd, and A. T. Weichert. 1984. Seedling establishment of *Spartina alterniflora* and *Spartina patens* on dredged material in Texas. Gulf Res. Rep. 7(4):325–329.

Response: VEG, HYDRO, SOIL

Genus: *Spartina*

Describes a study of seedling establishment of *Spartina alterniflora* and *S. patens* at a dredge-material site on Bolivar Peninsula, Galveston Bay, Texas. Effects of fertilization, elevation, and tidal inundation were evaluated. Based on study results, establishment of *Spartina alterniflora* by seed is feasible at low elevations only during low winter tides. Survival and growth of seedlings did not increase as a result of fertilization.

1042. Webb, J. W., M. C. Landin, and H. H. Allen. 1986. Approaches and techniques for wetlands development and restoration of dredged material disposal sites. Pages 132–134 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Assoc. State Wetland Managers, Berne, New York.

Response: VEG, HYDRO, SOIL

Genus: *Spartina*

Summarizes approaches and techniques for wetlands development and restoration of dredged material disposal sites at Bolivar Peninsula, Texas; Gaillard Island, Alabama; and Pass Christian, Mississippi. The U.S. Army Corps of Engineers has tested a variety of wetland establishment techniques, including planting without wave protection and wave protection provided by permanent breakwaters, temporary fixed and floating breakwaters, plant rolls, erosion control mats, and plant bundles. Wetlands can be established with careful planning and implementation on a site-specific basis using one or more of these techniques. Where costs are a high priority consideration, erosion control matting and plant rolls have been found to be much less expensive protection measures than riprap and permanent breakwaters.

1043. Webb, J. W., and C. J. Newling. 1985. Comparison of natural and man-made salt marshes in Galveston Bay Complex, Texas. Wetlands 4:75–86.

Response: VEG, SOIL, CHEM

Genus: *Batis, Distichlis, Salicornia, Spartina, Sporobolus*

Describes and compares the vegetation characteristics of three natural marshes and one artificial marsh (Bolivar) established on dredged material. The marshes are located at Pepper Grove, Jamaica Beach, and Eight-Mile road in Galveston Bay. After 2 years, plantings established at Bolivar were compared with vegetation of the three sites. *Spartina alterniflora* was dominant at lower intertidal elevations below mean high water. Biomass of *S. alterniflora* declined with increasing elevation, as *Salicornia bigelovii, Spartina patens, Batis maritima, Sporobolus viginicus,* and *Distichlis spicata* became dominant. All marshes were similar in species composition. Bolivar had higher productivity in terms of biomass, probably because of available nutrients in the accumulating silt layer. The experimental marsh exhibited characteristics typical of natural marshes.

1044. Wein, G. R., S. Kroeger, and G. J. Pierce. 1987. Lacustrine vegetation establishment within a cooling reservoir. Pages 206–218 *in* F. J. Webb, Jr., ed. Proceedings of the Fourteenth Annual Conference on Wetlands Restoration and Creation. Hillsborough Community College, Plant City, Fla.

Response: VEG

Genus: *Alnus, Brasenia, Carex, Cephalanthus, Eleocharis, Eleocharis, Glyceria, Juncus, Leersia, Lycopus, Nelumbo, Nymphaea, Nyssa, Panicum, Polygonum, Pontederia, Potamogeton, Sagittaria, Salix, Scirpus, Taxodium, Typha, Vallisneria*

Describes large-scale mitigation involving a reactor cooling reservoir (I-lake) at the Savannah River Plant, South Carolina. Approximately 100,000 wetland plants of 27 species were planted along 472 m of shoreline in 1987. Species were representative of submergent, floating-leaved, emergent, and woody zones found in regional South Carolina lakes and reservoirs. Initial observations indicate that plants have become established and are reproducing. Projeet success will be determined after the first year of growth. Hydrological, biological, and logistic problems encountered during transplanting, planting, and early establishment of plants are discussed.

1045. Wein, G. R., and W. D. Mccort. 1988. Sources of complexity in wetland mitigation. Pages 41–50 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: SHOREB, HYDRO, CHEM, WQUAL, SUCCESS

Genus: *Anabaena, Microcystis*

This paper uses the example of the restart of a nuclear reactor at the Savannah River Plant, Aiken, South Carolina, to illustrate how three factors can increase wetland mitigation complexity: (1) scale, (2) multiple regulatory agencies, and (3) conflicting goals and objectives. One component of the reactor restart, the establishment of a balanced biological community in I-lake, had large-scale effects, nebulous goals and objectives, and involved several regulatory agencies. In contrast, replacement of lost foraging habitat for the endangered wood stork at Kathwood Lake had small-scale effects that could be managed; a singular, well-defined goal; and clear guidance from

one regulatory agency. The 1-lake project has yet to succeed, whereas Kathwood Lake was immediately successful.

1046. Weiner, A. H. 1986. Restoration of American crocodile habitat (Florida). Restoration and Manage. Notes 4(2):78.

Response: REPT

Genus: None

Discusses restoration of 2 ha of saltwater wetlands in Key Largo, Florida, to provide habitat for the federally endangered American crocodile. Crocodile habitat was created in an abandoned limerock quarry. Large piles of limerock were removed from the site and a sloping ramp was created adjacent to a 1-ha, 18-m deep pit to allow crocodiles to "haul out" onto the land. Fill material was graded to provide protection from wind. A shallow trench was dug between the quarry and adjacent state road to prevent vehicular access. A mound of soft soil was placed in a remote corner of the site as a potential nesting area. Crocodiles have been regularly observed using the area for the last 2 years.

1047. Weller, M. W. 1975. Studies of cattail in relation to management for marsh wildlife. Iowa State J. Res. 49(4):383–412.

Response: VEG

Genus: *Typha*

Discusses experimental studies on the common cattail (*Typha latifolia*) and a robust hybrid (*T. latifolia* x *T. angustifolia*) conducted in the laboratory and in marshes of northwestern Iowa. Germination rates generally were inverse to water depth, with maximum germination in 1 inch of water. Hybrids grew taller than common cattail, but had stems of smaller average diameter. Rhizome shoot production was inverse to water depths. Flooding of cut stems for 1 year killed the plants. Maximum bird production required maintenance of a 50:50 cover–water ratio with interconnected and well-interspersed pools larger than 30 feet in diameter. Water-level manipulation and management of muskrat populations were considered the most natural, effective, and inexpensive means of providing such cover.

1048. Weller, M. W. 1978. Management of freshwater marshes for wildlife. Pages 267–284 *in* R. Good, D. Whigham, and R. Simpson, eds. Freshwater wetlands. Academic Press, New York.

Response: VEG

Genus: *Carex, Phragmites, Scirpus, Typha*

Presents an overview of freshwater marsh management for wildlife. Topics include (1) structure of marshes and their use by wildlife, (2) marsh succession, (3) influences of water depth and muskrats on vegetation, (4) the use of natural processes in marsh management (e.g., water-level manipulation, system management, grazing, burning, modification of water salinity), (5) artificial procedures for modifying marshes (e.g., cutting, herbicides, artificial nest sites), and (6) sociological aspects of marsh management. The author also discusses the need to gather experimental data to advance marsh management theory and practice. Over 75 references are cited in this overview of freshwater marsh management.

1049. Weller, M. W. 1981. Freshwater marshes: ecology and wildlife management. Univ. Minnesota press, Minneapolis. 146 pp.

Response: MAMMALS, WFOWL, NGBIRDS, VEG

Genus: Many

Management, restoration, and evaluation of freshwater marshes are the topics of two chapters from this book. Water level regulation for revegetation includes discussion of complete and partial drawdowns. Complete drawdowns are used when major restoration is essential. Partial drawdowns are useful when vegetation needs to be encouraged and herbivores discouraged. Discusses water level modification, management of herbivores, seeding and planting of vegetation, invasion by exotic species (e.g., carp), and other restoration and creation considerations. Describes water level modification and stability and various marsh functions.

1050. Weller, M. W., and L. H. Fredrickson. 1974. Avian ecology of a managed glacial marsh. Living Bird 12:269–291.

Response: MAMMALS, WFOWL, NGBIRDS, SHOREB, VEG, HYDRO

Genus: *Bidens, Ceratophyllum, Chara, Cyperus, Elodea, Hydrodictyon, Impatiens, Leersia, Lemna, Najas, Polygonum, Potamogeton, Riccia, Ricciocarpus, Sagittaria, Scirpus, Spirodela, Typha, Utricularia, Wolffia*

Discusses dominant emergent and submergent vegetation and wildlife populations of rush lake, a 400-acre semipermanent glacial marsh in Palo Alto County, Iowa, which was drawn down and then reflooded. Initial drawdown vegetation consisted of moist soil annuals as well as aquatic perennials. All but cattail (*Typha*) were eliminated within 3 years; cattail density increased steadily during that time. Diversity and numbers of avian species were greatest when 50–70% of the open water was well interspersed with emergent vegetation. After 6 years of flooding, emergent vegetation was eliminated in the central marsh by muskrats and water levels and bird populations were reduced to species using the marsh edge.

1051. Wells, J. 1975. Engineering considerations in the building and management of dredge islands. Pages 63–74 *in* J. F. Parnell and R. F. Soots, eds. Proceedings of a conference on management of dredge islands in North Carolina estuaries. Univ. North Carolina, Sea Grant Program, Raleigh, Publ. UNC-SG-75-01.

Response: None

Genus: None

Discusses the U.S. Army Corps of Engineers Wilmington district's role in construction and management of dredge material islands along the coast of North Carolina. The author discusses several cases that illustrate procedures used to create or protect habitat: (1) Shallow Bag Bay—timing of disposal to avoid nesting seasons and (2) Cape Fear River—control of effluent by diking to protect shrimp. The author urges good communication between biologists and the Corps so that both sides will be aware of natural resources and alterations of those resources.

1052. Wesche, T. A. 1985. Stream channel modifications and reclamation structures to enhance fish habitat. Pages 105–163 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publ., Boston, Mass.

Response: FISH, INVERT, HYDRO

Genus: None

Provides an overview of techniques for modification of stream channels to improve fish habitat. Stream parameters such as substrate, depth, and drift are discussed in terms of habitat needs (spawning and egg incubation areas and cover). A major objective of aquatic habitat reclamation is the addition of some degree of roughness back into a modified channel. Various

habitat reclamation treatments and planning procedures are discussed. Current deflectors (made of logs and/or boulders), dams (boulder or log), and other in-channel treatments such as boulder placement are described in detail. Substrate modification and bank cover treatments (riprap, log overhangs, tree retards, artificial overhangs) also are discussed and diagrammed.

1053. Westree, B. 1977. Biological criteria for the selection of cleanup techniques in salt marshes. Pages 231–235 *in* Proceedings, 1977 oil spill conference, 8–10 March, New Orleans, Louisiana. American Petroleum Institute, Washington, D.C.

Response: None

Genus: *Avicennia, Laguncularia, Rhizophora, Spartina*

Describes distribution and cleanup of oil spills in salt marshes. Physical characteristics of marshes are compared to biological features and state-of-the art cleanup techniques are identified. Effects of different types of oils are described. Cleanup techniques are related to behavior of uncontained oil in marshes; least damaging cleanup strategies are selected.

1054. White, J. M., and L. R. Sinclair. 1979. Effect of plant spacing on growth and yield of transplanted cattails. Proc. Soil Crop Soc. Fla. 38:18–20.

Response: VEG

Genus: *Typha*

Discusses effect of plant spacing on growth and yield of cattail (*Typha*) transplanted in Lauderhill muck soil (Florida). Cattail was transplanted 98 days after seeding and set 7.6, 15.2, 30.5, 45.7, And 61.0 cm apart with rows 61.0 cm on center. Plant height was greater at close spacings at the end of the first growing season. Close spacings of cattails produced more fresh and dry weight per unit area during the first season, but by the second season, spacing effect was not significant. If cattails are to be grown for longer than 1 year, spacings can be increased to at least 61 cm, thereby reducing the number of seedlings needed and labor required for transplanting.

1055. White, T. R., and R. C. Fox. 1980. Recolonization of streams by aquatic insects following channelization. Clemson Univ., Water Resour. Res. Inst. Rep. 87. Vol. I. 120 pp.

Response: INVERT, CHEM, WQUAL

Genus: *Alnus, Cornus, Impatiens, Nyssa, Panicum, Platanus, Polygonum, Rumex, Salix, Taxodium*, many

Compares species composition and richness of aquatic insects in five channelized and two natural streams in the piedmont and coastal plain regions of South Carolina. Aquatic insect fauna of channelized streams were composed primarily of tolerant pond-inhabiting species. Taxa preferring fast currents, vegetation, and low turbidity were found rarely in the channelized stream, but were present in natural streams. Aquatic insect fauna did not recover even after 21 years of channelization.

1056. Whitlow, T. H., and C. J. Bahre. 1984. Plant succession on Merced River dredge spoils. Pages 68–74 *in* Warner R. E., and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkley. Calif. Water Resour. Rep. 55.

Response: VEG, SOIL

Genus: *Alnus, Bromus, Eleocharis, Geranium, Juncus, Lotus, Oxalis, Populus, Quercus, Rubus, Rumex, Salix, Typha*, many

Investigates plant succession on five sites of 2,800 ha on Merced River dredge spoils in central California. The spoils were deposited in 1907 from gold mining operations and consisted of intervening swales of fine-textured soils and standing water. A floristic inventory of vegetation on mound tops, high swales, and low swales was conducted. Data were analyzed using the plant association program of Ceska and Roemer. Tables are included comparing the study sites with a control site. The analysis program correlated spoil topography with moisture availability. The control site had 12 plant species present, whereas spoil sites had 29–57 species.

1057. Whitlow, T. H., and R. W. Harris. 1979. Flood tolerance in plants: a state-of-the-art review. U.S. Army Eng. Waterways Exp. Stn., Environ. Lab., Vicksburg, Mississippi, Tech. Rep. E-79-2. 257 pp.

Response: VEG, SOIL, CHEM

Genus: *Acer, Celtis, Cephalanthus, Fraxinus, Liquidambar, Nyssa, Platanus, Quercus, Salix*, many

Summarizes experimental studies of flood tolerance in plants and discusses factors and applications for revegetating reservoirs and canals throughout the United States. Changes in soil pH and oxygen depletion result from flooding and stress vegetation. Plants have the ability, in varying degrees, to compensate for these stresses. Provides a detailed summary of research and techniques relating to reservoir revegetation. Outlines specific construction of reservoir drawdown zones. Information regarding forested wetland species includes lists of species tolerant, moderately tolerant, or intolerant to flooding.

1058. Wieder, R. K., G. E. Lang, and A. E. Whitehouse. 1985. Metal removal in sphagnum-dominated wetlands: experience with a man-made wetland system. Pages 353–364 *in* R. P. Brooks, D. E. Samuel, and J. B. Hill, eds. Wetlands and water management on mined lands, proceedings of a workshop. Pennsylvania State University, School of Forestry Resources, University Park.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Acer, Agrostis, Betula, Carex, Dennstaedtia, Eleocharis, Juncus, Polytrichum, Pyrus, Rhynchospora, Rubus, Scirpus, Sphagnum, Vaccinium*

Describes a study of an artificial wetland constructed to remove iron from a series of springs and seeps emanating from within the permit area of an active surface coal mine near McHenry, Maryland. The 10-m by 60-m wetland was constructed by partially filling the discharge end of a pond and adding about 180 m^3 of surface peat, which was predominantly sphagnum-derived organic substrate. Water samples were taken from 18 stations. Because iron concentrations remained high throughout the study, it was concluded that the wetland was too small for effective treatment of the input water.

1059. Wilcox, C. G. 1986. Comparison of shorebird and waterfowl densities on restored and natural intertidal mudflats at upper Newport Bay, California. Colonial Waterbirds 9(2):218–226.

Response: WFOWL, SHOREB

Genus: *Salicornia, Spartina*

Describes a study of effects of wetland restoration at upper Newport Bay, Orange County, California, on shorebirds and dabbling duck populations. Compares populations of birds using restored areas to those using nearby natural mud flats. After 3 years, more dabbling ducks were using the restored

area than the natural area. However, total population within the study area did not increase; the population was redistributed over the area. Shorebirds did not respond as quickly to use the restored areas. This probably corresponded to benthic community development.

1060. Wilcox, D. A., and R. W. Buchholz. 1986. Vegetation restoration in a road salt effected bog (Indiana). Restoration and manage. News 4(1):28.

Response: VEG, SOIL, CHEM, WQUAL

Genus: *Chamaedaphne, Drosera, Larix, Onoclea, Panicum, Pyrus, Scirpus, Sphagnum, Typha, Vaccinium*

Describes techniques used to revegetate 2 ha of Pinhook Bog, Laporte County, Indiana, after the removal of a salt pile that had contaminated the area. Contiguous plots were established in *Typha* and *Pyrus*. The *Typha/Pyrus* canopy was cut to determine the effect of canopy removal on soil pH. Transplants of eight common bog plants were then placed in the cleared areas. Data on soil pH and water chemistry were collected every 3 weeks. The following genera survived tranplanting: *Larix, Chamaedaphne*, and *Sphagnum*. *Panicum implicatum* showed the greatest increase in growth.

1061. Wilhelm, M., S. R. Lawry, and D. D. Hardy. 1988. Creation and management of wetlands using municipal wastewater in northern Arizona: a status report. Pages 154–159 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: WFOWL, HUSE, WQUAL, ECON

Genus: *Tamarix, Xanthium*

Discusses the Apache–Sitgreaves National Forest Wetlands Management Program by which secondarily treated effluent has been used to create wetlands in northern Arizona. Since 1979, 113 ha of marsh have been developed in pinyon-juniper wetlands. The wetlands include dikes for water control, 68 nesting islands, and 123 ha of uplands fenced for protection from livestock grazing. Management practices on the wetlands have included wildlife food plant/cover plantings, predator control, and water level manipulations. The created marshes have provided (1) economical disposal of municipal wastewater for local communities and (2) highly productive marsh ecosystems heavily used by hunting and viewing publics. Systems used for the cities of show low and pinetop-lakeside are presented in more detail.

1062. Willard, D. E., and R. B. Reed. 1986. The use of native species to restore and create wetland habitat for mitigation. Pages 340–342 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Assoc. State Wetland Managers, Berne, New York.

Response: VEG, ECON, SUCCESS

Genus: None

Discusses the use of native plant species in wetland restoration or creation projects. A brief literature review is followed by a discussion of costs. Project cost analyses reflect land preparation, labor and equipment, planting, and hydrological manipulation. The most important component of a successful project appears to be the establishment of a favorable water regime. Research needs are identified.

1063. Williams, D. D. 1977. Movement of benthos during the recolonization of temporary streams. Oikos 29:306–312.

Response: INVERT

Genus: None

Discusses the relative importance of four main sources of recolonizing benthic invertebrates during the annual repopulation of two temporary streams (Mosher Creek and Kirkland Creek) of the grand river drainage basin, Ontario, Canada. Drift and upstream migration from pools, migration from within substrate, and aerial sources were examined. Invertebrates that spent the summer drought as dormant forms buried in the substrate were the most important recolonizers, although isolated pools also may have acted as faunal refuges. Drift provided an effective means of dispersing clumped individuals at the start of each lotic phase; upstream migration also was prevalent at that time. Aerial sources contributed only minimally to the recolonization of the streams.

1064. Williams, D. D., and H. B. N. Hynes. 1977. Benthic community development in a new stream. Can. J. Zool. 55(7):1071–1076.

Response: INVERT, VEG

Genus: *Carteria, Chlamydomonas, Navicula, Nitzschia, Spirogyra, Stauroneis*

Discusses development of invertebrate fauna in a manmade, permanent stream that replaced a natural, temporary stream (Moser Creek) in Waterloo County, Ontario, Canada. Species colonized the new stream through drift, upstream migration, migration from a nearby underground field drainage system, and aerial migration from neighboring bodies of water. Although stability was approached after 109 days of flow when thick algal growths were appearing, the natural colonization process was altered when a nearby septic tank overflowed and the stream had characteristics of sewage pollution. In some sections, invertebrate diversity decreased by 50%. At the end of 1 year, colonization rate exceeded extinction rate by five times, possibly reflecting continued instability.

1065. Williams, D. D., and H. B. N. Hynes. 1976. The recolonization mechanisms of stream benthos. Oikos 27:265–272.

Response: INVERT

Genus: None

Discusses invertebrate recolonization of experimental substrates in a tributary of Nith River, Wilmot Township, Ontario, Canada. Drift was the most important source of recolonizing animals, contributing 41% of the total number. Aerial sources contributed 28%, whereas upstream migration and movement up from within the substrate contributed about equally (18–19%). Many groups of organisms were found to have preferred sources from which they recolonize. Therefore, separate and distinct faunal assemblages may result if one or more sources of recolonization are excluded from the stream section undergoing recolonization.

1066. Williams, P. B. 1986. Hydrology in coastal wetland restoration design. Pages 329–336 *in* J. A. Kusler, M. L. Quammen, and G. Brooks, eds. Proceedings national wetland symposium: mitigation of effects and losses. Assoc. State Wetland Managers, Berne, New York.

Response: SUCCESS

Genus: None

Describes the design of restoration projects (specifically along the Pacific coast) in terms of (1) description of wetland functions in a natural, undisturbed state; (2) evaluation of effects to that system as a result of human actions (e.g., Filling, levees, freshwater discharges); and (3) analysis of hydrology and hydrodynamics of restored wetland systems, including freshwa-

ter marsh, seasonal wetlands, tidal salt/brackish marsh, mud flats, and lagoons. Methods for accomplishing hydrological goals in restoration projects are included.

1067. Williams, P. B., and H. T. Harvey. 1982. Examples of marsh restoration design practice in San Francisco Bay: a controlled level marsh in Corte Madera. Pages 102–103 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif., Sea Grant Coll. Prog., Rep. T-CSGCP-007.

Response: None

Genus: *Spartina*

Describes the design and planning for the restoration of 35 acres (14.2 ha) of salt marsh on a diked wetland area near Mugzi Marsh, San Francisco Bay. This marsh creation effort is required mitigation for the filling of 20 acres (8.1 ha). The marsh is designed for flood control, water quality improvement, and enhancement of wildlife habitat. Includes implementation, scheduling, and costs.

1068. Williams, P. B., and H. T. Harvey. 1982. Examples of marsh restoration design and practice in San Francisco Bay: a brackish marsh on Coyote Creek Slough. Page 103 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: VEG, MAMMALS

Genus: *Salicornia, Scirpus*

Focuses on 265 acres (107.4 ha) of former marshland at the southern end of San Francisco Bay. This action is mitigation for the development of 552 adjacent acres (223.6 ha). Located upstream of artesian slough, the site offers the opportunity to create a large area of tidal alkali bulrush (*Scirpus maritimus*) marsh. About 200 acres (81 ha) will be open to unrestricted tidal action after initial excavation and grading. High siltation rates would eventually establish mud flats, which will be revegetated with alkali bulrush. Sixty-five acres (26.4 ha) will be excavated as a flood retention basin and 25 acres (10.1 ha) will be an undisturbed pickelweed (*Salicornia virginica*) area for use as potential habitat for the endangered salt marsh harvest mouse.

1069. Wilm, B. W., and J. R. Nawrot. 1987. Metallic ion relationships of aquatic macrophytes established on slurry wetland substrates. Pages 65–70 *in* Proceedings 1987 national symposium on mining, hydrology, sedimentology, and reclamation. University of Kentucky, Lexington.

Response: VEG, CHEM

Genus: *Scirpus, Typha*

Describes the relation between metallic ion uptake by plants growing in coal slurry impoundments and potential bioaccumulation of these ions. Vegetation and soils from four inactive slurry wetland sites and two nonmine wetlands were analyzed for iron, aluminum, manganese, boron, copper, zinc, cadmium, and nickel. No toxicity problems were detected in slurry wetland vegetation during the study; however, generalizations concerning metal toxidity cannot be made because of the large variability of slurry wetlands.

1070. Wilson, J. A., and R. Q. Landers. 1973. Plant species as wildlife cover and erosion control on "mudflats" in Iowa's large reservoir systems. Iowa State Water Resour. Res. Inst., Ames, Annu. Rep. 72/73/77/78. 10 pp.

Response: VEG

Genus: *Acnida, Ambrosia, Carex, Conyza, Phragmites, Polygonum, Sagittaria, Scirpus, Setaria, Sparganium, Typha*

Summarizes observations of reestablished vegetation on the mudflats of two reservoirs and one natural marsh in central Iowa. Comparisons between the two systems were made to determine the relationship between marsh plant survival and seasonal water fluctuations. The natural marsh vegetation was comprised of *Carex atherodes, C. lacustris, Scirpus acutus, S. fluviatilis, Phragmites australis, Sparganium eurycarpum*, and *Typha spp*. Survival of vegetation to maturity was near zero at the reservoirs because of three inundations during summer. Principal component analysis revealed that marsh vegetation in reservoir areas exists in dynamie equilibrium as opposed to one species replacing another.

1071. Winchester, B. H., J. S. Bays, and J. C. Higman. 1988. Inundation characteristics of wet prairie and marsh wetlands in southwestern Florida. Pages 243–252 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Illinois. Association of State Wetland Managers, Berne, N.Y.

Response: VEG, HYDRO

Genus: *Cephalanthus, Cladium, Fraxinus, Hypericum, Panicum, Pontederia, Rhynchospora, Sagittaria, Salix*

Describes a study of hydrologic characteristics of marsh and prairie wetlands on the Ringling Macarthur Reserve in southwestern peninsula Florida. Water levels at 26 wetlands were measured monthly for 1 year. Focuses on water level hydrographs, average water depth, maximum flooding depth, maximum drydown depth, and hydroperiod or duration of flooding. Similar patterns of water fluctuation were exhibited by the study wetlands although they differed in size, basin, physiography, and hydrologic continuity.

1072. Winget, R. N. 1980. Methods for determining successful reclamation of stream ecosystems. Pages 165–192 *in* J. A. Gore, ed. The restoration of rivers and streams. Butterworth Publishing, Boston, Mass.

Response: INVERT, SOIL, CHEM, WQUAL, SUCCESS

Genus: None

Describes several methods for the biological evaluation of stream habitat and water quality reclamation. One such method is the biotic condition index for evaluating the condition of actual stream macroinvertebrate communities based on their biological potential. Evaluations are based on water quality, physical habitat, and aquatic biota. Management success is determined by physical habitat data and restoration of the macroinvertebrate community. Tolerance quotients of various aquatic macroinvertebrates are based on tolerance to low stream gradients, substrate materials, total alkalinity, and sulfate. Application examples are given based on data from the Provo River, Utah.

1073. Winters, G. R., and J. L. Gridley. 1981. Evaluation of stream channel relocation effects and mitigation measures on aquatic biota. Calif. Dep. Transp. Rep. FHWA/CA/TL-81-01. 268 pp.

Response: INVERT, VEG, CHEM, WQUAL

Genus: *Abies, Acer, Alnus, Arctostaphylos, Artemisia, Cercocarpus, Pinus, Populus, Rubus, Salix*

Investigates four California highway and bridge construction projects requiring significant relocation of adjacent streams to determine the effects on aquatic biota, principally macroinvertebrate populations. The sites were located at Hedge Creek, Siskiyou County; Trinity River, Trinity County; Millberry Creek, Alpine County; and Rock Creek, Inyo

County. For best recovery of aquatic biota, new channels should replicate the original channel as closely as possible in terms of length, meander pattern, slope, velocity, substrate, habitat diversity, percent shade, pools, riffles, and shelter. Erosion control should begin before construction and continue throughout the project. Lowered macroinvertebrate populations in the streams resulted from sediment deposition from bank erosion and runoff, improper pool: riffle ratios, and improper stream gradients.

1074. Wise, D. H., and M. C. Molles, Jr. 1979. Colonization of artificial substrates by stream insects: influence of substrate size and diversity. Hydrobiologia 65(1):69–74.

Response: INVERT

Genus: None

Describes a study of colonization of artificial substrates by stream insects in a riffle area of Rio San Antonio, Jemez Mountains, northern New Mexico. Experimental substrates consisted of small gravel (10–25 mm), large gravel (>75 mm), or a 1:1 mixture of the two. Results suggested that drift is a major source of insects for recolonization. More individuals and more species were present in the small gravel substrate. Compared results to other studies.

1075. Wolf, P. L., J. L. Gallagher, and C. H. Pennington. 1978. Field bioassay test for detecting contaminant uptake from dredged material by marsh plants. U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss., Misc. Pap. D-78-6. 32 pp.

Response: VEG, CHEM

Genus: *Carex, Deschampsia, Distichlis, Salicornia, Spartina*

Describes a series of tests in which bioassay experiment test (BET) units were used to determine uptake of potentially toxic materials from contaminated dredged material by marsh plants on Sapelo Island, Georgia, and in Siletz Bay, Oregon. The BET units consisted of inexpensive and easily constructed plastic buckets, which were easily implanted and removed in the field. A large number of plant species can be tested at one time under natural conditions. Uptake of chlorinated pesticides and PCB's could not be demonstrated in these experiments, because of low concentrations in sediments or inadequate sampling. Translocation of some heavy metal ions did occur. The authors caution that additional procedural refinements are necessary before general application of the BET units.

1076. Wolverton, B. C. 1979. Engineering design data for small vascular aquatic plant wastewater treatment systems. Pages 179–192 *in* R. K. Bastian and S. C. Reed, eds. Aquaculture systems for wastewater treatment: seminar proceedings and engineering assessment. U.S. Environmental Protection Agency, Washington, D.C.

Response: VEG, CHEM, WQUAL

Genus: *Eichhornia, Lemna, Spirodela, Wolffia*

Presents a summary of research findings of the National Aeronautics and Space Administration's vascular aquatic plant program using water hyacinth (*Eichhornia crassips*) and duckweeds (*Lemna* spp.) to treat domestic wastewater in lagoon systems of various communities in southern Mississippi. Additional reduction of BOD was attributed to the plants. An average total BOD removal rate of 4.0 mg BOD/g (wet weight) was achieved in a 7-day retention time. Results were used to develop design criteria for small, domestic wastewater treatment systems servicing a maximum of 3,000 people. Discusses problems of BOD reduction, total suspended solids reduction, odor control, and sludge accumulation in these systems.

1077. Wolverton, B. C. 1987. Artificial marshes for wastewater treatment. Pages 141–151 *in* K. R. Reddy and W. H. Smith, eds. Aquatic plants for water treatment and resource recovery. Magnolia Publishing, Orlando, Fla.

Response: CHEM, WQUAL

Genus: *Canna, Colocasia, Eichhornia, Hydrocotyle, Juncus, Lemna, Peltandra, Phragmites, Pontederia, Sagittaria, Spirodela, Typha, Wolffia*

Presents an overview of the use of artificial marshes for wastewater treatment and discusses biotechnology developed by the National Aeronautics and Space Administration for natural treatment of wastewater. The technique involves the use of marsh plants, microrganisms, and high surface area support media such as rocks. Several plant species have been planted in rock filters and been shown to reduce BOD levels and toxic organic chemicals in addition to removing toxic heavy metals and radioactive elements from contaminated waters. Describes designs for single home, domestic sewage, and industrial wastewater treatment. Discusses advantages and disadvantages of using artificial marshes for wastewater treatment and plant management requirements for these systems.

1078. Woodhouse, W. W., Jr. 1979. Building salt marshes along the coasts of the continental United States. U.S. Army Corps Eng., Fort Belvoir, Va., Spec. Rep. 4. 96 pp.

Response: VEG, SOIL, ECON

Genus: *Avicennia, Calamagrostis, Carex, Deschampsia, Distichlis, Iva, Jaumea, Juncus, Laguncularia, Panicum, Phragmites, Rhizophora, Salicornia, Scirpus, Spartina, Triglochin*, many

This is a comprehensive report on coastal marsh creation in the United States. Discusses analysis and interpretation of available information on elevation, slope, exposure, and salinity pertaining to marsh creation. Lists adaptations of marsh plants for the following six coastal regions: (1) Atlantic coast, (2) peninsular Florida, (3) Gulf coast, (4) north Pacific coast, (5) south Pacific coast, and (6) the Great Lakes. Discusses suitable regional culture and planting techniques for selected marsh plants.

1079. Woodhouse, W. W., Jr., E. D. Seneca, and S. W. Broome. 1976. Ten years of development of man-initiated coastal barrier dunes in North Carolina. N.C. Agric. Exp. Stn. Bull. 453. 53 pp.

Response: VEG, SOIL, SUCCESS

Genus: *Ammophila, Panicum, Spartina, Uniola*, many

Discusses the 10-year development of experimental coastal barrier dunes at Ocracoke and Portsmouth islands, North Carolina. American beachgrass (*Ammophila breviguiata*) was found to be suitable for early stabilization and dune development, being easy to propagate and quick to establish. However, this species is susceptible to several pests, short-lived in the region, and eventually replaced by sea oats (*Uniola paniculata*). Sea oats are difficult to propagate and slow to establish and are not very satisfactory for initial stabilization. Mixed species plantings are suggested for most situations on the North Carolina coast. Results indicate that where sand supplies and climate permit, the "growing" of foredunes

through the use of suitable plantings, supplemented by sand fences, is feasible and praetical.

1080. Woodhouse, W. W., Jr., E. D. Seneca, and S. W. Broome. 1974. Propagation of *Spartina alterniflora* for substrate stabilization and salt marsh development. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Memo. 46. 155 pp.

Response: VEG, SOIL, CHEM

Genus: *Spartina*

Describes methods of establishing *Spartina alterniflora* on dredged material to stabilize eroding shoreline. The study site was along the coast of central North Carolina. Primary emphasis was placed on vegetative responses to soil type, fertilizer treatments, site preparation methods, and planting techniques. Conditions that enhanced *Spartina* propagation were sandy substrates; applications of nitrogen and phosphorus; planting in March, April, and May in the upper half of the tide range; planting transplants at 10–15 cm deep and 0.5–0.3 m apart; and broadcasting seeds at 100 viable seeds/m^2. Discusses the relation between *Spartina* productivity and mineral nutrition.

1081. Woodhouse, W. W. 1982. Coastal sand dunes of the U.S. Pages 1–44 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, SOIL, ECON, SUCCESS

Genus: *Abronia, Ambrosia, Ammophila, Artemisia, Calamovilfa, Carpobrotus, Elymus, Panicum, Spartina, Uniola*, many

Describes beach and dune communities of the coastal United States. Describes vegetation zones, plant types and sources, productivity, and habitat values. Discusses restoration techniques for each of six plant species. Discusses soil moisture, salinity, fertilization, and planting. Provides a brief manpower analysis, along with some general costs of restoration. Factors controlling success or failure of restoration projects include sand burial, blow-outs, washouts, weak planting stock, inadequate nutrients, poor planting procedures, improper handling/storage of plants, and location and placement of barrier dunes.

1082. Woodhouse, W. W., and R. E. Hanes. 1967. Dune stabilization with vegetation on the outer banks of North Carolina. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Memo. 22. 45 pp.

Response: VEG, SOIL, ECON

Genus: *Ammophila, Panicum, Spartina, Uniola*

Describes results of several years of experimentation on revegetation of dunes and beaches along the outer banks of North Carolina. Compares methods to (1) produce nursery stock, (2) transplant at the shore, and (3) plant and fertilize vegetation. Includes guidelines for planting american beachgrass and optimal planting times and locations.

1083. Woodhouse, W. W., and P. L. Knutson. 1982. Atlantic coastal marshes. Pages 45–70 *in* R. R. Lewis, ed. Creation and restoration of coastal plant communities. CRC Press, Boca Raton, Fla.

Response: VEG, ECON, SUCCESS

Genus: *Distichlis, Juncus, Phragmites, Salicornia, Scirpus, Spartina*

Describes plant materials, planting methods, and costs for restoration of marshes along the Atlantic coast. Provides detailed plant descriptions and cultural techniques. Describes site preparation, fertilization, planting season, spacing, maintenance, and costs. Factors that influence planting success are elevation, soil types, soil salinity, and wave severity. One method for evaluating wave climate relates fetch, shoreline configuration, and sediment grain size to determine the probable success rate of vegetative stabilization. Discusses marsh habitat values.

1084. Woodhouse, W. W., E. D. Seneca, and S. W. Broome. 1976. Propagation and use of *Spartina alterniflora* for shoreline erosion abatement. U.S. Army Corps Eng., Fort Belvoir, Va., Tech. Rep. 76–2. 72 pp.

Response: VEG, SOIL

Genus: *Spartina*

Describes the planting of *Spartina alterniflora* to stabilize eroding shoreline at Pine Knoll Shores, bogue sound, near Moorehead City, North Carolina. All plants were germinated from seed collected at Oregon Inlet, North Carolina. Planting specifications for *S. alterniflora* are based on results from several experiments at various locations along the north Carolina coast. Rhizomes without attached culms did not survive in the intertidal zone. Soils optimal for growth were characterized by the ammonium form of nitrogen and low ambient oxygen. *S. alterniflora* was unable to use nitrate effectively. Includes responses to fertilization.

1085. Woodhouse, W. W., E. D. Seneca, and S. W. Broome. 1973. Salt marsh established on spoil. World Dredging Mar. Constr. 9:60–62.

Response: VEG, CHEM, WQUAL

Genus: *Spartina*

Discusses the feasibility of propagating *Spartina alterniflora* for dredge spoil stabilization. Study sites at Snow's Cut and Beaufort, North Carolina, consist of sandy dredge material. A sand fence was erected to prevent wind blown material from covering *Spartina* seeds. At about 17 months, *Spartina* produced in aboveground standing crop was 65% of the crop measured in nearby long-established marshes. Seeding is inexpensive; however, it provides complete vegetative cover in about 3 months on sheltered sites in the upper half of the tide range.

1086. Woodhouse, W. W., E. D. Seneca, and S. W. Broome. 1972. Marsh building with dredge spoil in North Carolina. N.C. Agric. Exp. Stn. Bull. 445. 28 pp.

Response: VEG, SOIL, CHEM

Genus: *Panicum, Spartina*

Documents a study of the stabilization of sandy dredge spoil by *Spartina alterniflora* plantings. Experimental sites were located along the North Carolina coast: Oregon Inlet, Pamlico Sound, Hatteras Inlet, Harker's Island, and Snow's Cut Dredge Island in the Cape Fear River. Complete cover by *S. alterniflora* was achieved in two growing seasons in some areas. Establishment was by seeds or transplants. Direct seeding was less expensive; however, transplants were more adaptable to a variety of conditions. *Spartina* cover appears to provide considerable protection from storm-induced erosion. Elevation limits are identified for plant survival and optimum growth. Transplants flourished on a range of substrates, but dieback occurred where soil solution salinity exceeded 45 ppt.

1087. Woods, L. C., III, and B. L. Griswold. 1981. Channelization and mitigation: their effects on macroinvertebrate communities of the Olentangy River, Columbus, Ohio. Pages 113–118

in L. A. Krumholz, ed. The warmwater stream symposium. Allen Press, Lawrence, Kans.

Response: INVERT

Genus: None

Compares macroinvertebrate communities of natural and channelized sections of the Olentangy River, Columbus, Ohio. Artificial riffles (cobbles and boulders placed over earthen fill) and banks were installed on a mitigated channelized section. Both the natural area and the mitigated channelized section had significantly greater diversty, numbers, and biomass of macroinvertebrates than the unmitigated channelized section. No difference was found between the natural and mitigated section. Mitigation allowed for a quicker return to preeffect conditions within a relatively short time and reduced the possibility for long-term harmful effects at the mitigated site.

1088. Yocum, S. C. 1976. Trough Creek limestone barrier installation and evaluation. U.S. Environ. Prot. Agency, Cincinnati, Ohio, Rep. EPA-600/2-76-114. 93 pp.

Response: HYDRO, CHEM, WQUAL

Genus: None

Discusses installation of crushed limestone barriers to reduce acidity of Trough Creek, southcentral Pennsylvania, which was polluted with acid mine drainage in the upper reaches of the watershed. Limestone barriers were effective in reducing acidity and raising pH of the water during low streamflow, marginally effective at design or average streamflow, and ineffective during high runoffs. Progressive accumulations of sediment also reduces reactivity of the limestone. Washing and rehandling the crushed materials restores performance of limestone barriers. Watershed improvements such as backfilling strip-mined areas, replanting, and mine scaling, in addition to limestone barriers, appear to be necessary for mine drainage pollution abatement in most streams.

1089. Zedler, J. 1986. Wetland restoration: trials and errors or ecotechnology? Pages 11–16 *in* R. Strickland, ed. Wetland functions, rehabilitation, and creation in the Pacific Northwest: the state of our understanding. Wash. State Univ. Publ. 86–14.

Response: None

Genus: Many

Presents an overview of the problems and pitfalls encountered by wetland restoration projects. Using specific examples from California's coastal wetlands, trial and error processes and results are illustrated. Development of a science of wetland restoration is proposed ("ecotechnology"). Major points include (1) wetland restoration requires careful control of hydrology; each different wetland community requires slightly different conditions; (2) restoration is still experimental; and (3) findings should always be documented so results can be evaluated in relation to original project goals.

1090. Zedler J., M. Josselyn, and C. Onuf. 1982. Restoration techniques, research, and monitoring: vegetation. Pages 63–74 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: VEG

Genus: *Ruppia, Scirpus, Spartina, Zostera*, many

Discusses marsh restoration in terms of vegetative establishment. Objectives include high biological productivity, wildlife habitat, dredge spoil disposal, substrate stabilization, and water quality improvement. Marsh enhancement techniques include restoration of tidal flow through removal of manmade dikes and levees, establishment of optimal substrate elevations, and planting. Describes characteristics, values, and restoration of submerged seagrass systems. Plant establishment and projeet monitoring procedures are outlined. Lists factors limiting vegetation establishment success for each coastal region of California.

1091. Zedler, J. B. 1983. Salt marsh restoration: the experimental approach. Pages 2578–2586 *in* O. T. Magoon and H. Converse, eds. Coastal zone 83: proceedings of the third symposium on coastal and ocean management. American Society of Civil Engineers, N.Y.

Response: VEG

Genus: *Spartina*

Describes experimental procedures and results associated with the reestablishment of salt marsh cordgrass, *Spartina foliosa*, in Southern California. Herbivory, hypersaline soils, competition, and wave action reduced *S. foliosa* survival and growth. Transplants in highly saline soils (50–60 ppt) died. They were invaded (and sometimes out-competed) by freshwater marsh species in low salinity areas (0–20 ppt). Once established, cordgrass can tolerate high salinity. Discusses proposed objectives for restoration of coastal marshes in this area and presents recommendations.

1092. Zedler, J. B. 1984. Salt marsh restoration, a guidebook for Southern California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-009. 45 pp.

Response: VEG, SOIL, CHEM, SUCCESS

Genus: *Avicennia, Batis, Cordylanthus, Distichlis, Frankenia, Jaumea, Limonium, Monanthochloe, Salicornia, Scirpus, Spartina, Suaeda, Triglochin, Typha, Zostera*, many

This guidebook focuses on restoration goals, techniques, and recommendations for salt marshes in coastal Southern California. Restoration and enhancement experiments were carried out in Mission Bay, Mugu Lagoon, Tijuana Estuary, Los Cerritos wetlands, and the San Diego River marsh. Planting guidelines discuss sources of seeds, planting information from local scientists, fertilizer treatments, and salinity effects on plants. Holding cordgrass (*Spartina*) in low-salinity solutions can improve survival, height, growth, and rate of flowering. Includes techniques for growing seedlings and successful transplanting. Incorporates some information on project monitoring to assess restoration success.

1093. Zedler, J. B., and P. A. Beare. 1986. Temporal variability of salt marsh vegetation: the role of low-salinity gaps and environmental stress. Pages 295–306 *in* D. Wolfe, ed. Estuarine variability. Academic Press, N.Y.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Anemopsis, Cotula, Eclipta, Jaumea, Juncus, Monanthochloe, Rumex, Salicornia, Scirpus, Spartina, Suaeda, Triglochin, Typha*

Discusses changes in growth and distribution of salt marsh plants from 1979–85 at Tijuana Estuary and San Diego River salt marsh in California. At Tijuana, winter floods of 1980 reduced channel and soil salinities. *Spartina foliosa* expanded until 1984 when a drought resulted in blocking of the estuary and a nearly seven-fold increase in soil salinity. Populations of short-lived marsh plants crashed during the hypersaline drought while *Salicornia virginica* increased. At San Diego, prolonged flooding eliminated halophytes and allowed fresh-

to-brackish species to invade in 1980. Summarizes causes of these vegetation dynamics are summarized in a conceptual model of community composition.

1094. Zedler, J. B., J. Covin, C. Nordby, P. Williams, and J. Boland. 1986. Catastrophic events reveal the dynamic nature of saltmarsh vegetation in southern California. Estuaries 9(1):75–80.

Response: VEG, HYDRO, SOIL, CHEM, WQUAL

Genus: *Salicornia, Spartina*

Discusses hydrological disturbances, including flooding, dry-season streamflow, and drought, that greatly altered coastal wetland habitats at Tijuana Estuary in southern California. Poorest growing conditions for cordgrass occurred when both river and tidal flows were lacking, resulting in low soil moisture and extreme salinities. Plant mortality was 62% higher and height 19% lower than the previous year with summer freshwater influxes. A carbon allocation model is proposed to explain the varied responses.

1095. Zembal, R., and B. M. Massey. 1982. Habitat considerations for light-footed clapper rails in marsh design. Pages 103–104 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: SHOREB

Genus: *Salicornia, Scirpus, Spartina, Typha*

Provides an overview of wetland conditions necessary to sustain populations of the endangered light-footed clapper rail. In 1982, 173 pairs of rails were found in 15 marshes. More intensive habitat studies were conducted at upper Newport Bay and Anaheim Bay. Rails prefer cordgrass (*Spartina*) marshes, followed by pickelweed (*Salicornia virginica*) dominated marshes and brackish/freshwater marshes dominated by emergents (*Scirpus* and *Typha* spp.). The most productive areas for these birds are large wetlands comprised of a variety of habitats. Free-water foraging areas must be available regularly; rails do not survive in areas periodically flooded for a prolonged time. Describes feeding requirements and preferred nesting sites.

1096. Zentner, J. 1982. Development of regional wetland restoration goals: coastal wetlands. Pages 23–31 *in* M. Josselyn, ed. Wetland restoration and enhancement in California. Univ. Calif. Sea Grant Coll. Prog. Rep. T-CSGCP-007.

Response: FISH, SHELLF, HUSE, SHOREB, NGBIRDS, WFOWL, MAMMALS, SUCCESS

Genus: *Enteromorpha, Salicornia, Spartina, Ulva*

This overview of regional wetland restoration goals focuses on coastal wetlands of California. The relevance and merits of citing wetland values as restoration goals are examined. Values include primary productivity, shoreline protection, wildlife habitat, endangered species, water quality improvement, groundwater recharge, flood protection, production of commercially valuable fish and shellfish, and cultural values. Of these, wildlife habitat and human use (e.g., recreation), which depends on quality habitat, are the most important restoration goals for the coastal California region. Restoration goals should be specific to ensure successful implementation. Examines regional goals for wetland restoration for northern, central, and southern coastal California.

1097. Zentner, J. J. 1988. Wetland restoration success in coastal California. Pages 216–219 *in* J. Zelazny and J. S. Feierabend, eds. Increasing our wetland resources, proceedings of a conference. National Wildlife Federation, Washington, D.C.

Response: ECON, SUCCESS

Genus: None

Reviews 63 wetland restoration projects in coastal California to determine the success of wetland restoration. A project was judged successful if wetland functions were similar to those of nearby natural wetlands. In addition, scientists involved in the planning of the project were interviewed to determine if they believed the project successfully carried out project goals. Sixty-five percent of the projects were judged completely successful, 25% were partially successful, and 10% were completely unsuccessful. Monitoring of wetlands increased success by alerting appropriate agencies when problems arose. Local government agencies and local special purpose districts achieved higher success (90%) than state or Federal agencies (40–50%). Presents five minimum requirements for success.

1098. Zimmerman, J. H. 1983. The revegetation of a small yahara valley prairie fen. Wis. Acad. Sci. Arts Letters 71(2):87–102.

Response: VEG

Genus: *Andropogon, Betula, Bidens, Carex, Cornus, Gentiana, Populus, Rubus, Salix, Sarracenia, Scirpus, Triglochin, Typha*, many

Compares the revegetation of exposed dredged peat to an undisturbed portion of a 3-ha prairie fen near the Yahara River in Cherokee Marsh City Park, Madison, Wisconsin. In the absence of alien plant species and hydrologic alteration, and with manual removal of the initial invasion of willows (*Salix*) and cottonwoods (*Populus*), full plant cover was restored in two seasons; 49 of the 71 enduring vascular plant species had returned at reasonable to full frequency in 8 years. Lists of plant species include frequency of occurrence at 3-year intervals for both disturbed and undisturbed sites for competition-tolerant perennials, competition-intolerant herbs, and woody species. Describes life stages and life forms.

1099. Zimmerman, J. H. 1988. A multipurpose wetland characterization procedure featuring the hydroperiod. Pages 31–48 *in* J. A. Kusler and G. Brooks, eds. Proceedings of the national wetland symposium: wetland hydrology. 16–18 September 1987, Chicago, Ill. Association of State Wetland Managers, Berne, N.Y.

Response: VEG, HYDRO

Genus: Many

Characterizes wetlands in terms of biogeoclimate type, local site, successional phase, and degree of stress. Describes vegetative physiological adaptations to varying degrees of wetlands. An environmental screen model serves to successively eliminate plant species from potential establishment after catastrophic devegetation, according to their requirements and tolerances. Describes plant responses to different hydroperiods, resistance to change, and tolerance to waterlogging and drought. Discusses hydroperiods and hydrologic classifications of wetlands. A 3-dimensional wetland continuum is developed, based on hydroperiod, soil chemistry, and wetness.

1100. Zurbuch, P. E. 1984. Neutralization of acidified streams in West Virginia. Fisheries 9(1):42–47.

Response: WQUAL, ECON

Genus: None

Describes various methods of neutralizing streams affected by acid precipitation in West Virginia. The rotating drum system

for continual dispensing of limestone was improved to include a pretreated filter bed of limestone to remove metals such as aluminum and iron. Describes experimental self-feeding rotary drum limestone neutralization stations. Includes related studies involving lake neutralization in West Virginia. Additional data are required to determine the long-term effectiveness of neutralization efforts.

Schneller-McDonald, K., L. S. Ischinger, and G. T. Auble. 1990. **Wetland Creation and Restoration: Description and Summary of the Literature.** U.S. Fish Wildl. Serv., *Biol. Rep.* 90(3). 198 pp.

This report provides a hard copy of the bibliographic information contained in the Wetland Creation/Restoration data base. One thousand one hundred records are included. Each record represents one article, report, or other publication dealing with the creation or restoration of wetlands. Information contained in the data base records is (1) introduced in a description of all fields and keywords, (2) summarized in terms of findings in a set of graphs and tables, and (3) accessible through a cross-referenced index (location, plant genus, wetland type, and subject).

Key words: Mitigation, wetland creation, wetland restoration, wetlands.

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NOTE: The mention of trade names does not constitute endorsement or recommendation for use by the Federal Government.

TAKE PRIDE
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U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Departmnet also has a major responsibility for American Indian reservation communities and for people who live in island territories under U. S. administration.