

A Human-Dimensions Review of Human-Wildlife Disturbance: A Literature Review of Impacts, Frameworks, and Management Solutions



Open-File Report 2007-1111

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia 2007

For product and ordering information:
World Wide Web: <http://www.usgs.gov/pubprod>
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth,
its natural and living resources, natural hazards, and the environment:
World Wide Web: <http://www.usgs.gov>
Telephone: 1-888-ASK-USGS

Suggested citation:
Cline, R., Sexton, N., and Stewart, S.C., 2007, A human-dimensions review of human-wildlife
disturbance: a literature review of impacts, frameworks, and management solutions:
U.S. Geological Survey, Open-File Report 2007-1111, 88 p.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply
endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual
copyright owners to reproduce any copyrighted material contained within this report.

Cover photograph of canoeing at Upper Klamath National Wildlife Refuge by Dave Menke,
courtesy of the U.S. Fish and Wildlife Service.

Cover photograph of off highway vehicle courtesy of the Bureau of Land Management.

Cover photograph of sleigh ride at National Elk Refuge courtesy of Darius Panahpour.

Contents

Contents	iii
Preface	1
Introduction	1
Defining Human-Wildlife Disturbances.....	2
Direct Impacts to Wildlife	3
Indirect Impacts to Wildlife	3
Responses of Wildlife to Disturbance	3
Recreational Activities that Impact Wildlife.....	6
Hunting.....	6
Fishing.....	7
Wildlife Viewing and Photography	7
Motorized Recreation	8
Off-road Vehicles	8
Snowmobiles.....	9
Defining Concepts of Human Dimensions of Wildlife	10
Values and Value Orientations	11
Attitudes and Norms	12
Theoretical Basis for Visitor Education	12
Theories of Persuasion	12
Theories of Moral Development.....	13
Theory of Planned Behavior.....	13
Recreational Conflicts	14
Case Study: Conflict at Mount Evans, Colorado	15
Social Carrying Capacity.....	15
Management Objectives	16
Indicators and Standards of Quality.....	16
Choosing Indicators.....	17
Choosing Standards of Quality	17
Wilderness Threats Matrix: A Tool to Develop Indicators	18
Sources for Standards	19
Carrying Capacity Frameworks.....	19
Application of Human Dimensions to Wildlife Disturbance Issues.....	21
Case Study: Bear-viewing at Katmai National Park, Alaska and McNeil River State Game Sanctuary, Alaska	21
Management Solutions	22
Site Management	22
Facility Design.....	22
Use of Vegetation.....	23
Physical Barriers.....	24
Buffer zones	24
Strengthening/Hardening Sites	25
Facility Modification	25

Areas and Facilities Closures	26
Rationing and Allocation.....	26
Limit Access Using Reservations.....	27
Limit Access Using Queuing	27
Limiting Length of Stay.....	27
Restricting Group Size.....	27
Zoning.....	28
Regulations and Restrictions	28
Licensing.....	29
Environmental Education.....	29
Redistributing Visitors	29
Knowledge Gain	30
Behavioral Change Following Education.....	30
Change in Resource Conditions Following Education.....	31
Messages and Delivery	31
Input and Discussion with USFWS Field Personnel.....	32
Informal Survey of Refuge Managers and Biologists	32
Teleconference of Refuge Personnel.....	33
Conclusions and Considerations	34
Incorporating Human Dimensions in the Planning Process.....	34
Sharing Information on Human-Wildlife Disturbance.....	34
Human-Dimensions Training for Refuge Personnel.....	35
Consultation with Experts	35
Survey of Refuge Managers, Biologists, Planners, and Visitor Services Specialists.....	35
Human-wildlife Disturbance Workshops.....	35
Application of Recreation Management Frameworks to Refuges	36
Continued Baseline Research on Refuge Visitor Experience, Attitudes and Preferences.....	36
Streamlined Approval Process for Surveying Refuge Visitors	37
References Cited	39
Annotated Bibliography.....	49
Index for Annotated Bibliography	67

Figures

1. A conceptual model of responses of wildlife to recreation activities.....	5
2. The cognitive hierarchy model of human behavior.....	11

Tables

1. Four major causes of conflict.....	14
2. Five criteria for choosing indicators	17
3. Carrying capacity frameworks.....	20

A Human-Dimensions Review of Human-Wildlife Disturbance: A Literature Review of Impacts, Frameworks, and Management Solutions

By Robert Cline, Natalie Sexton, and Susan C. Stewart

Preface

The following report was prepared for the U.S. Fish and Wildlife Service National Refuge System in support of their Comprehensive Conservation Planning (CCP) efforts by the Policy Analysis and Science Assistance Branch (PASA), Fort Collins Science Center, U.S. Geological Survey. While this document provides a summary of contemporary recreation management literature and methodologies, relevant to the subject of managing wildlife disturbances on national wildlife refuges, this document should be viewed as a *starting point* for management administrators. This document identifies general issues relating to wildlife disturbance and visitor impacts including a description of disturbance, recreational impacts, related human dimensions applications, management frameworks, and a general summary of management solutions. The section on descriptions of wildlife disturbance and impacts draws heavily from the report entitled “Managing the Impacts of Visitor Use on Waterbirds -- A Literature Review of Impacts and Mitigation” (DeLong, 2002; DeLong and Adamcik, in press) and is referenced in the text. This document is more comprehensive in its review of wildlife response to disturbance. This document is intended to discuss the human-dimensions aspect of wildlife disturbance, summarizing human dimensions and recreation management literature as it applies to this topic.

Introduction

The National Wildlife Refuge System, managed by the U.S. Fish and Wildlife Service (USFWS), is the largest system of lands in the world dedicated for the conservation of wildlife. There are over 545 refuges nationwide, encompassing 94 million acres. The mission of the National Wildlife Refuge System is to “administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources, and their habitats within the United States for the benefit of present and future generations of Americans.” Part of achieving this mission is the goal of fostering, “...an understanding and instill appreciation of fish, wildlife, and plants, and their conservation, by providing the public with safe, high-quality, and compatible wildlife-dependent public use.” Such use includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation. About 98 percent of the system is open to the public, attracting more than 40 million visitors annually. More than 25 million people per year visit refuges to observe and photograph wildlife, 7 million visit to hunt and fish, and more than a half million visit to participate in educational programs (The Citizen’s Wildlife Refuge Planning Handbook <http://www.defenders.org/pubs/refuge00.html>).

The National Wildlife Refuge Improvement Act of 1997 (Public Law 105-57, USC668dd) is the guiding legislation for the management of these lands. The law identifies the above stated six wildlife-dependent recreational uses that should be given priority, and it provides a process for ensuring that these and other activities do not conflict with the management purpose and goals of the refuge.

However, site-specific conflicts between wildlife and recreational impacts occur that can potentially threaten the health, safety, and well-being of the wildlife and habitat that refuges are charged with managing. Refuge managers are often faced with the challenge of managing, monitoring, and mitigating these impacts to the extent possible. Though much literature exists regarding wildlife response to disturbance (DeLong, 2002; DeLong and Adamcik, in press), less is understood about the social component of human-wildlife conflicts. Ultimately, refuge managers and planners must make value-based decisions regarding what uses are acceptable. Such decisions are inevitably value judgments, but they should be based on baseline data, scientific theory, and local knowledge and experience.

As a result of discussions with various National Wildlife Refuge System personnel, a need for information on this topic was identified. PASA, at the U.S. Geological Survey Fort Collins Science Center, is dedicated to studying relations between humans and the environment. One of PASA's research missions is to conduct studies to understand how humans are affected by environmental management decisions and how human activities impact use and conservation of natural resources. PASA has collaborated with the USFWS National Wildlife Refuge System in support of their CCP efforts.

To assist in adding to the understanding of human-wildlife disturbance issues from a social science or "human dimensions" perspective, USFWS contracted with PASA to complete a review of existing methodologies and frameworks from wilderness and recreation management literature that were applicable to managing visitor capacities on national wildlife refuges, and to evaluate completed studies with a social component to the wildlife-disturbance issues. In addition, this report includes a discussion on the natural resource human dimension and its application to management.

By discussing different techniques, evaluating existing management frameworks, and identifying methods that have been used to address human-wildlife disturbances, this document is intended to provide refuge managers, biologists, visitor services specialists, and planners a starting point to appropriately address human-wildlife disturbances. This document is intended to act as a reference guide for refuge managers by providing a cumulative summary of relevant management methods and solutions.

Defining Human-Wildlife Disturbances

Human-wildlife conflict can be viewed in two contexts: 1) Wildlife behavior conflicting with human goals (e.g., safety, satisfaction, property), or 2) human behavior conflicting with wildlife safety and well-being (e.g., harassment, noise, direct mortality due to hunting, destruction of habitat). Regardless of either situation, human behavior and the decisions made regarding human-wildlife interactions ultimately determine the outcome for both humans and wildlife. Management actions needed to direct these decisions inevitably rely on a combination of both biological and sociological data. For the purpose of this document, only a review of human-attributed disturbances and associated impacts are discussed.

Regardless of management actions, outdoor recreation has the potential to disturb wildlife. As noted by Pomerantz and others (1988), meeting the public demand for wildlife recreational opportunities is complicated because recreational uses have multiple impacts. The mere presence of

visitors may harm wildlife by displacing them from essential habitats or disrupting the raising of young (Knight and Cole, 1995). Therefore, the question is not so much does the activity cause impact, but rather, how much and what level of impact is acceptable. Disturbance includes both direct and indirect effects toward wildlife. These impacts are defined below.

Direct Impacts to Wildlife

Direct impacts are those causing direct physiological effects, behavioral modifications, or mortality to wildlife. Much of the literature relating to human-wildlife disturbances measures direct impacts such as behavioral or biophysical responses of specific animal species (e.g., death, energetic costs, altered behavior and fitness, and avoidance of otherwise suitable habitat). A major disadvantage to this approach however, is that these responses generally apply to individuals rather than populations or communities (Knight and Cole, 1995). Of the literature reviewed in an annotated bibliography conducted by Boyle and Samson (1985) on the effects of nonconsumptive recreation on wildlife, impacts primarily included only direct impacts such as death, displacement, increased heart rate, and nest abandonment. While research on direct impacts provides a sense of a clear causal relationship, results from these studies often cannot be generalized. Furthermore, this narrow scope of wildlife impacts and the poor understanding of their significance may be partially explained by the lack of information about impacts at critical scales of analysis (Cole, 2004). This lack of understanding is further exemplified in the minimal knowledge of the long-term effects of such impacts (Cole, 2004).

Indirect Impacts to Wildlife

While direct impacts focus on immediate physiological effects, indirect impacts are typically identified as alterations to wildlife habitat such as availability of food, shelter, and living space (Cole and Landres, 1995). By altering the availability of suitable habitat and/or food, both individuals and populations of wildlife are indirectly impacted.

Indirect impacts occur wherever and whenever recreational use occurs. They are typically a chronic problem, occurring over a long period of time and affecting a broader ecological problem than wildlife disturbance (e.g., pollution, available habitat, water quality, etc.). Much of these indirect impacts occur through normal recreation activities such as hiking, biking, hunting, and fishing. Through these activities, recreationists have the potential to negatively impact the physical environment (e.g., trampling vegetation, soil compaction, erosion, disturbances due to noise and motion, pollution, nutrition loading, and introduction of non-native invasive plant species). While indirect wildlife impacts such as erosion, pollution, and trampling have been studied extensively in the fields of ecology and recreation ecology, their impacts on wildlife still are not fully understood.

While direct and indirect impacts are simple concepts that differentiate the sources of impacts, they are fundamental in understanding how researchers and managers begin to identify and manage wildlife disturbance impacts. In terms of identifying the significance and magnitude of recreational impacts, more attention has been placed on the type, extent, intensity, and timing of the activity (Cole and Landres, 1995). The following section discusses such recreational impacts on wildlife, as well as the effects they have on the behavior and survival of wildlife.

Responses of Wildlife to Disturbance

Numerous studies have identified a variety of factors that influence both the frequency of human-wildlife disturbance and the response or vulnerability of wildlife. These factors include: wildlife species and their feeding and breeding characteristics; the type, degree, and length of

disturbance; and season and weather conditions (Wall and Wright, 1977). Animal characteristics and group sizes also have been found to influence the outcome of human-wildlife encounters. However, despite that numerous factors have been identified, wildlife responses are relatively unpredictable and may vary even within a given species. Based on contemporary literature this section identifies characteristics of wildlife responses to disturbance.

As identified by Knight and Cole (1991), recreational activities that impact habitat modification, pollution, and disturbance are identified as being most crucial for wildlife. Immediate responses of wildlife to recreation-related disturbances include behavioral changes and death (Figure 1). Long-term effects on *individuals* include altered behavior, vigor, productivity, as well as death. The long-term effects on *populations* are altered abundance, distribution, or demographics; and the long-term effects on the *communities* are altered species composition and interactions (DeLong, 2002; DeLong and Adamcik, in press). Because long-term effects are inherently more difficult to study, few studies examine these relationships.

In an attempt to identify and classify visitor impacts, Purdy and others (1987) described six categories of wildlife responses to recreational disturbances.

1. **Direct mortality:** immediate, on-site death of animals.
2. **Indirect mortality:** eventual, premature death of an animal caused by an event or agent that predisposed the animal to death.
3. **Lowered productivity:** reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site.
4. **Reduced use of refuge:** wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity.
5. **Reduced use of preferred habitat on the refuge:** wildlife use is relegated to less suitable habitat on the refuge due to visitor activity.
6. **Aberrant behavior/ stress:** wildlife demonstrating unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates.

Developed for the Northeast Region of the USFWS, this classification of impacts is intended to provide administrators and managers a means to classify effects of visitor use. The basis of this classification system focuses on wildlife, habitat, and people. Authors suggest that this classification of wildlife responses can help managers define and assess specific public impacts.

According to Knight and Cole (1991), there are three learned responses that wildlife may exhibit: 1) habituation, 2) attraction, and 3) avoidance.

Eibl-Eibesfeldt (1970) defined habituation as an influence of a repeated stimuli that does not illicit a response, either positively or negatively (Knight and Temple, 1995). As cited by DeLong and Adamcik (in press), Alcock (1993) defined habituation as “a form of learning in which individuals stop responding to stimuli that carry no reinforcing consequences for the individuals that are exposed to them.”

Attraction is defined as the strengthening of an animal’s behavior because of rewards or reinforcement, such as feeding wildlife (Knight and Temple, 1995). Recreationists who attract wildlife create a potentially harmful situation to both humans and wildlife. The term “a fed bear is a dead bear” reflects the management tactics often needed to manage “problem” bears that have been attracted to humans. DeLong and Adamcik (in press) noted that other potentially harmful attraction situations include an increased population of flies, rats, and mice around waste receptacles. Not only are these animals a nuisance, they serve as vectors for the spread of disease.

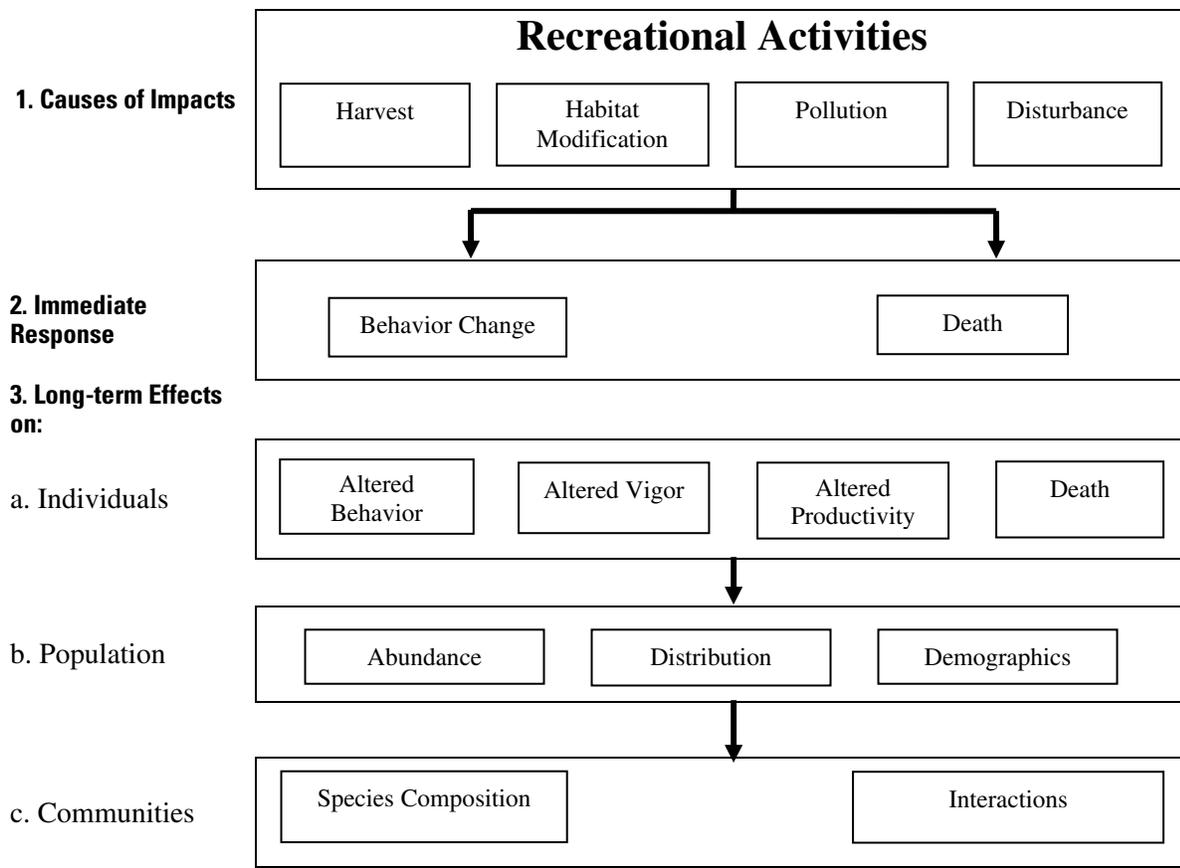


Figure 1. A conceptual model of responses of wildlife to recreation activities (Cole and Knight, 1995).

Wildlife learn to avoid humans or other stimuli when encounters result in negative interactions. Avoidance is influenced by a number of factors including: 1) type, distance, movement pattern, speed, and duration of the disturbance; 2) time of day, time of year, weather; and 3) food, cover, energy demands, and reproductive status (Knight and Cole, 1991 in Anderson and others, 1998). As identified by Gabrielsen and Smith (1995) wildlife avoidance behavior responses can include:

- Increased heart rate and respiration,
- Increased respiration depth,
- Increased blood flow to skeletal muscle, brain, and heart,
- Increased oxygen consumption,
- Increased body temperature,
- Elevation of blood sugar,
- Increased metabolism, and
- Reduced blood flow to the skin and digestive organs.

Furthermore, the magnitude of the avoidance response may depend on the type of activity, timing, location, frequency, predictability, and characteristics of the wildlife species being disturbed (Knight and Cole, 1991).

A number of biological and environmental variables also contribute to individual response to disturbance. These variables are complex because wildlife respond differently to disturbance between species, between individuals of the same species, and between different periods of time for a single individual (HaySmith and Hunt, 1995; Knight and Temple, 1995). These confounding variables make studying disturbances difficult at best.

Recreational Activities that Impact Wildlife

Recreationists have the potential to degrade the land, water, and wildlife resources that support their activities by simplifying plant communities, increasing animal mortality, displacing and disturbing wildlife, and impacting wildlife habitat (Boyle and Samson, 1985). The type of recreation activity, its location and spatial extent, the severity or magnitude of impact, and its timing (interval, frequency and predictability) all shape the characteristics and magnitude of recreation impact (Cole, 1987). Cole (2004) suggests the following factors as most important in determining recreation impacts:

- Amount of use,
- Type and behavior of use,
- Timing of use,
- Resistance and resilience of the environment, and
- The spatial distribution of use (Cole, 2004).

These variables equally contribute to the “big picture” by providing a description of who, what, when, and where regarding recreation use. Hunting, fishing, wildlife observation, photography, and motorized activities are summarized and discussed in the following sections.

The authors are aware that this section is not a comprehensive review of wildlife response to these activities. Because the biological response to wildlife disturbance was not the focus of this literature review, this section simply provides a brief overview. For more detailed review of wildlife response to these and other activities, please refer to DeLong (2002), DeLong and Adamcik (in press), and the *Effects of Recreation on Rocky Mountain Wildlife Online Database*, an online database served by the Montana Chapter of The Wildlife Society, available at <http://www.montanatws.org/chapters/mt/pages/page4b.html>.

Hunting

The very nature of hunting inherently assumes an acceptable amount of wildlife disturbance without harming the population. In hunting, emphasis is placed on the population rather than individuals. The use of hunting as a management tool has traditionally provided a means to control populations by removing an expendable segment of the population that would naturally succumb to predation, disease, and competition (Bartmann and others, 1992). In addition to animals harvested, hunting can potentially affect other individuals (not hunted) in a population, and the structure, distribution, and patterns of the population (Cole and Knight, 1990; Cole, 1995).

A number of studies have substantiated differences between hunted and nonhunted populations, in which nonhunted populations function differently from hunted populations (Wood, 1993). For example, King and Workman (1986) found that hunted populations of ungulates became more wary, stayed closer to cover, and fed in the open mainly at night. Other studies have found

that hunting may alter reproductive behavior in wildlife (Cole and Knight, 1990), and alter the spatial and temporal patterns of wildlife populations (Bell and Austin, 1985).

Similarly, it has been suggested that the mere nature of hunting makes waterfowl skittish and prone to disturbance (Morton, 1995). The effects of waterfowl hunting include a reduction of foraging time, disruption of pair and family bonds, and altering use distribution of available habitat (Raveling, 1979; Thomas, 1983; Owen, 1977; White-Robinson, 1982; Madsen, 1985; Bartelt, 1987). For several species of wintering and migrating waterfowl, hunting disturbances have reportedly reduced time spent in feeding and/or resting activities (Cronan, 1957; Thompson, 1973; Morton and others, 1989; Belanger and Bedard, 1995; as cited by DeLong and Adamcik, in press). Direct effects of waterfowl hunting include direct mortality, crippling, and disturbance (DeLong and Adamcik, in press). Bélanger and Bédard (1995) concluded that disturbances caused by waterfowl hunting can: 1) modify the distribution and use of various bird habitats (Owens, 1977; White-Robinson, 1982; Madsen, 1985), 2) affect bird activity budgets, and 3) reduce bird foraging time and consequently their ability to store fat reserves necessary both for migration and breeding (Raveling, 1979; Thomas, 1983).

While direct impacts associated with hunting are inevitable (e.g., mortality of harvested game), indirect impacts can also be significant. However, hunting is perhaps the most intensely monitored recreational activity, particularly in refuges. As a result of this and the zoning that usually accompanies hunting, impacts are limited to predetermined boundaries.

Fishing

Direct wildlife disturbances associated with fishing include direct mortality in harvest, mortality in catch and release, and harvest of nontarget species. In addition, indirect impacts associated with fishing such as access, boating, and facility impacts are common (DeLong and Adamcik, in press). Other indirect impacts include littering, introduction of non-native species, and disturbance of waterfowl. Waterfowl impacts include entanglement with fishing lines, trotlines, and trammel nets (Thompson, 1969). Observations of mergansers, loons, and diving ducks snared by trotlines have been reported in some national wildlife refuges (Braun and others, 1978; in DeLong and Adamcik, in press). As cited by DeLong and Adamcik (in press), waterfowl deaths have been attributed to the ingestion of lead fishing sinkers (Simpson and others, 1979; Birkhead, 1981, 1982; Birkhead and Perrins, 1985; as cited by Wilcove and others, 1992).

Much like other activities, management tactics to mitigate fishing-related wildlife disturbances include temporal restrictions of fishing during critical waterfowl wintering and breeding periods, and zoning specific areas for fishing to limit disturbance (Johnson, 1964; Bouffard, 1982; Braun and others, 1978; Mathews, 1982). Knight and others (1991) found that anglers influenced the number, behavior, and diurnal distribution of avian scavengers (bald eagles, common ravens, and American crows). Furthermore, management approaches that included restricted access, buffer zones, and diurnal restrictions appeared to be successful in mitigating disturbance (Knight and others, 1991).

For more in depth information regarding boating, see DeLong and Adamcik (in press).

Wildlife Viewing and Photography

Within the last 20 years, wildlife management research has expanded beyond traditional consumptive uses of wildlife to include studying the impacts of wildlife viewing and photography, as well as other nonconsumptive activities. Now with more people in the United States participating in nonconsumptive activities (e.g., observing, feeding, and photographing wildlife), the social characteristics and opportunities sought by the public are more broadly considered (U.S.

Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census, 1996; cited in Vaske and others, 2001). As an example, in a study conducted by Fulton and others (1993), authors suggested that wildlife viewers in Colorado outnumbered hunters by a ratio of 6 to 1, and anglers by a margin of 3 to 1. According to Delong and Adamcik (in press), “wildlife viewing is the fastest growing outdoor recreational activity in the nation.”

Much like hunting, wildlife viewing is highly goal oriented. Rather than harvesting species, specialized wildlife viewers, particularly birders, seek out specific and often rare species. “Because these activities may occur during sensitive times of the year (e.g., nesting), and because they often involve close approaches to wildlife for purposes of identification or photography, the potential for negative effects is large” (Knight and Cole, 1995). As refuges face an increasing demand for wildlife viewing, the need to identify, monitor, and manage wildlife viewers continues to grow.

In a 1989 survey conducted by the USFWS, 82 percent of refuge units allowed wildlife photography and 13 refuges considered it harmful (U.S. Fish and Wildlife Service, 1990; in Delong and Adamcik, in press). In a study of waterbird behavioral responses to human disturbances at “Ding” Darling National Wildlife Refuge, approaching birds on foot was found to be the most disruptive aspect of the usual visitor activities (nature observation, photography, fishing, crabbing, shell collecting, boating, fitness, or driving) (Klein, 1993). Furthermore, it was identified that wildlife photography was more disruptive than other common recreation activities primarily because photographers were more likely to stop, leave their vehicles, and approach wildlife (Klein, 1993). Although nature observers also frequently stopped, they were much less likely to leave their vehicles than photographers. Burger (1995) noted that photographers and birdwatchers often get too close to nesting, brooding, or foraging plovers, forcing them to shift habitats or abandon nests (Delong and Adamcik, in press). Furthermore, it was found that mortality can increase as a result of human intrusion and interaction of nesting sites (Snyder and Snyder, 1974).

Motorized Recreation

Vehicles both on and off the highway can have potentially fatal impacts on wildlife due to collisions (Zande and others, 1980; Purdy and others, 1987; Rosen and Lowe, 1994). Aside from direct mortality, several studies have identified numerous indirect impacts associated with vehicle use, including noise, pollution, habitat degradation, disturbance, and harassment. Due to the wide variety of recreational vehicles – all-terrain vehicles (ATV), off-road vehicles (ORV), snowmobiles, and on-road vehicles -- the literature reflects the variety of impacts associated with each specific sub-group. In response to some of these issues, previous executive orders were adopted as early as the 1970s, which included controls on ORV use on federal public lands (Executive Order 11644) and immediate closure of trails to ORVs that were causing or would cause considerable adverse effects to the ecosystem (Executive Order 11989) (Kockelman, 1983).

Despite negative impacts associated with vehicle use, auto tour routes on refuges are relatively popular. This has largely been attributed to findings that suggest that traveling by vehicle is sometimes less disturbing to wildlife than travel by foot, while providing a better viewing vantage inside a vehicle (Morton, 1996; Klein, 1993). This is certainly not to say that restrictions on auto touring do not exist. Delong and Adamcik (in press) noted that some refuge managers recommended prohibiting driving between midnight and 5 a.m. in order to provide wildlife with needed rest, while only minimally curtailing visitor access (Purdy and others, 1987).

Off-road Vehicles

Direct effects of ORVs on wildlife have been documented in a variety of geographical and ecological environments. Several studies have indicated that wildlife, including birds, reptiles, and

large ungulates, respond to disturbance with accelerated heart rate and metabolic function, and suffer from increased levels of stress resulting in displacement, mortality, and reproductive failure (Havlick, 2002). Yarmoloy and others (1988) found that radio-collared mule deer disturbed by ATV use displayed altered feeding and spatial-use patterns, while undisturbed animals maintained normal usage. They also reported that harassed deer experienced decreased reproduction the following year, where undisturbed deer did not.

Noise by ORVs also may negatively affect certain small mammals and reptiles by interfering with their acute hearing. In a study conducted on the effects of ORVs on desert vertebrates (Brattstrom and Bondello, 1983), the magnitude and frequency of noise generated by ORVs were found to cause significant (direct) impacts. On populations of desert kangaroo rats, ORV noise was observed causing frantic behavior, ear bleeding, and temporary hearing loss. Authors also found that the noise of dune buggies induced hearing loss in the Mojave fringe-toed lizard “even under moderate intensity of short duration” (Brattstrom and Bondello, 1983).

In addition to direct impacts on wildlife species, ORV use has been attributed to a number of indirect impacts. Through disruption and compaction, soil stabilizers including macro and micro floral elements and inorganic elements can be severely affected and damaged by ORV use (Wilshire, 1983). These natural soil protective elements are particularly vulnerable in arid regions where impacts have been shown to have long-lasting negative effects (Webb, 1983). Effects of soil compaction due to ORV use include decreased water infiltration, increased runoff, and erosion problems (Webb, 1983). The use of ORVs also has been identified as one of the key links in the spread of invasive and noxious plants. Lacey and others (1997) determined that the spotted knapweed was capable of transporting thousands of seeds by collecting on the undercarriage of ORVs for distances in excess of 10 miles. The use of ORVs also may “reduce natural plant cover and height, lowering species diversity, and altering community composition (Hosier and Eaton, 1980; in Delong and Adamcik, in press).”

In addition to terrestrial effects, ORV use near streams, rivers, and lakes can create substantial water pollution threats (Havlick, 2002). Turbidity reduces the penetration of sunlight into the water that may affect the primary producers such as algae, phytoplankton, and other aquatic plants. This can potentially limit photosynthesis that many organisms depend upon for survival (Kolbe and Luedke, 1993). Suspended solids also have been shown to lower reproductive rates by disturbing fish eggs and nests (Taylor, 2004). These changes can significantly alter habitat for aquatic insects, fish, and other fauna and flora.

Snowmobiles

Snowmobiles impact both wildlife and vegetation alike. Semi-aquatic mammals such as muskrat and mink are affected by the polluting impact that snowmobile oil residue has on vegetation (Adams, 1974; in Waller and others, 1999). In addition to the influence on vegetation, these pollutants can negatively impact fish populations on which semi-aquatic mammals feed. Besides indirect impacts to their food supply, these species can be directly impacted through collisions with snowmobiles and their physiological health affected by the stress induced by fast approaching recreational vehicles (Waller and others, 1999).

The use of snowmobiles also has been shown to impact fragile environments, particularly bogs. Snowmobile use can cause a delay in the spring thaw of bog plants leading to their damage and decline (Wanek, 1973; in Hickman and others, 1999). The degradation of these environs leads directly to impacts on wildlife, such as bog lemmings and shrews that live within them (Hickman and others, 1999).

The vast majority of studies involving snowmobiles and ungulates conclude that snowmobiles and snowmobile trails are stressful for ungulates (Simpson, 1987; Tyler, 1991; Freddy and others, 1986; McLaren and Green, 1985). To avoid snowmobiles, ungulates may run through deep snow, leave optimal cover/forage, or change normal periods of activity; subsequently these activities could reduce the animals' winter survival and reproduction. Despite negative effects of snowmobiles, it has been suggested that snowmobile trails could possibly benefit ungulates by improving mobility in poor snow conditions (Richens and Lavigne, 197; Eckstein and others, 1979). This argument, however, works both ways as snowmobile trails also have been identified as providing hard-packed travel corridors for predators as well (Webster, 1997).

Among caribou, snowmobile activity increases the amount of energy the animals expend to avoid interaction. How much an animal expends depends on a variety of variables, such as the degree of previous harassment, animal activity prior to disturbance, snow depth and compaction, visibility, wind speed and direction, and topographical features (Simpson, 1987; Fancy and White, 1986; McLaren and Green, 1985; Tyler, 1991; as cited in Webster, 1997).

In a study of energy expenditures of caribou, Fancy and White (1985) found that extensive snowmobile activity compacted snow, making winter foraging energetically expensive. It was suggested that this increased energy expenditure might influence body condition and, in extreme cases, threaten winter survival (Webster, 1997).

Dorrance and others (1975) studied two areas in Minnesota: one where snowmobile numbers averaged from 10 to 195 machines per day, and another where snowmobile use was prohibited. In the first site, snowmobile traffic immediately displaced deer from areas adjacent to snowmobile trails. On the second site, after snowmobile use was introduced, increased animal home-range sizes, increased movement, and displacement of deer from areas along trails was observed.

Carnivores also can be affected by snowmobile use. Several studies have indicated that snowmobile trails can act as corridors for both competitors and predators of lynx (Claar and others, 1999). Studies have not shown that bears are detrimentally impacted by snowmobiles, as den sites are in terrain that is not easily accessed by these vehicles (Mace and others, 1999). Wolves can be helped as well as harmed by snowmobiles. Snowmobile tracks make convenient transportation corridors that allow increased and less inhibited access to prey. This includes access to previously untapped ungulate populations (O'Karma and others, 1995; in Claar and others, 1999). This access also provides potential problems for wolves by giving them access to more areas populated by humans, leading to increased conflict (Claar and others, 1999). Additionally, wolves may be inadvertently caught in snares intended for furbearer species that are set by trappers along snowmobile routes. When humans have increased access to wolves, the effects are more detrimental. For example, wolf mortality due to hunting, and both accidental and intentional snowmobile collisions with wolves, may increase (Claar and others, 1999).

Defining Concepts of Human Dimensions of Wildlife

Despite existing methodology and research that has addressed human-wildlife disturbances, there is still much to learn. One of the fundamental components, and the primary source of disturbance, is people. People, or more specifically, recreationists, hold a wide variety of values, beliefs, and expectations regarding wildlife, recreation, and other natural components. These variations can be observed through the wide array of behaviors managers must contend with daily. Human-dimensions research provides an appropriate context to explore the underlying components that influence behavior, in turn, identifying more appropriate management solutions. By integrating human-dimensions theories into a management framework designed to address human-wildlife

disturbances, managers can more appropriately address human-caused disturbances of wildlife. A combination of sociological and biological data on recreation impact is vital for an informed decision (Manfredo and others, 1995).

Human-dimensions research uses two main theoretical approaches to examine, explain, and predict human behavior: the motivational approach that is used to understand and predict human behavior, and the cognitive approach that examines the underlying process of thought to action by examining values, attitudes, and norms. Managers can use such theoretical frameworks to help articulate management decisions and determine the types of human dimension data that might be useful in informing those decisions (Decker and others, 2001).

Motivation theory allows managers to identify why people do what they do. Motivation theory can be used to identify why people participate in certain activities (i.e., hunting, fishing, wildlife viewing). By focusing on the needs and outcomes sought from behavioral experiences, motivation theory can help determine what drives visitors' actions.

The cognitive approach, and the social concepts that formulate its theoretical approach (values, attitudes, and norms), help managers predict individuals' actions by identifying what influences visitors' decisions. Arranged in order of cognitive hierarchy, the cognitive approach uses values, value orientations (patterns of basic beliefs), attitudes, and norms in order to explain behavior (Figure 2).

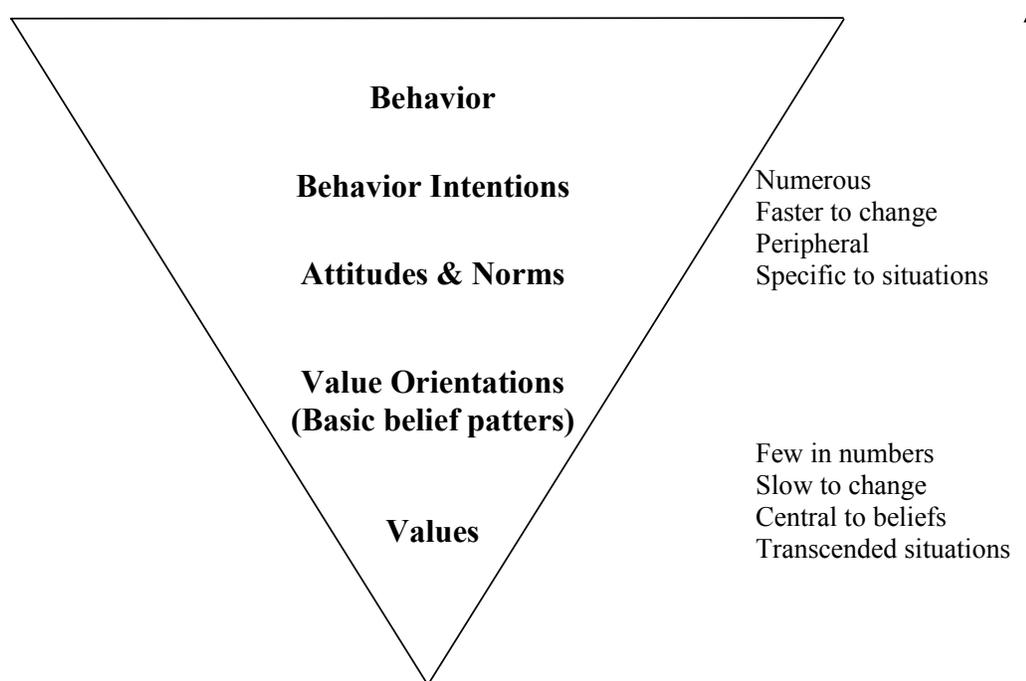


Figure 2. The cognitive hierarchy model of human behavior. Adapted from Fulton and others, 1996.

Values and Value Orientations

Values are general mental constructs defined as “what we hold dear, “ such as family values, religious values, economic values, and even value of wildlife (Rokeach, 1973). Because values are central to one’s identity, they are extremely difficult to change (Berm, 1970; Rokeach,

1973). Furthermore, individuals have few values, and these fundamental constructs are usually without specific reference to objects or issues (Fulton and others, 1996). Because values are a central construct formed early in life they are shared by all members of a culture, however, individual differences account for much of the variability in specific attitudes, norms, and behaviors. Values cannot be directly observed, however an individual's basic beliefs can be measured, which can then be used to identify individuals' value orientations. Value orientations are the patterns of direction and intensity of these basic beliefs (Fulton and others, 1996). By identifying basic beliefs and value orientations human dimensions can help explain behavior intentions and behavior from broad values.

Attitudes and Norms

An attitude is defined as the evaluation, either favorable or unfavorable of an entity, object or situation. While values and value orientations are believed to direct attitudes, attitudes are believed to directly influence behavior. Attitudes are used to measure respondents' preferences, opinions, and perceptions. Human-dimensions research measures attitudes on surveys by framing opinion questions in terms of "like-dislike," "good-bad," and "positive-negative."

Norms can be defined as what most people are doing (a descriptive norm) or as what people "should" or "ought" to do (an injunctive norm) in a given situation (Cialdini and others, 1991). Norms are standards that individuals use to evaluate activities, environments, or management proposals as good, bad, better, or worse (Vaske and others, 1986). Norms shared by the members of a social group (social norms), are often formalized into legal mandates with formal sanctions for noncompliance (e.g., littering, and speeding) (Vaske and others, 1986; Donnelly and others 2000).

Theoretical Basis for Visitor Education

The current body of literature that focuses on education programs as a management application is extensive. For several years, researchers and managers have invested substantial attention to understanding the mechanism by which visitor education alters an individual's behavior. To date, three theories have been advanced and thoroughly tested through studies: 1) persuasion, 2) moral development, and 3) planned behavior.

Theories of Persuasion

The two components of the persuasion model are pertinent to visitor education efforts: the central route to persuasion and the peripheral route to persuasion (Roggenbuck, 1992; Vande Kamp and others, 1994). The central route to persuasion relies on visitor attention, consideration, and internalization of a message. The central route to persuasion is cited as the most effective method of communication because complex concepts are conveyed to interested visitors, and long-term behavioral change results as a consequence of careful consideration and internalization by the participants. The peripheral route to persuasion relies on the source of the message rather than the message itself. This approach is characterized by a known spokesperson or authority figure conveying a simple message to an audience with a short attention span in need of consistent reinforcement (Roggenbuck, 1992; Roggenbuck and Manfred, 1990). The model also emphasizes non-substantive elements of information and education messages. The messages are considered by visitors to be authoritative or powerful, and may influence behavior while non- or less authoritative messages may be ignored. The latter model is particularly useful when competition from other messages exists.

Theories of Moral Development

Moral development builds on two prominent theories as suggested by Kohlberg (1976) and Gilligan (1982). Both theories suggest that people tend to evolve through a series of moral development stages, ranging from those that are very self-centered to those that are highly altruistic, and are based on principles of justice, fairness, and self-respect (Manning, 1999). These theories suggest that people evolve through several stages of moral development that range from pre-conventional (characterized by fear of punishment), conventional (characterized by attention to the opinions of significant others and societal norms), and post-conventional (characterized by consideration for justice, fairness, and self-respect) (Kohlberg, 1976). Management implications of this conceptual approach are that the most effective information and education programs will aim to reach visitors at each of these levels of moral development, yet emphasis on extrinsic rewards and punishments for selected types of behavior also may prove effective (Manning, 1999). Christensen and Dustin (1989) suggested that managers need to communicate different messages to target visitors at these different levels of moral development. For example, visitors at pre-conventional moral levels would likely respond best to law enforcement actions or behavioral incentives, while visitors at post-conventional levels would likely respond to rationales appealing to a sense of altruism and justice (e.g., what is best for society at large) (Manning, 1999). In contrast, visitors at conventional levels of morality may need to be convinced that land managers, their family, peers, and society as a whole, condone certain actions in contrast to others.

Application of communication theory to outdoor recreation suggests that the potential effectiveness of information and education is dependent upon a number of variables associated with visitors, and the content and delivery of messages (Roggenbuck and Ham, 1986; Vaske and others, 1990; Manfredo and Bright, 1991; Manfredo, 1992; Widner and Robbenbuck 1999; Bright and others, 1993; Bright and Manfredo, 1995; Basman and others, 1996; Vander Stoep and Roggenbuck, 1996). Visitor behavior is at least partially driven by attitudes, beliefs, and normative standards. Information and education programs aimed at connecting with or modifying relevant attitudes, beliefs, or norms, may be successful in guiding or changing visitor behavior (Manning, 1999). Applied behavior analysis is the simplest and most direct theoretical model of information. Since it does not address fundamental behavior variables such as attitudes, beliefs, and norms, its success may be short term and dependent on management actions.

Theory of Planned Behavior

The theory of planned behavior suggests that behavioral intentions and behavior are related, and that social norms and knowledge affect behavioral intent (Fishbein and Ajzen, 1975). The theory of planned behavior is an extension of the theory of reasoned action (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). The original theory of reasoned action incorporated the individual's intention to perform a given behavior. This intention of behavior was then assumed to control the motivational factors that influence a behavior. The theory of reasoned action then indicated that an individual's motivational factors are indications of how hard people are willing to try -- of how much of an effort they are planning to exert in order to perform the behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance (Ajzen, 1991). In short, knowledge affects behavioral intent, which is a strong indicator and antecedent of actual behavior (i.e., behaviors can be modified by increasing knowledge).

Recreational Conflicts

Human-dimensions research has played an important role in the last two decades when it has been used to analyze conflict in the field of outdoor recreation. Jacob and Schreyer's (1980) goal interference model stimulated most of this research. The goal interference model suggests that human behavior is goal oriented (e.g., people participate in a recreational activity for a specific goal), and that satisfaction is the difference between the desired and achieved goal. According to Jacob and Schreyer (1980) conflict can be caused by four major factors: 1) activity style, 2) resource specificity, 3) mode of activity, and 4) lifestyle tolerance (Manning, 1999) (Table 1). The majority of this research has focused on conflict between different recreational groups. Nonmotorized canoeists and rafters, for example, have been shown to dislike encounters with motorized rafters (Lucas, 1964a, 1964b; Lime, 1975; Adelman and others, 1982; Nielsen and Shelby, 1977; Schreyer and Nielsen, 1978; Shelby, 1980; Whittaker and others, 1990). Similarly, cross-country skiers dislike encounters with snowmobilers (Jackson and Wong, 1982; Knopp and Tyger, 1973; Lindberg and others, 2001; Cline, 2004). These studies consistently show that when recreationists experience negative consequences from the physical presence or behavior of an individual or a group, conflict occurs.

Table 1. Four major causes of conflict adopted from Manning (1999), and Jacob and Schreyer (1980).

1) Activity Style	
Description	Activity style is defined by how specialized or general a recreationist is; often based on various personal meaning of a recreational activity.
Components	Intensity of participation (defined by equipment, expertise and range of experience, and definition of quality).
	The more specific the expectation of what constitutes a quality experience, the greater the potential for conflict.
2) Resource Specificity	
Description	Resource specificity refers to an individual's attachment to a specific recreation resource for a given recreation area.
Components	Evaluation of resource quality, sense of possession, and status based on intimate knowledge of a recreation area.
	Conflict results when users with a possessive attitude toward the resource confront users perceived as disrupting traditional uses and behavioral norms.
3) Mode of Experience	
Description	The mode of experience refers to the expectations of how the natural environment will be perceived.
Components	Extent to which the recreation participant is focused or unfocused on the environment.
	When a person in the focused mode interacts with a person in the unfocused mode, conflict results.
4) Lifestyle Tolerance	
Description	Lifestyle tolerance refers to recreationists' tendency to accept or reject lifestyles different from their own.
Components	Lifestyle tolerance includes level of technology, resource consumption, and prejudice.
	Conflict occurs between recreationists who do not share the same norms.

These four factors suggest conditions in which recreational conflict is most likely to occur (Manning, 1999). Even so, while conflict among recreationists often results from direct interactions or interpersonal conflicts (when the behavior of one individual or group interferes with the goals of another individual or group), the underlying cause of the conflict may be solely values-based.

Case Study: Conflict at Mount Evans, Colorado

A study at Mount Evans, Colorado (Vaske and others 1995), examined the magnitude of interpersonal and social value conflict for two general classes of events: hunting and wildlife viewing. Interpersonal conflicts between hunters and nonhunters were minimized by the natural topography of the region and by management regulations that physically separated hunters and nonhunters. The conflict that was found between hunters and nonhunters was primarily attributed to differences in contemporary value orientations toward hunting and wildlife viewing. Although nearly all of the nonhunters did not physically observe hunting-associated behaviors (e.g., seeing hunters, seeing animals being shot), they still perceived conflict.

Conflict arising from watching others feed wildlife at Mount Evans also was examined. Interpersonal conflicts among respondents who observed others feeding wildlife explained 4 percent of the perceived conflict, where as social values (individuals who did not observe the activity but still perceived a problem) only explained 23 percent of reported conflict. Respondents who reported no conflict (individual who both observed others feeding wildlife and those who did not observe people feeding wildlife) explained 20 percent of the cases in which no problem was perceived. These results indicated that feeding wildlife was a perceived problem by visitors at Mount Evans; but more importantly, the source of conflict was a result of interpersonal conflict.

By differentiating between interpersonal and social values conflict at Mount Evans, management actions were more appropriately identified for both situations. In terms of feeding wildlife, management actions such as the enforcement of sanctions or increased signage were suggested to deter wildlife feeding. Since conflict between hunters and nonhunters was attributed to social values conflict, educating nonhunters about wildlife population management was suggested. In this case, traditional zoning between hunters and nonhunters would not have reduced conflict, as physical interaction was not the cause of the conflict. Rather, it was a conflict of values.

Social Carrying Capacity

Carrying capacity has played a vital role in natural resource management for more than half a century. Prior to its adoption in the field of outdoor recreation, carrying capacity was a primary fixture in wildlife and range management. In that context, it was first defined as the number of animals that can be ecologically sustained in a given habitat (Dasmann, 1964). In the mid-1930s, a National Park Service report posed the question: "How large of a crowd of humans can be turned loose in the wilderness without destroying its essential qualities?" (Sumner, 1936). As opposed to the number of animals determined sustainable in a given habitat, Sumner's (1936) question marked carrying capacity as a quality of the recreation experience for visitors. Carrying capacity did not become a familiar component of outdoor recreation planning and management until the 1950s, when Wagar (1964) listed it as one of the eight major principles in recreation land use (Manning, 1999). An even more significant contribution was Wagar's (1964) consideration of both biological and social value components to recreation experience.

Since its adoption, many have been disenchanted with the concept of recreational carrying capacity. This can be attributed to the fact that managers who were familiar with traditional (biological) carrying capacity, found the human-applied concept difficult to grasp, as well as

implement. Unlike traditional carrying capacity, recreational carrying capacity does not intend to specify the number of recreationists for a given area. As a result, the term carrying capacity has been argued to be inappropriate and misleading. The misconception that recreational carrying capacity implies a single “magic number” has caused some authors to argue that the term should be dropped altogether (Wagar, 1964).

However, recognizing that recreational carrying capacity is not a panacea, it is, however, an important component of outdoor recreation management if used appropriately. Recreational carrying capacity is based on the formulation of management objectives, associated indicators, and standards of quality (Lime and Stankey, 1971; Frissell and Stankey, 1972; Lucas and Stankey, 1974; Bury, 1976; Stankey and others, 1985; Stankey and Manning, 1986; Graefe and others, 1990; Lime, 1995; and Manning, 1999). These are quite similar to the concepts of biological carrying capacity and mesh well with the goal and objective setting that is a part of carrying capacity planning.

Management Objectives

Management objectives are broad, narrative statements that define the type of visitor experience to be provided and are stated as being “essential guides in formulating appropriate programs of management” (Stankey and Manning, 1986). In order for recreational carrying capacity to be implemented, management objectives must be developed for all natural resource, social, and managerial factors.

Indicators and Standards of Quality

Indicators are the biophysical, social, managerial, or ecological characteristics that provide measurable and observable data to show the present state, current condition, or trend. They allow managers to identify and monitor conditions for a given experience or event. Standards restate management objectives in quantitative terms and specify the appropriate levels or acceptable limits for the impact indicators. As such, standards define how much impact is acceptable. Overall, standards identify conditions that are desirable, and the conditions that managers do not want to exceed (e.g., encounters with other people, wildlife flight reactions, incidents of wildlife-human conflict) (Vaske and others, 2002).

Development of indicators and standards requires an initial inventory of current environmental, social, and management conditions. Indicators and standards aid management by identifying and defining management goals and objectives; and establish priorities by focusing on future conditions. By using quantitative standards, managers are able to accurately monitor change. In order to successfully monitor change there is a need to look ahead to what actions might be employed to meet standards, and a need to look back at the optimal conditions management is trying to provide (Vaske and others, 2000). In terms of identifying human-wildlife disturbances, this requires assessing ecological conditions, such as wildlife population levels (Johnson and Vandekamp, 1996), habitat quantity, and quality (Anderson and Gutzwiller, 1996). For identifying social conditions, recreationists’ perceptions of crowding and conflict, as well as demographic characteristics (e.g., type of use, frequency of use, skill level) are often examined. It is equally important to assess the management conditions such as identifying recreationists’ and stakeholders’ perceptions and acceptance of management strategies (Vaske and others, 1995). In contrast to traditional wildlife management where the number of visitors in an area is emphasized (Vaske and others, 1995), standards return the managers’ attention to the quality of recreation opportunities (Vaske and others, 2001). Through proper monitoring, standards allow managers to identify

impacts that are becoming a problem rather than waiting for problems to occur (Whittaker and Shelby, 1991).

Choosing Indicators

When choosing indicators, five criteria have been suggested (Vaske and others, 2001) (Table 2). First, indicators should be specific and responsive, addressing unambiguous conditions that reflect change. The choice of indicators and standards depends on the particular impact under consideration and the specific characteristics of the site. Indicators and standards should be chosen specific to the resource characteristics. It is important to identify indicators that are the most relevant to issues of concern for a given event or experience (Graefe and others, 1990). Second, an indicator should be sensitive to change. In order to identify that an indicator has changed over a given time, it is important that it can be measured under a reasonable temporal context. Furthermore, change must be proactively measured prior to reaching the established threshold standard. Third, indicators should be measurable, using data-collection techniques that consistently ensure valid and reliable results. Fourth, effective indicators must reflect management objectives. For example, if management's objective is to reduce direct wildlife disturbances caused by recreationists, the indicators might focus on the number of encounters between visitors and wildlife. More importantly, indicators must be controllable by management actions. And finally, indicators should represent important impacts (Whittaker and Shelby 1991). In order to justify the time, money, and personnel required to monitor indicators, it is vital that indicators represent management goals and objectives.

Table 2. Five criteria for choosing indicators

-
- 1 Indicators should be specific and responsive to the resource characteristics.
 - 2 Indicator should be sensitive to change.
 - 3 Indicators should be measurable; consistently ensuring valid and reliable results.
 - 4 Indicators must reflect management objectives.
 - 5 Indicators should represent important impacts.
-

Adopted from Vaske and others (2001)

Variables that are good indicators of social carrying capacity must be important to visitors in defining the quality of the recreation experience. Visitors' preferences for site attributes, crowding, encounters with other visitors, motivations of recreation, and conflict with other types of users are all suggestive or potential indicators of quality. While potential indicators of quality can be wide ranging, variables should be categorized into the three categories mentioned previously.

Choosing Standards of Quality

Similar to indicators, standards must represent an acceptable level of impact as determined by management goals and objectives. These standards are quantifiable value judgments that determine management action (e.g., if thresholds are exceeded, then the site is closed to the public) and reflect management objectives. More importantly, these objectives must be obtainable. When adopting indicators and standards, standards should be set at levels that realistically reflect management's intent for resource or experiential outcomes for the area (Whittaker and Shelby, 1992).

Standards allow management to quantify appropriate levels or acceptable limits for impact indicators, as well as a means to implement management objectives (Vaske and others 2001).

These quantifiable value judgments reflect management goals and objectives, and identify and define what is desirable or acceptable; establishing the level of impact for each indicator.

Based on previous research, good standards of quality must be: 1) quantifiable, 2) time bound, 3) attainable, and 4) output oriented (Schomaker, 1984; Graefe and others, 1990; Whittaker and Shelby, 1991). Quantifiable standards unequivocally state the level of acceptable impact determined by management objectives, and provide managers a measurable standard for indicators of quality. Time bound standards specify “how much, how often” or “how much, by when” (Vaske and others, 2001). This is especially important when dealing with seasonal variations that often correlate with fluctuations in visitor numbers (e.g., hunting season or wildlife viewing opportunities). In addition to being quantifiable and time bound, management standards need to be attainable, yet moderately challenging to progressively manage impacts (Schomaker, 1984). By establishing standards that are attainable, management can achieve realistic resource or experiential outcomes (Whittaker and Shelby, 1991). Finally, standards should be output rather than input oriented, focusing on conditions to be achieved (Schomaker, 1984).

Wilderness Threats Matrix: A Tool to Develop Indicators

The wilderness threats matrix is a comprehensive framework designed for assessing potential threats to wilderness. However, it can be modified and applied to other resources besides wilderness. By using the wilderness threats matrix prior to other frameworks (e.g., LAC, VIM, and VERP), managers and planners can identify indicators that are of most concern. Unlike most frameworks, the wilderness threats matrix examines a full range of significant threats and potential impacts. Cole (1994) suggests that planners should use the threats matrix as an initial step in developing indicators of quality.

The primary attributes identified in the wilderness threats matrix are:

- Air;
- Aquatic systems, rocks and landforms;
- Soils;
- Vegetation;
- Animals;
- Ecosystems and landscapes;
- Cultural resources; and
- Opportunities for wilderness experiences (Cole, 1994).
-

As identified by Cole (1994), the most significant threats accounted for in the threats matrix include:

- Recreational use and its management;
- Livestock grazing and its management;
- Mining;
- Fire and its management;
- Exotic species introductions and invasions;
- Water projects;
- Atmospheric pollutants; and
- Practices on adjacent land.

The threats matrix assesses potential threats to wilderness by specific wilderness attributes that represent impacts of each threat on each attribute. Planners, managers, and visitor services specialists can use the matrix during the scoping process to describe the current management situation and develop assumptions about future conditions. Furthermore the threats matrix can aid decision makers in assessing the impacts of alternative management actions. By identifying a

comprehensive overview of management needs, the matrix provides a starting point to assess impact priorities.

Sources for Standards

Sources for selecting standards may include laws, professional opinion, biological data, public involvement, and visitor surveys. While laws reflect public opinion, they are often too vague. Managers' professional judgment is often based on local knowledge, professional experience, and interpretation of laws (Whittaker and Shelby, 1991). Furthermore, wildlife managers often develop standards based on their idea of what is appropriate, or even their own personal values in the decision-making process (Manfredo and others, 1995). While biological expertise is vital to the decision-making process, the increasingly political nature of all natural resource actions implies that decisions made in isolation are likely to generate considerable public scrutiny (Bright and Manfredo, 1993). By employing management standards that are scientifically grounded, decisions can be supported through empirical data.

Although it has been assumed that managers understand the acceptability of different resource and experiential conditions, a growing body of empirical evidence suggests considerable differences between the views of managers, visitors, and organized interest groups (Magill, 1988; Gill and others, 1996). By formalizing the process for developing standards and including different points of view, managers gain a greater understanding of their objectives, have more justification for their actions, and are able to be more proactive when potential problem situations arise (Whittaker and Shelby, 1991).

Biological research provides a vital component in developing standards by clarifying what management goals are biologically possible and describing how management actions affect wildlife impacts (Vaske and others, 2001). However, biological research alone cannot predict which alternatives are more or less desirable by the public. Although the refuge mission of "wildlife first" is the guiding principle in refuge planning, public preference and acceptability is one piece of the planning puzzle that when factored into the process can lead to more comprehensive plans that are more likely to be implemented (Burby, 2003).

Public involvement, which may include stakeholder participation, focus groups, and public meetings, is another viable method for developing standards, particularly social-impact indicators and standards. Public involvement provides managers and decision makers with a useful starting point for identifying and prioritizing which impacts matter more (Whittaker and Shelby 1991). Stakeholder participation provides feedback from diverse interest groups and facilitates collaborative efforts to resolve wildlife-management challenges.

Visitor surveys are yet another useful source for developing standards for social indicators (Manfredo and others, 1996). Surveys allow managers to identify several different types of impacts, and their levels of importance by examining a range of impact conditions. Surveys also can facilitate the indicator selection process by asking respondents to consider the relative importance of different impacts. Statistical comparisons of survey findings provide empirical data about specific impacts, as well as what standards would be most appropriate for a given impact (Vaske and others, 1986). Overall indicators and standards provide a foundation for management goals and objectives, and operationalize what conditions managers are trying to provide.

Carrying Capacity Frameworks

In response to the demand for a carrying capacity solution, several management frameworks have been developed for applying this concept to outdoor recreation, including:

- Limits of Acceptable Change (LAC) (Stankey and others, 1985; McCool and Cole, 1997),

- Visitor Impact Management (VIM) (Graefe and others, 1990),
- Carrying Capacity Assessment Process (C-CAP) (Shelby and Heberlein, 1986),
- Quality Upgrading and Learning (QUAL) (Chilman and others, 1989),
- Visitor Activity Management Process (VAMP) (Hof and Lime, 1997), and
- Visitor Experience and Resource Protection (VERP) (Manning and others, 1996b; Hof and Lime, 1997).

While each framework has unique individual characteristics, all are conceptually the same. Of the six cited, VERP, LAC, and VIM are the most well-known and most frequently used. The primary components of these frameworks include: 1) a definition of recreation as well as associated indicators and standards of quality, 2) monitoring of indicator variables, and 3) appropriate management actions (Manning, 1999). Table 3 illustrates the basic steps or elements of the three most applied carrying capacity frameworks (Manning, 1999). As seen in Table 3, LAC, VIM, and VERP all share numerous commonalities despite subtle differences in terminology and sequence of steps.

Table 3. Carrying capacity frameworks (Manning, 1999).

Limits of Acceptable Change (LAC)	Visitor Impact Management (VIM)	Visitor Experience and Resource Protection (VERP)
Step 1. Identify area concerns and issues.	Step 1. Pre-assessment database reviews.	Element 1. Assemble an interdisciplinary project team.
Step 2. Define and describe opportunity classes.	Step 2. Review of management objectives.	Element 2. Develop a public involvement strategy.
Step 3. Select indicators of resource and social conditions.	Step 3. Selection of key impact indicators.	Element 3. Develop statements of primary park purpose, significance, and primary interpretive themes.
Step 4. Inventory resource and social indicators.	Step 4. Selection of standards for key impact indicators.	Element 4. Analyze park resources and existing visitor use.
Step 5. Specify standards for resource and social indicators.	Step 5. Comparison of standards and existing conditions.	Element 5. Describe a potential range of visitor experiences and resource conditions.
Step 6. Identify alternative opportunity class allocation.	Step 6. Identify probable causes of impacts.	Element 6. Allocate potential zones to specific locations.
Step 7. Identify management actions for each alternative.	Step 7. Identify management strategies.	Element 7. Select indicators and specify standards for each zone; develop an monitoring plan.
Step 8. Evaluate and selection of an alternative.	Step 8. Implementation.	Element 8. Monitor resource and social indicators.
Step 9. Implement actions and monitor conditions.		Element 9. Take management action.

While each framework has unique steps and general procedures, they all maintain three conceptual components: 1) environmental, 2) social, and 3) managerial (Manning and Lime, 1996). Various descriptions of these dimensions have surfaced through the years, but all have been similar to the original three components (Alldredge, 1973; Manning, 1999). The primary elements of these frameworks depend on management direction, research findings, public input, and managerial judgments (Stankey and Manning, 1986).

As with biological carrying capacity, monitoring is an essential requirement of any carrying capacity framework. To determine when threshold standards have been reached or exceeded,

indicators must be monitored. While managers ultimately make the value-based decision, these decisions should be based on empirical data. The goal of carrying capacity is to aid managers in identifying the levels of change that are acceptable.

Application of Human Dimensions to Wildlife Disturbance Issues

Case Study: Bear-viewing at Katmai National Park, Alaska and McNeil River State Game Sanctuary, Alaska

At Brooks River in Katmai National Park, Alaska, platforms were used to provide visitors a premier opportunity for viewing brown bears (*Ursus arctos*) (Whittaker, 1997). Over a number of years however, increasing human use and activity at Brooks River led to a concern about impacts to the bear population and the quality of viewing experiences (Whittaker, 1997). In response to this concern, a biological study was conducted that indicated that the number of bears at Brooks River had remained static and were potentially increasing (Olson and Gilbert, 1994). As a result, it was believed that the bears had adjusted to the wildlife viewing. As part of the National Park Service planning efforts to review management and development options, major planning questions focused on 1) whether overnight facilities should be relocated away from the core bear use area along the lower river; 2) whether current viewing platforms were of sufficient size and being managed for appropriate capacities; 3) how large to make any new platform, lodge, or campground; and 4) whether there should be limits on visitation in the area (Whittaker, 1997).

A human-dimensions study was conducted to examine visitors' capacity norms specific to the bear-viewing platforms (e.g., the acceptable number of people on a platform at one time) (Whittaker, 1997). As a result of this study use limits were defined (e.g., 20 to 40 people per existing platform), and standards for capacities of bear-viewing platforms were developed. By employing standards based on the normative data, National Park Service managers used human dimensions to establish platform use limits and helped designers develop future wildlife viewing platforms that met social and biological objectives.

At McNeil River State Game Sanctuary, Alaska wildlife viewers are offered a completely different bear-viewing experience. Rather than observing bears from wildlife-viewing platforms, visitors have the rare opportunity to view bears from very close distances. As described by Matt and Aumiller (2002), "visitors are close enough to smell bears as they pass by, and even hear the sound of a female suckling her cubs". The McNeil Game Sanctuary is able to offer visitors this unique opportunity largely in part, by limiting the number of visitors and controlling their behavior; (e.g., encourage safe, close contact with bears through their habituation) (Matt and Aumiller, 2002).

In 1997, managers at the sanctuary began to assess the program's structure in hopes to identify a way that the McNeil viewing program could "pay for itself," while maintaining the values that have made the program successful (Matt and Aumiller, 2002). In order to assess the current and proposed permit systems, a survey was conducted by Bright (1998) that measured applicant's perceptions and experiences at McNeil and other bear viewing sites, and how much applicants were willing to pay for a permit at McNeil River Game Sanctuary. In addition to the survey, managers collaborated with stakeholders and citizens who had a direct interest in the operations of the sanctuary. By integrating data collected from the surveys with stakeholder and citizen input, managers were able to assess the economic valuation and prioritize the highest use of potential wildlife viewing sites (Matt and Aumiller, 2002). By using human dimensions as a tool, managers were able to meet the supply and demand changes while adhering to the agencies' objective to protect bears and provide a highly unique visitor experience.

While wildlife managers are faced with conserving and protecting wildlife and wildlife habitat, they also are faced with providing recreational opportunities for visitors to enjoy and learn about wildlife. Through human dimensions, managers can measure visitors' values of wildlife, how they affect wildlife, and how visitors will respond to management decisions. By identifying why people behave the way they do, human dimensions can be used to resolve a number of management issues (e.g., negative visitor behaviors, why they occur, and how might they be managed). As observed at Brooks River in Katmai National Park and McNeil River State Game Sanctuary, human-dimensions research provides managers with a valuable tool to identify effective and practical solutions.

Management Solutions

In a handbook commissioned by the National Park Service, "Maintaining the Quality of Park Resources and Visitor Experiences: A Handbook for Managers," (Anderson and others, 1998), the authors provide an extensive step-by-step approach for identifying and defining unacceptable impacts to biological, cultural resources, and visitor experiences. A significant component of the handbook identifies and describes a number of management strategies and tactics used to mitigate unacceptable impacts. Using Anderson's, Lime's, and Wang's (1998) handbook as a template, this section is intended to provide a summary of contemporary management solutions. Although this section summarizes management solutions identified by Anderson and others (1998), it is highly recommended that readers obtain and read the original document to gain an understanding of concepts not covered.

As noted by Manning (1999), management solutions can be identified by four basic strategies: 1) increase supply, 2) reduce impact of use, 3) increase durability of use, and 4) limit use. These basic conceptual approaches allow management to control visitor behavior and sustain desirable standards of quality. The following sections will discuss site management tactics, facility design and modifications, strengthening and/or hardening, and site closures.

Site Management

Site management allows recreation use to be concentrated to maintain a desired environmental standard (as defined by management goals and objectives). As noted by Hultsman and others (1987), many unacceptable visitor impacts are attributed to poor planning, inadequate design, and lack of adequate administration. Site management can be applied in a variety of ways and can be implemented using a number of specific management solutions. These solutions can be implemented by using any one of the following approaches and/or combination of approaches in order to mitigate undesirable visitor impacts. Applications of site management include:

- Providing appropriate facilities and structures,
- Use of vegetation,
- Physical barriers,
- Strengthening and/or hardening sites,
- Close areas or facilities to public use,
- Eliminate facilities that are deemed inappropriate, and
- Increasing or decreasing, and improving or unimproving sites.

Facility Design

By providing facilities and other structures as a management tactic, visitor behavior can be altered by either attracting or discouraging visitation, or directly concentrating physical and social

impacts. Facility design may include a number of different management strategies. Boyle and Samson (1985) concluded that in order to reduce disturbance by wildlife viewers, management must design viewing facilities and regulate or prohibit activities deemed inappropriate or harmful (DeLong and Adamcik, in press). One of the major objectives of facility design is to concentrate use and limit the geographical extent of the impact. This can be achieved in a number of ways, acting either as an indirect or direct management tool. As noted by Cole (1987), some authors have discussed habituating wildlife to encounters with humans in an attempt to condition animals to be less vulnerable. For example, by designating and/or concentrating use, the predictability of visitor use patterns can be used to habituate wildlife to non-threatening visitor use.

As a direct management tool, visitor use can be designed to avoid critical wildlife habitat. By designing trails that physically control the amount and type of habitat impacted by visitor use, managers can directly alter impacts. Management decisions such as trail design, however, should be based on a site-specific inventory to determine appropriate facility placement.

Although not adequately documented in recreational settings, facility design is an effective way to concentrate use and limit the geographical extent of the impacts. Limited research, including a 1991 survey of 93 National Park Service backcountry managers, found that 34 percent of the parks relocated backcountry campsites from fragile to durable soils or vegetative types, while 43 percent concentrated use on site through fire pit and facility placement (Marion and others, 1993). Other facility design features included tent platforms for backcountry campers, tables, and hitching rails. In addition, 13 percent of parks provided tent platforms for backcountry campers, 30 percent provided some type of fire grate, 20 percent provided tables, and four percent provided hitching rails. These facility design features helped managers maintain acceptable resource conditions.

Indirect facility design also can be a useful management tool. Indirect facility design can use site characteristics to influence visitor's decisions by attracting or discouraging visitation. For example, by allowing certain trails to be more attractive and accessible than others, managers can indirectly concentrate use to specific trails. By indirectly distributing visitors to more attractive sites or trails, visitor use can be managed to avoid critical habitat, while maintaining visitor satisfaction.

Despite obvious benefits of facility design, it is important to note that facility design can detract from visitor experience, particularly in wilderness/backcountry settings. It is also important to note that inadequate or inappropriate facility design can actually exacerbate actual or perceived crowding, as well as visitor use conflicts (Anderson and others, 1998). If careful consideration and planning is used, appropriate facility design strategies can aid managers in protecting natural resources and visitors' experiences.

The decision to implement facility design to minimize impacts is often determined by available funding rather than actual needs. The financial costs of both the design and construction phase of the project can be substantial and often requires outside consultants and contractors. For this reason, modifications facility design is not always a feasible.

Use of Vegetation

Vegetation can be used to: 1) Rehabilitate an area that has sustained unacceptable impacts, 2) hinder erosion, 3) shield areas not intended for visitor use, or 4) act as a physical barrier to reduce visual or audible impacts (for both visitors and wildlife).

When rehabilitating an area that has sustained impacts from visitors who have traveled off-trail, revegetation can indirectly prevent other visitors from following suit. When evidence of off-trail travel is removed through vegetation restoration, future visitors will be less likely to travel

off-trail (Vande Kamp and others, 1994). By integrating other management tactics (such as educating visitors about appropriate behavior) with re-vegetation, future undesirable impacts to resource conditions can be reduced. Anderson and others (1998) also suggests that well-maintained vegetation can actually hinder future undesirable impacts to resource conditions by indirectly initiating appropriate resource-protective behavior. Site restoration efforts, however, are generally less successful than simply concentrating visitor use into already impacted areas. Following a relatively long recovery period, restored areas often revert to their previous highly impacted state, even under conditions of light use (Hammit and Cole, 1998).

Revegetation is generally considered ineffective if, following the restoration period, the site is reopened to visitor use (Anderson and others, 1998). However, if revegetation is intended to reduce noncompliant visitor behavior, such as off-trail travel, efforts may be successful in the long run. By reducing the temptation to travel off-trail, disturbance to wildlife and wildlife habitat may indirectly benefit from revegetation efforts.

Vegetation can be used as a facility design tactic to conceal visitors, reduce noise, increase wildlife's level of comfort, and bring wildlife closer to trails and wildlife viewing areas (DeLong and Adamcik, in press). When integrating vegetation with available topography, visitors and visitor facilities (e.g., blinds) can be effectively concealed from wildlife. Vegetation also may be strategically placed to subtly direct visitor use to designated impact zones, and can be used to create a barrier from areas inappropriate for visitor use. Nevertheless, when used to block or hinder access, vegetation may actually be perceived by visitors as obtrusive, and may result in decreased enjoyment whether or not visitors choose to bypass the barriers. Modifying vegetation to ensure that acceptable biophysical, social, and managerial conditions are maintained is generally a cost-effective management tactic, though periodic maintenance costs are common.

Physical Barriers

Physical barrier commonly are used to obstruct or limit access to an area or to separate visitors from the resource and/or each other. As previously discussed, vegetation is commonly used to directly block or hinder access from inappropriate visitor use. Other physical barriers such as gates, rocks, and fences are also commonly used to prevent access. By controlling visitor behavior, physical barriers function to ensure visitor safety, protect resources, maintain desired traffic-flow patterns, and prevent such noncompliant behavior as vandalism or off-trail travel (Anderson and others, 1998). Barriers are likely to be more effective if they convey a behavioral message to visitors (e.g., trail closed to prevent erosion). At three barrier beaches in Massachusetts, fences successfully minimized human disturbances of piping plover nesting habitat (Deblinger and others, 1989). The use of barriers is a common management technique for protecting critical habitat during sensitive times of the year.

Buffer zones

Buffer zones also can be used as effective barriers. DeLong and Adamcik (in press) cited Burger (1999) as stating, "that viewing distances can serve as useful guides for managers lacking good site-specific information and serve as a starting point in determining what is appropriate elsewhere." When establishing appropriate set-back distances, the use of formulas as developed by Rodgers and Smiths (1995, 1997), can aid managers in determining appropriate distances for wildlife buffer zones. Due to the variability of flushing distances of individual wildlife and wildlife species populations, distances may need to be developed on an individual colony basis (Rodger and Smith, 1995).

Strengthening/Hardening Sites

Site strengthening or hardening is defined as any physical modification or improvement to a resource that increases the resistance of the resource. By using techniques that increase a site's durability, management can then ensure that the area can sustain future use or increased use. More importantly, by strengthening a site's resistance to impacts, visitor use can be concentrated to designated areas that are less vulnerable. Strengthening or hardening a site is particularly effective in handling excessive trail erosion. Examples of site strengthening techniques include:

- Changing soil and vegetation conditions;
- Using cement, asphalt, crushed rock, corduroy or steps on trails or parking areas;
- Watering, fertilizing, or planting resistant turf grasses;
- Opening up the tree canopy to encourage growth of resistant grasses;
- Bridges, boardwalks, or turnpikes;
- Tent platforms at campsites; and
- Permanent fire rings or cooking grates.

It is important to note that site-strengthening techniques are primarily used in high-use settings and considered by both managers and visitors to be inappropriate in wilderness or "backcountry" areas. Obtrusive strengthening techniques can easily detract from the natural appearance of an area and decrease visitor freedom. Visitors, however, generally are receptive to trail improvements that often are attributed to increased visitor convenience (Stankey and Schreyer, 1987). The cost of many site-strengthening techniques is relatively low, although this is dependent on the number of improvements that are needed. Ultimately, the decision to strengthen or harden an area, and which techniques to use, primarily depends upon the biophysical, social, and managerial conditions for which the area is intended.

Facility Modification

Facility modifications are intended to redistribute use by making access to an area easier or more difficult. Through facility management, managers may selectively modify facilities and/or other physical features to encourage or discourage certain types of use, or to alter the recreational opportunities the area provides. Increasing or decreasing the number of, improving or not improving, or eliminating facilities may address the underlying cause of a problem, or may serve as a secondary measure to support another tactic which addresses the cause of the problem. For example, if increased visitation occurs in a specific location and managers cease to maintain trails leading to the area to discourage visitor access, this is an indirect management tactic. It does not control visitor behavior directly by limiting the number of visitors or restricting visitor access. Rather it tries to decrease visitation by making access less convenient.

Expanding parking lots, adding additional trails, restrooms, buildings, or a visitor center, or eliminating any of the above, directly influences visitor behavior. This has great potential to alter both natural conditions and the recreational experience opportunities an area provides. Modifications can either be subtle or obtrusive. Some visitors may regard deteriorating trails as a sign of neglect and mismanagement, while others may view the same trail as a sought-after opportunity to get off the beaten track. Newly constructed facilities can be obtrusive and infrastructure development costly. Facility modification must generate enough change in existing conditions to alleviate or substantially reduce acceptable impacts. Small, incremental changes are unlikely to be effective.

As a result of an impact analysis, elevated boardwalks and a vehicle ramp were constructed at three barrier beaches in Massachusetts to reduce erosion. “Monitoring indicated that these facility modifications had significantly reduced unacceptable impacts” (Vaske and others, 1992, in Delong and Adamcik, in press).

Areas and Facilities Closures

Area or facility closures are a direct management tactic that is intended to permanently or temporarily remove the source of the resource impact (i.e., visitors). By closing sensitive resource areas, especially critical wildlife habitat or cultural resources, facility closures are intended to allow the impacted resource to recover. Area closures are often used as part of a rehabilitation scheme for an area that has suffered unacceptable impacts. Area or facility closures are often implemented through the use of signs and barriers, as well as staff to inform and enforce the closure.

It is important to note that area or facility closures do not directly address the cause of visitor use problems, but rather displaces visitor use to other areas. Unless closures are permanent, impacts are likely to reoccur when the site is reopened. Furthermore, site closures are likely to be ineffective at reducing overall impacts to resources, unless more durable sites are identified. Since area or facility closures do not directly address the cause of the problem (visitor behavior), they are not effective for addressing impacts on visitor experiences (e.g., crowding, inappropriate behavior, and conflict).

If visitor experience is a concern, other management tactics may be more appropriate, such as reducing use, limiting number of visitors, zoning use, encouraging use of other areas, or requiring certain skills or equipment. In Deblinger and others (1989) study of impacts on barrier beaches in Massachusetts, seasonal closures to nesting sites were implemented using protective fencing. Authors noted that of the visitors surveyed, the majority supported the closures.

Rationing and Allocation

Rationing is a management tactic that is used to regulate the use and intensity of an area by limiting visitor access, and is intended to address the source of specific visitor-use problems. Allocation refers to how use limits are apportioned among visitors, particularly among groups of conflicting or competing interests. Rationing and allocation techniques are dependent upon one another, integrating synonymous objectives for limiting use. Use limits generally are a direct management tactic that acts directly upon visitor behavior as it pertains to visitation. Rationing tactics are fairly direct and obtrusive; however, they may vary in terms of their effects upon visitor experiences. Of all the management tactics available to managers, rationing and allocation have perhaps generated the most controversy (Stankey and Baden, 1977; Cole, 1995). Pricing, for example, is argued as being potentially discriminating due to the concern that those lacking financial resources to pay fees do not have equal access to public lands. With rationing, the way use limits are implemented is frequently controversial.

To minimize or negate potential conflicts associated with allocation or rationing tactics, public involvement is highly recommended. Public involvement during the planning process may aid in the acceptability of management tactics and help identify specific needs and concerns. When stakeholders and the public understand that use limits are needed to maintain acceptable biophysical and/or social conditions, management actions are supported more often (Cole, 1987; McCool and Christensen, 1996).

Limit Access Using Reservations

To establish acceptable use patterns, reservation systems can be used to limit use amount and use extent in an area. Reservation systems also allow management to control the intensity of visitor use by redistributing types of recreational users. Overall, reservation systems have generally proven to be an effective tactic for controlling the intensity of visitor use in terms of overall numbers of visitors within an area at a given time.

To implement a reservation system as a rationing strategy, permits must be mandatory, and the number of available permits finite. The very nature of this approach is obtrusive and will displace visitors either intentionally or unintentionally. Since a reservation system requires visitors to obtain a permit before visiting a desired recreational site or attraction, some visitors may feel confined or inconvenienced. However, once a visitor obtains a permit, visitor's satisfaction is likely to increase due to reduced crowding and lack of other tactics such as signs and barriers (Anderson and others, 1998).

Although the cost of reservation systems are relatively high for management, due to amount of time and staff required for operation and enforcement, reservation systems are common in a large number of National Parks, recreation areas, wild and scenic rivers, national monuments, and national historic sites, and may have applicability to some refuges with high visitation.

Limit Access Using Queuing (First-come, First-serve)

Queuing is a rationing tactic that requires visitors to obtain a permit on a first-come, first-serve basis. Queuing is a redistribution technique that allows management to control the intensity of visitor use by limiting and distributing the amount and type of recreational use for an area and/or place. Queuing may be used to mitigate visitor impacts such as crowding and interpersonal conflict. Like other rationing tactics, queuing may be used alone or in conjunction with other tactics.

Limiting Length of Stay

In addition to regulating how long visitors can stay, length-of-stay regulations include day-use restrictions, entry date and time assignments, peak season regulations, and trip scheduling (Anderson and others, 1998). Length-of-stay restrictions are common in front country areas (e.g., prohibiting over night use), and designated campsites to ensure turnover. Given that length-of-stay restrictions do not directly address specific visitor impacts, they are best used with other tactics. Other temporal restrictions, such as seasonal restrictions during critical nesting habitat, are more appropriate for mitigating wildlife disturbances.

Restricting Group Size

Restricting group or party size is a common tool for minimizing social and ecological impacts as well as wildlife disturbances. Since no formulas exist for calculating group size, size limits are typically determined through professional judgment and management objectives (Cole, 1987). As cited by Manning (1999), the majority of wilderness visitors reported that they would prefer to see five small groups during the day rather than one large group (Stankey, 1973). As such, most visitors support limitations on group size (Anderson and others, 1998). However, since group size limits do not control visitors' behavior, group size restrictions alone may not adequately address unacceptable impacts. Roggenbuck and Schreyer (1977), and Heywood (1985), have noted that in addition to group size, restrictions of the types of groups also should be considered.

Zoning

Zoning is a basic recreation management tool that allows managers to assign or restrict access or certain recreation activities to selected areas (Manning, 1999). By controlling visitor access and activities to certain areas, zoning can distribute visitor use and prohibit incompatible uses. Identified management zones allow managers to accommodate different types of activities, maintain diverse and high-quality recreation opportunities, and protect desired resource conditions. Zoning most often is used to restrict outdoor recreation activities from environmentally sensitive areas and to separate recreational groups in conflict. Furthermore, this concept also can be applied to temporal circumstances. Zoning also is used as a way to create different types of outdoor recreation opportunities.

As previously mentioned, zoning is frequently used as a tool to mitigate conflict between recreational groups. More specifically, zoning addresses conflict among recreationists that experience interpersonal conflict, that is, the negative consequences from the physical presence or behavior of an individual or a group. Zoning, on the other hand, is not effective when recreationists experience social value conflicts that occur between users with different beliefs and values, even when there is no contact between users (Vaske and others, 1995; Carothers and others, 2001; Jackson and Wong, 1982; Lindberg and others, 2001; Cline, 2004). In such situations, education efforts plus zoning may be a more appropriate management tool.

Overall, zoning is a direct management tactic that allows managers to control visitor behavior by designating specific activities to specific areas. Once visitors are within the specified area, visitors are often free to pursue their chosen recreational activity without further restrictions. Regulations that direct visitors to specific access points within an area tend to exert a great amount of control on visitor behavior.

Regulations and Restrictions

- Rules and regulations are commonly used recreation management practices, though their use can sometimes be controversial (Lucas, 1982, 1983). Common applications of rules and regulations in outdoor recreation include:
 - Group size limitations,
 - Assigned campsites and/or travel itineraries,
 - Area closures,
 - Length of stay limitations, and
 - Restrictions on, and/or prohibiting certain uses such as dog walking (Manning 1999).
- Regulations allow management to control the nature of visitor use by establishing specific standards that define what is and what is not appropriate. By enforcing these standards, regulations can specifically address the cause of visitor problems.

Whether regulatory or educational tactics are used, it is important that visitors understand how the unacceptable behavior leads to undesired impacts to resources or visitor experiences. As identified by Ross and Moeller (1974), visitors often are unaware of rules and regulations. In a study of visitor knowledge, campers on the Allegheny National Forest, Pennsylvania, were asked their knowledge of rules and regulations for the area. Researchers identified that only 48 percent of respondents answered six or more of the 10 questions correctly (Ross and Moeller, 1974).

When effectively interpreted, rules and regulations can help control undesired visitor behavior and impacts related to various facilities within an area. Given that rules and regulations are inherently direct and obtrusive, how managers choose to communicate a regulation to the public determines how subtle or obtrusive visitors will perceive it to be. When visitors believe that regulations are appropriate and necessary, they may have a subtle, negligible, or even a positive

effect upon visitor experience. More importantly, by protecting natural and wildlife resources, and ultimately the quality of visitors' experiences, regulations may actually maximize the visitors' experience. In a study that examined visitors' perceptions of regulations, Frost and McCool (1988) identified that visitors supported the closings of selected public use areas if the underlying reason is clear and justified. Cole and Ranz (1983) also noted that visitors are likely to obey regulation closings of selected backcountry campsites for ecological reasons.

Restrictions can be used to regulate or modify visitor use, behavior, equipment use, length-of-stay, group size, and even pets. When used in conjunction with geographical or temporal regulations, restrictions can "delineate the basics regarding the where, when, and what of visitor behavior" (Anderson and others, 1998). The benefit of restrictions that focus on "activity-based regulation" is that they can specifically address the source of the unacceptable impact to resources or visitor experiences (Anderson and others, 1998). Furthermore, when used in conjunction with other management tactics (e.g., education), they more effectively can address the causes of unacceptable impacts.

Activity- and equipment-based restrictions can be useful for mitigating interpersonal conflict between incompatible user groups (hikers vs. bicyclists). Activity-based restrictions modify visitor behavior by controlling the activities in which visitors engage. Like all regulations, activity-based restrictions are a potentially obtrusive management tactic. Regulations or restrictions of activities and equipment deemed incompatible with wildlife effectively could address wildlife disturbances.

Licensing

Licensing is a common activity-based regulation that can be used to impose merit or eligibility requirements, to restrict the rate or place of entry into a recreation area, to limit the kinds of activities permitted, and to specify when and where activities will take place (Stankey and Baden, 1977).

Environmental Education

Visitor education has often been cited as a preferred and more appropriate response to reduce resource impacts or improve visitor experiences (Manning, 1999; Roggenbuck, 1992). Visitor education, in this discussion, is defined more broadly than it is defined for refuges as one of the six priority public uses. Compared to regulations that directly restricts visitor freedoms and site management that can alter the natural setting, visitor education is considered a light-handed management response (Stankey and Schreyer, 1987). To provide additional insight into the effectiveness of visitor education programs, the most effective components of visitor education programs, as identified by the literature, are discussed below.

Redistributing Visitors

A number of studies have documented the effectiveness of education in redistributing visitors and reducing contact among recreation groups (Gilbert and others, 1972; Romesburg, 1974; Smith and Krutilla, 1974; Smith and Headly, 1975; Smith and Krutilla 1976; McCool and others, 1977; Peterson, 1977; deBrettencourt and others, 1978; Shechter and Lucas, 1978; Manning and Ciali, 1981; Peterson and deBettencourt, 1979; Peterson and Lime, 1980; Manning and Potter, 1982; Potter and Manning, 1984; Rowell, 1986; Van Wagtendonk and Colio, 1986; Wang and Manning, 1999; Manning, 1999). For example, Lucas (1981) evaluated the effectiveness that a brochure had in redistributing visitors to more lightly used wilderness campsites. The brochure was ineffective, which Lucas attributed to its limited distribution, narrow focus, and presentation late in

the decision process. He also speculated that visitors familiar with the area were less receptive to the information. In contrast, Roggenbuck and Berrier (1981, 1982) distributed brochures intended to direct visitors away from a congested wilderness camping area to more lightly used sites. A comparison between the behavior of visitors exposed to the brochure only versus those exposed to the brochure and a ranger revealed that both communication techniques were equally effective in altering visitor behavior. In Yellowstone National Park, Krumpe and Brown (1982) showed visitors a trail-selector information chart that described routes and destinations with different qualities. They found that descriptive information about the most heavily used sites helped redistribute visitors to lesser-used sites. With the exception of Lucas (1981), these studies found that visitor use could be effectively redistributed through information and that some information distribution methods were more effective than others. Based on later recreation ecology findings, managers concluded that the redistribution of visitors to more lightly used areas was not an appropriate management strategy for reducing resource impacts (Cole and Fichtler, 1983).

Knowledge Gain

A second category of studies focuses primarily on enhancing visitor knowledge through information and education programs. Most of these studies examine how knowledge reduces the potential ecological and social impacts caused by recreation (Manning, 1999). Fazio (1979) developed some of the first tests on the effectiveness of educational methods to improve visitor knowledge of low-impact camping techniques. Fazio studied this technique in Rocky Mountain National Park, Colorado, and in the Selway-Bitterroot Wilderness, Montana. In both studies he evaluated the effectiveness of brochures, trailhead signs, slide shows, television programs, and newspaper coverage in conveying low-impact messages to visitors. The results showed that personal contact from an agency representative was the most significant. Visitor-activated slide show presentations with sound and trailhead signs were also found to be effective methods. Brochures were shown to be less effective, while communication through the mass media (e.g., newspapers and television) was not effective at all.

Not all research has found information and educational programs to be as effective. A study on the effectiveness of interpretive programs at Great Smoky Mountains National Park found mixed results (Burde and others, 1988). This particular study showed no difference in knowledge about general backcountry policies among general backcountry visitors exposed to the park's interpretive services and those who were not exposed. It is important to note, however, that the visitors exposed to the park's interpretive services did score higher on knowledge of park-related hazards.

Behavioral Change Following Education

Johnson and Swearingen (1988) assessed the effectiveness of different trailside signs in deterring off-trail hiking in Mt. Rainier National Park. Researchers observed and recorded the number of visitors exposed to each sign and the number who hiked off-trail despite the signs' messages. The use of signs did deter the majority of off-trail hiking, but it was found that the use of different sign messages varied in their effectiveness. Signs with an ethical appeal to stay on the trail to preserve the meadow, signs with a humorous tone, and symbolic signs were found to be somewhat effective, while signs that threatened sanctions for noncompliance (e.g., fines) were most effective. Other messages representing higher moral appeal levels changed visitor behavior to a lesser degree. Martin (1992) compared the effects of three sign types and a brochure to discourage visitors from removing pumice from Mount St. Helens National Park. As with Johnson and

Swearingen's (1988) study, all four approaches effectively reduced pumice theft, but the sign that threatened sanctions for theft was the most effective.

Using the theory of moral reasoning and normative theories, Widner and Roggenbuck (1999) assessed the effectiveness of three educational interventions on the theft of petrified wood in Petrified Forest National Park. The interventions included an interpretive sign with multiple moral approaches that discouraged the theft of petrified wood, a visitor-signed pledge that stated the visitor would not take petrified wood, and a uniformed volunteer patrolling the site. Each of the three educational treatments significantly reduced wood theft. There were no significant differences between approaches, indicating that a good interpretive sign can be as effective as an on-site uniformed volunteer in reducing depreciative behavior.

Change in Resource Conditions Following Education

A study by Oliver and others (1985) gauged the efficacy of three educational methods in reducing tree damage and litter in a campground. The first approach was to distribute a brochure on low-impact camping practices, the second employed the brochure plus ranger contact, and the third used the brochure, the ranger, and a request to report any destructive acts observed by campers. All three educational treatments significantly reduced litter and tree damage, with the personal contact being more effective than the brochure alone. The personal contact combined with the request to report observed depreciative behavior was less effective than the simple ranger request to reduce littering and tree damage.

Messages and Delivery

Message content is a critical, yet obvious, variable of message effectiveness. Not surprising, messages that are considered useful and interesting have been found to be the most effective (Oliver and others, 1985). Oliver et al. concludes that consistency is critical to the effectiveness of the message. It also suggests that identifiable desirable and undesirable behaviors should be incorporated into the educational message (Gramann and Vander Stoep, 1986).

Audience awareness is another key element in effectively educating the public (Fazio, 1979; Gramann and Vander Stoep, 1986). Audience awareness allows an educator to target efforts to a specific group, regardless of the media used. Audience awareness also allows educators to better target less receptive audiences through creative messages and delivery methods, such as through peers or respected sources. By understanding the audience's needs, researchers and managers can prioritize specific content to ensure that the audience's concerns are effectively addressed.

The delivery method of educational messages also has been shown to influence the effectiveness of visitor education. Source credibility is a fundamental key to the success of any educational effort. Oliver and others (1985), and Roggenbuck and Berrier (1981), suggest that source reliability and validity are key to visitors' receptiveness to educational messages. Sending mixed messages can undermine source credibility. This finding implies that consistent messages based on defined objectives can help establish source credibility.

An important consideration for both message content and delivery is the application of theoretical approaches of persuasion, moral development, and planned behavior. Regardless of whether managers are aware of it, land management education efforts utilize these theoretical frameworks, and a greater understanding of the theoretical paradigms could help message content and delivery reach their full desired potential. Widner and Roggenbuck (1999) suggest that signs using multiple persuasive and moral techniques are more effective than those developed with no theoretical grounding. Vande Kamp and others (1994), recommend that a multifaceted approach be

used to reduce noncompliant behavior, a concept easily extended to low-impact education efforts (Douchette and Cole, 1993). Of course, the ability to apply different approaches is dependent upon available resources.

Input and Discussion with USFWS Field Personnel

Informal Survey of Refuge Managers and Biologists

In March 2004, the USFWS Northeast Region held a meeting of Refuge project leaders and biologists during which a panel on visitor-use impacts on wildlife was convened. Panel members were Kathy Zeamer, R5 visitor services chief; Tom Comish, Sunhaze Meadows National Wildlife Refuge (NWR) Manager; Deb Melvin, Parker River NWR biologist; and Natalie Sexton, USGS/Fort Collins Science Center natural resource social scientist. As part of that discussion, the panel conducted an informal survey of meeting participants to better understand wildlife disturbance issues on refuges in the Northeast Region. Below is a summary of the questions and general themes that emerged from the approximately 50 responses received.

First, attendees were asked, “What visitor activities at your refuge need further evaluation?” Some general themes emerged, including:

- The need for “baseline” information about visitors and activities; there is a sentiment that research should be ongoing and thorough in order to monitor uses and levels.
- Illegal and/or damaging activities; ORV use and horseback riding were specifically mentioned.
- Carrying capacity and seasonality of use – how much is too much? Are certain activities appropriate during all seasons? Are they appropriate during seasons when they are allowed?
- Motorboat use, including jet-skis. Are such activities appropriate? When, where and how much?
- Kayaking, canoeing – are such activities appropriate? When, where and how much?
- Use of pursuit dogs for waterfowl hunting and deer hunting.
- Effects of and appropriateness of usage levels of birdwatching and other wildlife observation.
- Trail use research and development.
- Beach-use effects on wildlife, especially on migratory shorebirds.
- Collection of live shellfish, collection of shells. Impact on shellfish population.
- Fishing – levels, when, where?
- Dog walking, jogging.

Attendees also were asked, “What species are being impacted? At what time of year?” The following were identified as being affected:

- Migratory shorebirds – all year, wintering, nesting, spring, summer and fall.
- Terns.
- Plovers, particularly piping plovers
- Bald eagles.
- Osprey.
- Waterfowl.
- Shellfish.
- Salt marsh and upland vegetation.
- Sharp-tailed sparrows.

When asked, “What do the managers, biologists, outdoor recreation planners, and others at your station need to effectively address this situation?” responses included:

- Personnel – in the form of technical expertise, more regular placement of outdoor recreation planners.
- More law enforcement personnel responsible for enforcing existing laws.
- Baseline information – assessments of impacts—What causes them – overuse? Inappropriate use?
- Literature search of studies already done – access to and partnership with state resources. Better access to state entities responsible for refuges management.
- Money. For staff, research on species impacts, funding to focus on disturbance problems.
- Information on survey techniques.
- A lot of specific research questions were asked, varied by location and species. All want resources to attempt to answer the research questions.

Finally, regarding, “What steps should come next? What ideas do you have for continuing this dialogue?” The following ideas were offered:

- The need for top-down guidance on what uses are appropriate and at what levels?
- Regional communication and cooperation, especially from refuges that have similar issues.
- The need to compile the concerns of refuges, perhaps developing multi-refuge studies. A site where information that has been collected can be easily obtained by other refuges or personnel. The possibility of including standardized methods that have been used with success before on that site. Access to and distribution of relevant literature/studies.
- Visitor studies to identify visitor needs and expectations regarding wildlife disturbance

Teleconference of Refuge Personnel

To gain a more in-depth perspective for this human dimensions review of wildlife disturbances, and, more importantly, management needs, natural resource professionals were invited to participate in a teleconference to discuss this topic. Participants included:

- Tom Comish, Refuge Manager, Sunhaze Meadows NWR, Maine.
- Ken Sturm, Refuge Biologist, Canaan Valley National Wildlife Refuge, West Virginia.
- Brian Glaspell, Social Scientist, Division of Conservation Planning and Policy, Anchorage, Alaska.
- Anita Delong, Consultant (Former FWS employee), Alta, Wyoming.
- Natalie Sexton, U.S. Geological Survey, Fort Collins, Colorado.
- Robert Cline, U.S. Geological Survey, Student Contractor, Fort Collins, Colorado.

One of the topics discussed was availability of resources (e.g., funds, data, and information). The general consensus of this topic was, “...monitoring public use takes away from other tasks.” More specifically, when discussing the need for baseline data, participants recognized the need for this information, but felt in many cases it was not feasible, give current financial, time, and personnel constraints. This concern was most significantly identified with the costs of biological research, which tends to be species specific, timely, and generally descriptive. Currently the most common method of determining impacts is by using the “best guess approach,” however, this is highly variable due to the diversity among refuges. While participants collectively identified that baseline data was difficult to gather, they also agreed that it was necessary to “tackle the problem” of wildlife disturbance.

Conclusions and Considerations

The National Wildlife Refuge System is responsible for protecting and preserving wildlife and wildlife habitat. They also have an obligation to provide compatible wildlife-dependent recreational opportunities as a second priority. As previously discussed, recreational impacts have the potential to directly disturb and displace wildlife, and indirectly impact wildlife habitat. Despite these impacts, wildlife-dependent recreation also provides visitors the opportunity to experience nature and recognize the value of wildlife. Not only are these experiences important for recreationists, they provide an opportunity to educate visitors about wildlife conservation and garner long-term support for these resources.

It has been said that wildlife management is 10 percent managing wildlife and 90 percent managing people (Fazio and Gilbert, 1986). Wildlife disturbance is a biological phenomenon that is defined by the physiological and behavioral response of wildlife. However, the solutions for managing wildlife disturbances lies in the understanding of wildlife response and human behavior.

Despite the vast amount of literature on the topic of wildlife disturbance, it was evident from this review that management solutions have not been adequately explored. This is not to say that wildlife disturbance research is not extensive. Research on wildlife disturbance includes countless studies on the causal relationship between recreation activities and wildlife impacts as identified by physiological and behavioral responses. While these studies provide insight for researchers and managers, they do not help identify the “who, what, and why” associated with wildlife disturbance. Human-dimensions research can help in understanding these relationships; empirical evidence is imperative. As a result of this review, it was evident that, to date, human-dimensions research has not been adequately used to examine wildlife disturbances. While this report presents research relevant to this topic, including theoretical concepts and relative frameworks, there is an obvious lack of knowledge and research on this subject.

Based on this literature review and PASA’s ongoing research in support of refuge CCP, the following considerations are offered.

Incorporating Human Dimensions in the Planning Process

As stated in the USFWS Goals and Objectives Handbook (Adamcik and others, 2004), goals and objectives “are the unifying elements of successful refuge management. They identify and focus management priorities, provide a context for resolving issues, guide specific projects, provide rationale for decisions, and offer a defensible link among management actions, refuge purpose(s), service policy, and the National Wildlife Refuge System (Refuge System) mission.” Traditionally, the setting of goals and objectives has been applied to wildlife and their habitats. However, the same concepts can be applied to the management of refuge visitor use. According to Vaske and others (2001), determining objectives, whether they address the management of a wildlife population or the management of visitors is a critical step in defining appropriate and acceptable environmental and social conditions. A theory-based scientific approach to wildlife management is most effective when it includes human dimensions.

Sharing Information on Human-Wildlife Disturbance

Attendees of the Northeast Region’s Manager/Biologist meeting expressed the need for a site where information on human-wildlife disturbance could be shared among refuge staff. In particular, the link could provide a place to communicate about ongoing efforts to address impacts and the effectiveness of those management strategies. Having an interactive site, such as the Fish and Wildlife Service Intranet (<http://intranet.fws/r9/refuges>), where information could be shared,

both from the region out to refuges, and among refuges, may provide important information that would not otherwise be shared.

Another site where information can be shared is the Montana Chapter of The Wildlife Society. They have compiled and reviewed over 1,300 scientific studies on the topic of wildlife disturbance. The website serves a searchable online bibliography and two summary reports.

Human-Dimensions Training for Refuge Personnel

Most refuge managers and, certainly, biologists, have an educational background in wildlife, fisheries, or biology. Most were stimulated to enter their profession because of their love of hunting and fishing or their interest in the outdoors, woods, wildlife, and the natural world. Very few have training in the social sciences (Brinson and Benson, 2002). As a result, they may be ill equipped when faced with these difficult human component issues.

Developing training for refuge professional about the concepts and application of human dimensions of natural resources management should be a consideration for USFWS. Once developed, this training could be given as a module of the existing refuge CCP training or stand-alone training that could be made available for those most needing it. One option may be online training similar to what has been developed jointly by U.S. Geological Survey (USGS) and USFWS for Habitat Management Planning (HMP) through Horizon Live. Over 150 people have taken this remote, interactive, web-based course from their own desk. It has been well received and provides cost savings in travel and time away from the office. In addition, the USFWS National Conservation Training Center is developing a new web-based system for training with the ability to offer live instruction and distance learning modules that could possibly be used for this type of training.

Consultation with Experts

Survey of Refuge Managers, Biologists, Planners, and Visitor Services Specialists

A formal survey of refuge personnel that would identify and evaluate the methods or frameworks being used to address wildlife disturbance problems would provide meaningful information to managers, biologists, planners, and visitor services specialists. Outcomes of this query could be a collection of case studies that could be served on a data-sharing site. Additionally, this survey could further identify research needs for addressing wildlife disturbance on refuges.

Human-wildlife Disturbance Workshops

A workshop or series of workshops addressing visitor use and wildlife disturbance would be an important step in identifying thresholds and developing associated standards and mitigation techniques for disturbance. These workshops could include USFWS planners, managers, biologists, and visitors services specialists, USGS personnel, university representatives, and other identified experts in the field of wildlife disturbance and visitor use. One purpose of the workshops would be to further assess the state-of-knowledge regarding the quality and usability of wildlife disturbance data related to visitor use. Specifically, can existing data answer questions regarding human/wildlife conflicts? A second purpose of the workshops could be to agree upon a discreet set of contemporary visitor uses on national wildlife refuges that are of concern to refuges and identify key species or groups of species that are recognized as being threatened by these activities. A third purpose of the workshops would be to identify two or three refuges in each region to use as future case studies where these issues have not been adequately addressed.

Application of Recreation Management Frameworks to Refuges

There is extensive literature on the effects of human recreation activities on wildlife (DeLong, 2002; DeLong and Adamcik, in press; Bennet and Zuelke, 1999; Field, 1995; Radle 1998; York, 1994). Though wildlife response to human disturbance has been heavily studied, research on thresholds and timing of public use activity is inconclusive, especially as it relates to wildlife on refuge lands. Most research related to recreation disturbance and visitor experience comes from the field of recreation ecology and resource protection. These relate to frameworks developed for National Park Service and U.S. Department of Agriculture Forest Service lands that use indicators and standards to measure limits of acceptable change, visitor experience, and resource protection (VERP; Hof and Lime, 1997; Manning, 1996). These frameworks have especially been applied in the area of wilderness management. They have two main components: description (objective data on number of visitors) and evaluation (subjective data on how much impact is acceptable). The gap between impact to the resource and amount of visitor use is defined through measuring indicators and standards. Indicators are simply measurable and objective variables of change. Standards are the minimum acceptable condition. Indicators and standards are based on management objectives and become the proxies for those objectives. They are developed through literature synthesis, review of past research, consultation with the public, and management judgment. However, these frameworks have not been applied specifically to wildlife disturbance on refuge lands. Because the indicators and standards are management driven there is flexibility in the emphasis placed on wildlife conservation versus visitor experience. Though probable, it is uncertain if these frameworks can be applied to the refuge system. Research is needed to determine the obstacles and opportunities to application of indicators and standards to refuges.

Possible methods of determining indicators and standards include surveying visitors with visual approaches such as the use of digitally manipulated photographs to measure the extent of wildlife disturbance that is acceptable at any one time in a given space. Methods also include associated questions covering a range of normative standards from more restrictive “preference” questions (how likely are visitors to tolerate change, or what are visitors’ type, period of use, or scope of activity) to less restrictive “tolerance” questions (identifying restrictions that would be so unacceptable that visitors would not return to the refuge). Also involved would be questions regarding visitors’ knowledge of impacts they may be inflicting and tradeoffs they would be willing to make in order to minimize impacts. Tradeoffs would represent social, ecological, and managerial dimensions of the visitor experience. The outcome of this task would be a framework that could be tested on identified case-study refuges.

Continued Baseline Research on Refuge Visitor Experience, Attitudes and Preferences

USFWS CCP goals and objectives have focused largely on habitat and wildlife management. Increasingly, however, refuges are including visitor services goals and objectives in their CCP to ensure that visitor appreciation and support for fish and wildlife conservation is a part of the refuge’s long-term plan.

Regardless of specific CCP goals and objectives, the National Environmental Policy Act (NEPA; Public Law 91-190:852-859.42, U.S.C. and as Amended (P.L. 94-52 and P.L. 94-83) 42 U.S.C. 4321-4347) mandates that the CCP for each refuge must contain an analysis of social and economic conditions (the affected environment), and evaluate social and economic results from likely management scenarios. In addition, public review and comment on alternatives for future management is required. There are many reasons to obtain public input, besides legal mandates. It can provide managers with a better understanding of public acceptability of alternatives/future

changes that may be proposed in the CCP. This public participation process also facilitates the engagement of a variety of stakeholders in the refuge planning process.

Collecting this information can also provide much-needed baseline data on public/visitor use, experience, preferences, and expectations. In the CCP process, the public meeting is the forum typically used to collect citizen input. This is especially problematic for visitors to a refuge. Attendance at public meetings is often inconvenient or impossible for occasional visitors to refuges who frequently live long distances from the relevant USFWS offices. In addition, those visitors who most often attend meetings of this type may represent a vocal minority group that is usually not representative of the full range of visitors to a given refuge. Also, there is a limit in the type of scientific baseline data that can be collected through this forum.

Another tool that can be used to collect baseline information and input is a visitor, community, or stakeholder survey. Conducting a survey is one way that the CCP planning team can reach out to the public and collect baseline data in support of their CCP. It is an effective supplement to a public meeting when detailed information on visitors or stakeholders is needed. Survey research applied to refuge planning can help managers characterize current visitor services and experiences. It also can help managers understand how current and proposed management activities affect individuals in terms of their preference for services and experiences and potential changes in visitation patterns. Economic analyses provide a means to estimate how current management (no action alternative) and proposed management activities (alternatives) affect the local economy. This type of analysis provides two critical pieces of information: 1) it illustrates a refuge's contribution to the local community; and 2) it can help determine whether local economic effects are or are not a real concern in choosing among management alternatives.

The PASA Program at the USGS Fort Collins Science Center has been working closely with USFWS headquarters, regional offices, and refuges for the past four years in identifying and conducting research in support of CCP planning. Through successful cooperation and collaboration with USFWS personnel at all levels, a streamlined process has been developed as well as surveying tools and techniques to effectively collect this needed baseline socioeconomic data.

Based on communications and feedback from different levels and regions of USFWS, collection of this type of baseline data is important and valuable to the planning process.

Streamlined Approval Process for Surveying Refuge Visitors

Any information that is collected from the public by a federal agency must comply with the Paperwork Reduction Act (PRA). Such information includes data collected by visitor surveys or other collection methods conducted, funded, or sponsored by the government. The Office of Management and Budget (OMB) provides oversight of compliance with PRA, which is applicable to federally supported social surveys whenever identical questions are asked of 10 or more people. The PRA is intended to reduce the paperwork burden the government places on the public as well as minimizing costs of information collection and assuring the information collected has practical utility and meets the specific needs of the agency. The standard OMB approval process for information collection efforts takes a minimum of six to eight months to complete, with two required public review notices published in the Federal Register. While necessary to comply with PRA, the length of time for approval of information collection efforts can make it difficult to collect information on a timeline that meets CCP efforts for USFWS refuges.

The creation of an expedited or programmatic clearance process for OMB approval of visitor, community, and stakeholder information collections related to CCP efforts would minimize the length of time and difficulty involved in obtaining that approval.

The National Park Service has had such an expedited approval process in place for surveys of park visitors, potential visitors, and residents of local communities for the past few years. This program has received positive support from OMB and Department of Interior (DOI) and was recently re-approved by OMB.

An initial meeting was held with USFWS to discuss the potential for such an OMB clearance. Meeting participants included:

- D. Bieniewicz, DOI Information Collection Coordinator;
- B. Forist, Senior Research Associate, National Park Service Partner, Social Science Program;
- D. Fulton, facilitator;
- B. Glaspell, Social Scientist, USFWS Division of Conservation Planning and Policy;
- H. Grey, Division of Policy and Directives Management, USFWS;
- J. Schomaker, phone;
- R. Schultz, Chief, Division of Conservation Planning and Policy;
- N. Sexton, Natural Resource Social Scientist, USGS/Fort Collins Science Center; and
- S. Stewart, Natural Resource Social Scientist, USGS/Fort Collins Science Center.

Meeting participants agreed that the demand for social data collection will likely increase as the number of CCPs increases over the next several years. Given the likely demand and the similar data that will be targeted for collection in these efforts, all agreed that a programmatic or expedited approval process was warranted and would lead to a savings in time, personnel effort, and monetary funds. Bieniewicz clearly expressed his support of an expedited process especially if the number of collection efforts associated with CCPs substantially increases in the near future. All were in agreement that such an increase in demand for social data collection is very likely to occur.

Identified next steps were to develop options for administering a USFWS expedited clearance and to meet with others in the agency to ensure internal support for such a program.

References Cited

- Adamcik, R.S., Bellantoni, E.S., DeLong Jr., D.C., Schomaker, J.H., Hamilton, D.B., Laubhan, M.K., and Schroeder, R.L., 2004, Writing refuge management goals and objectives—A handbook: U.S. Fish and Wildlife Service, National Wildlife Refuge System.
- Adelman, B.J., Heberlein, T.A., and Bonnicksen, T.M., 1982, Social psychological explanations for the persistence of a conflict between paddling canoeists and motor craft users in the Boundary Waters Canoe Area: *Leisure Sciences*, v. 5, p. 45–62.
- Ajzen, I., 1991, The theory of planned behavior: *Organizational Behavior and Human Decision Processes*, v. 50, p. 179–211.
- Ajzen, I., and Fishbein, M., 1980, *Understanding attitudes and predicting social behavior*: Englewood Cliffs, N.J., Prentice-Hall, 278 p.
- Alcock, J., 1993, *Animal behavior—An evolutionary approach* (5th ed.): Sunderland, Mass., Sinauer Association, 625 p.
- Allredge, R., 1973, Some capacity theory for parks and recreation areas: *Trends*, v. 10, p. 20–29.
- Anderson, D.H., Lime, D.W., and Wang, T.L., 1998, Maintaining the quality of park resources and visitor experiences—A handbook for managers: St. Paul, University of Minnesota Extension Tourism Center, TC-777, 149 p.
- Anderson, S.H., and Gutzwiller, K.J., 1996, Habitat evaluation methods *in* *Research and management techniques for wildlife and habitats*: Bethesda, Md., The Wildlife Society, p. 592–606, 740 p.
- Basman, C., Manfredo, M., Barro, S., Vaske, J., and Watson, A., 1996, Norm accessibility—An exploratory study of back and front-country recreational norms: *Leisure Sciences*, v. 18, p.177–191.
- Bartelt, G.A., 1987, Effects of disturbance and hunting on the behavior of Canada goose family groups in east central Wisconsin: *Journal of Wildlife Management*, v. 51, p. 517–522.
- Bartmann, R.M., White, G.C., and Carpenter, L.H., 1992, Compensatory mortality in a Colorado mule deer population: *Wildlife Monograph*, p. 121.
- Bélanger, L., and Bédard, J., 1995, Hunting and waterfowl *in* *Wildlife and recreationists—Coexistence through management and research*: Washington, D.C., Island Press, p. 243–256, 372 p.
- Bell, D.V., and Austin, L.W., 1985, The game-fishing season and its effects on overwintering wildfowl: *Biological Conservation*, v. 33, p. 65–80.
- Berm, D.J., 1970, Beliefs, attitudes, and human affairs: Belmont, Calif., Brooks, Cole.
- Bouffard, S.H., 1982, Wildlife values versus human recreation—Ruby Lake National Wildlife Refuge: *North American Wildlife Conference*, v. 47, p. 553–556.
- Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: *Wildlife Society Bulletin*, v. 13, p. 110–116.
- Brattstrom, B.H., and Bondello, M.C., 1983, Effects of off-road vehicle noise on desert vertebrates *in* *Environmental effects of off-road vehicles—Impacts and management in arid regions*: N.Y., Springer-Verlag, p. 167–206.
- Braun, C.E., Harmon, K.W., Jackson, J.A., and Littlefield, C.D., 1978, Management of National Wildlife Refuges in the United States—Its impacts on birds: *Wilson Bulletin*, v. 90, p. 309–321.
- Bright, A.D., 1998, Evaluation of the bear viewing program at McNeil River State Game Sanctuary: Applicant perceptions of the current and proposed permit systems, Report I for the Alaska Department of Fish and Game, Wildlife Conservation Division.
- Bright, A., and Manfredo, M., 1995, Moderating effects of personal importance on the accessibility of attitudes toward recreation participation: *Leisure Sciences*, v. 17, p. 281–94.
- Bright, A., Manfredo, M., Fishbein, M., and Bath, A., 1993, Application of the theory of learned action to the National Park Service controlled burn policy: *Journal of Leisure Research*, v. 25, p. 263–80.
- Brinson, A.A., and Benson, D.E., 2002, Values and attitudes of National Wildlife Refuge managers and biologists—Report to respondents: U.S. Geological Survey Open-File Report 02-459, 19 p.

- Burby, R.J., 2003, Making plans that matter—Citizen involvement and government action: *Journal of the American Planning Association*, v. 69, no. 1, p. 33–49.
- Burde, J., Peine, J., Renfro, J., and Curran, K., 1988, Communicating with park visitors—Some successes and failures at Great Smokey Mountains National Park: 1988 Research Monograph, Association of Interpretive Naturalists, p. 7–12.
- Burger, J., 1995, Beach recreation and nesting birds *in* *Wildlife and recreationists—Coexistence through management and research*: Washington, D.C., Island Press, p. 281–295, 372 p.
- Burger, J., 1999, Shorebird squeeze: The pressures of public recreation on waterbird populations: Fort Myers, Fla., 1999 Watchable Wildlife Conference, Abstract available from the Florida Fish and Wildlife Conservation Commission.
- Bury, R., 1976, Recreation carrying capacity—Hypothesis or reality?: *Parks and Recreation*, v. 11, no. 23–25, p. 56–58.
- Carothers, P., Vaske, J.J., and Donnelly, M.P., 2001, Social values versus interpersonal conflict among hikers and mountain bikers: *Leisure Sciences*, v. 23, p. 47–61.
- Chilman, K., Ladley, J., and Wilke, T., 1989, Refining existing recreational carrying capacity process—Recent refinements: St. Paul, Minnesota, Managing America’s enduring wilderness resource, Minn. Agricultural Experiment Station, p. 163–269.
- Christensen, H., and Dustin, D., 1989, Reaching recreationists at different levels of moral development: *Journal of Park and Recreation Administration*, v. 7, p. 72–80.
- Cialdini, R.B., Kallgren, C.A., and Reno, R.R., 1991, A focus theory of normative conduct—A theoretical refinement and reevaluation of the role of norms in human behavior: *Advances in Experimental Social Psychology*, v. 24, p. 201–234.
- Claar, J.J., Anderson, N., Boyd, D., Cherry, M., Conard, B., Hompesch, R., Miller, S., Olson, G., Ihsle Pac, H., Waller, J., Wittinger, T., and Youmans, H., 1999, Carnivores *in* *Effects of recreation on Rocky Mountain wildlife—A review for Montana*, Committee on Effects of Recreation on Wildlife: Montana Chapter of The Wildlife Society, p. 7.1–7.63, 307 p.
- Cline, R.C., 2004, Interpersonal and social value conflict between cross-country skiers and snowmobilers: Unpublished master’s thesis, Colorado State University.
- Cole, D.N., 1987, Research on soil and vegetation in wilderness—A state-of-knowledge review *in* *Proceedings—National Wilderness Research Conference—Issues, state-of-knowledge, and future directions*: Fort Collins, Colo., July 23–26, 1985, General Technical Report INT-20, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, p. 135–177
- Cole, D.N., 1994, Backcountry impact management—Lessons from research: *Trends*, v. 31, no. 3, p. 10–14.
- Cole, D.N., 1995, Disturbance of natural vegetation by camping: Experimental applications of low-level stress: *Environmental Management*, v. 19, p. 405–416.
- Cole, D.N., 2004, Environmental Impacts of outdoor recreation in wildlands: Fort Collins, Colo., International Association for Society and Natural Resources, 10th Anniversary ISSRM Book, v. 10, p. 107–116.
- Cole, D.N., and Fichtler, R.K., 1983, Campsite impacts on three western wilderness areas: *Environmental Management*, v. 7, p. 275–288.
- Cole, D.N., and Knight, R.L., 1990, Impacts of recreationists on biodiversity of wilderness areas: Logan, Utah, Proc. of Wilderness Areas: Their Impact Symposium, Utah State University.
- Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreation on wildlife *in* *Wildlife and recreationists—Coexistence through management and research*: Washington, D.C., Island Press, p. 183–201, 372 p.
- Cole, D.N., and Ranz, B., 1983, Temporary campsite closure in the Selway-Bitterroot Wilderness: *Journal of Forestry*, v. 81, p. 729–732.

- Cronan, J.M., 1957, Food and feeding habits of the scaups in Connecticut waters: *Auk*, v. 7, no. 4, p. 459–468. Knight, R.L., and D.N., Cole, 1991, Effects of recreational activity on wildlife in wildlands *in* Transactions of the North American Wildlife and Natural Resources Conference, v. 56, p. 238–247.
- Dasmann, R.F., 1964, *Wildlife Biology*: N.Y., John Wiley and Sons: Wildlife Biology.
- deBettencourt, J., Peterson, G., and Wang, P., 1978, Managing wilderness travel—A Markov-based linear programming model: *Environment and Planning*, v. 10, p. 71–79.
- Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management, Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.
- Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1992, Barrier beach impact management planning—Findings from three locations in Massachusetts: *Canadian Water Resources Association Journal*, v. 17, no. 3, p. 278–290.
- Decker, D.J., Brown, T.L., and Siemer, W.F., 2001, Evolution of people-wildlife relations *in* Human dimensions of wildlife management in North America: Bethesda, Md., The Wildlife Society, p. 3–22.
- DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.
- DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures *in* Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2: Portland, Oreg., prepared for Stillwater National Wildlife Refuge, U.S. Department of the Interior, Fish and Wildlife Service, Region 1, Appendix L, 114 p.
- Donnelly, M.P., Vaske, J.J., Whittaker, D., and Shelby, B., 2000, Toward an understanding of norm prevalence—A comparative analysis: *Environmental Management*, v. 25, p. 403–414.
- Dorrance, M.J., Savage, P.J., and Huff, D.E., 1975, Effects of snowmobiles on white-tailed deer, *Journal of Wildlife Management*, vol. 39, no. 3, p. 563–569.
- Doucette, J., and Cole, D., 1993, Wilderness visitor education—Information about alternative techniques: U.S. Department of Agriculture, Forest Service, General Technical Report, INT-295.
- Eckstein, R.G., O'Brien, T.F., Rongstad, O.J., and Bollinger, J.G., 1979, Snowmobile effects on movements of white-tailed deer—A case-study: *Environmental Conservation*, v. 6, no.1, p. 45–51.
- Eibl-Eibesfeldt, I., 1970, *Ethology*: N.Y., Holt; Rinehart, and Winston: The Biology of Behavior, 530 p.
- Fancy, S.G., and White, R.G., 1985, Energy expenditures by caribou while cratering in snow: *Journal of Wildlife Management*, v. 49, no. 4, p. 987–993.
- Fancy, S.G., and White, R.G., 1986, Predicting energy expenditures for activities of caribou from heart rates: *Rangifer*, Special Issue no. 1, p. 123–130.
- Fazio, J.R., 1979, Communicating with the wilderness user: University of Idaho, College of Forestry, Wildlife and Range Experiment Station, Bulletin No. 28.
- Fazio, J.R., and D.L. Gilbert, 1986, *Public Relations and Communications for Natural Resource Managers*, Dubuque, IO: Kendall Hunt Publishing, 399 p.
- Fishbein, M., and Ajzen, I., 1975, Belief, attitude, intention and behavior—An introduction to theory and research: Reading, Mass., Addison-Wesley Publishing Company, 578 p.
- Freddy, D.J., Whitcomb, B.M., and Fowler, M.C., 1986, Responses of mule deer to disturbance by persons afoot and snowmobiles: *Wildlife Society Bulletin*, v. 14, no. 1, p. 63–68.
- Frissell, S., and Stankey, G.H., 1972, Wilderness environmental quality—Search for social and ecological harmony: Hot Springs, Ark., Proceedings of the Society of American Foresters Annual Conference, Society of American Foresters, p. 170–83.
- Frost, J., and McCool, S., 1988, Can visitor regulation enhance recreational experiences?: *Environmental Management*, v. 12, p. 5–9.
- Fulton, D.C., Manfredo, M.J., and Lipscomb, J., 1996, Wildlife value orientations—A conceptual and measurement approach: *Human Dimensions of Wildlife*, v. 1, p. 24–47.

- Fulton, D.C., Manfredo, M.J., and Sikorowski, L., 1993, Summary of project report: Coloradoans' recreational uses of and attitudes toward wildlife: Fort Collins, Colorado State University, Summary Project Report no. 6, Project Report for the Colorado Division of Wildlife, Human Dimensions in Natural Resources Unit, 11 p.
- Gabrielsen, G.W., and Smith, E.N., 1995, Physiological responses of wildlife to disturbance *in* Wildlife and recreationists—Coexistence through management and research: Washington, D.C., Island Press, p. 95–107, 372 p.
- Gilbert, G., Peterson, G., and Lime, D., 1972, Towards a model of travel behavior in the Boundary Waters canoe area: *Environment and Behavior*, v. 4, p. 131–57.
- Gill, J.A., Sutherland, W.J., and Watkinson, A.R., 1996, A method to quantify the effects of human disturbance on animal populations: *Journal of Applied Ecology*, v. 33, p. 786–792.
- Gilligan, C., 1982, *In a different voice*: Cambridge, Massachusetts, Harvard University Press.
- Graefe, A.R., Kuss, F.R., and Vaske, J.J., 1990, Visitor impact management—The planning framework: Washington, D.C., National Parks and Conservation Association, v. 2.
- Gramann, J.H., and Vander Stoep, G.A., 1986, Reducing depreciative behavior at Shiloh National Military Park: Shiloh National Military Park, U.S. Department of Interior, National Park Service.
- Hammit, W., and Cole, D.N., 1998, *Wildland Recreation*: N.Y., John Wiley, Ecology and Management.
- Havlick, David G., 2002, *No place distance—Roads and motorized recreation on America's public lands*: Washington, D.C., Island Press, 297 p.
- Haysmith, L., and Hunt, J.D., 1995, Nature tourism—Impacts and management *in* Wildlife and Recreationists—Coexistence through management and research: Washington, D.C., Island Press, p. 203–219, 372 p.
- Heywood, J., 1985, Large recreation groups and party size limits: *Journal of Parks and Recreation Administration*, v. 3, no. 2, p. 36–44.
- Hickman, G.R., Dixon, B.G., and Corn, J., 1999, Small mammals *in* Effects of recreation on Rocky Mountain wildlife—A review for Montana: Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, p. 4.1–4.16.
- Hof, M., and Lime, D.W., 1997, Visitor experience and resource protection framework in the National Park System—Rationale, current status, and future direction *in* Proceedings: Limits of acceptable change and related planning processes—Progress and future change and related planning processes, progress and future directions: University of Montana, May 20–22, 1997: General Technical Report, INT-GTR-371, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, p. 29–33.
- Hosier, P.E., and Eaton, T.E., 1980, The impact of vehicles on dune and grassland vegetation on a southeastern North Carolina barrier beach: *Journal of Applied Ecology*, v. 17, p. 173–182.
- Hultsman, J., Cottrell, S., and Hultsman, W.W., 1987, *Planning parks for people*: State College, Pa., Venture Publishing.
- Jacob, G.R., and Schreyer, R., 1980, Conflict in outdoor recreation—A theoretical perspective: *Journal of Leisure Research*, v. 12, p. 368–380.
- Jackson, E.L., and Wong, R., 1982, Perceived conflict between urban cross-country skiers and snowmobilers in Alberta: *Journal of Leisure Research*, v. 14, p. 47–62.
- Johnson, D.R., and Swearingen, T.C., 1988, The effectiveness of selected trailside sign texts in deterring off-trail hiking *in* Vandalism—Research, prevention and social policy: Paradise Meadows, Mount Rainier National Park, Wash., U.S. Department of Agriculture, Forest Service, General Technical Report PNW-GTR-293, p. 103–119.
- Johnson, D.R., and Vande Kamp, M.E., 1996, Extent and control of resource damage due to noncompliant visitor behavior—A case study from the U.S. national parks: *Natural Areas Journal*, v. 16, no. 2, p. 134–41.
- Johnson, R.E., 1964, *Fish and fowl in Waterfowl tomorrow*: Washington, D.C., U.S. Department of the Interior, Fish and Wildlife Service, p. 453–458.

- Joslin, G., and Youmans, H., coordinators, 1999, Effects of recreation on Rocky Mountain wildlife—A review for Montana: Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, 307 p.
- King, M.M., and Workman, G.W., 1986, Response of desert bighorn sheep to human harassment—Management implications: Transactions of the North American Wildlife and Natural Resources Conference, v. 51, p. 74–85.
- Klein, M.L., 1993, Waterbird behavioral responses to human disturbances: Wildlife Society Bulletin, v. 21, p. 31–39.
- Knight, R.L., and Cole, D.N., 1991, Effects of recreational activity on wildlife in wildlands *in* Transactions of the North American Wildlife and Natural Resources Conference: v. 56, p. 238–247.
- Knight, R.L., and Cole, D.N., 1995, Wildlife responses to recreationists *in* Wildlife and recreationists—Coexistence through management and research: Washington, D.C., Island Press, p. 71–79, 372 p.
- Knight, R.L., and Temple, S.A., 1995, Origin of wildlife responses to recreationists *in* Wildlife and recreationists—Coexistence through management and research: Washington, D.C., Island Press, p. 81–91.
- Knopp, T.B., and Tyger, J.D., 1973, A study of conflict in recreational land use—Snowmobiling versus ski touring: Journal of Leisure Research, v. 5, p. 6–17.
- Kockelman, W.J., 1983, Introduction *in* Environmental effects of off-road vehicles—Impacts and management in arid regions: N.Y., Springer-Verlag, p. 1–11.
- Kohlberg, L., 1976, Moral development and behavior—Theory, research and social issues: N.Y., Holt, Rinehart and Winston.
- Kolbe, C.M., and Luedke, M.W., 1993, A guide to freshwater ecology: Austin, Texas Natural Resource Conservation Commission, 138 p.
- Krumpe, E.E., and Brown, P.J., 1982, Redistributing backcountry use through information related to recreation experiences: Journal of Forestry, v. 80, p. 360–364.
- Lacey, C.A., Lacey, J.R., Fay, P.K., Storey, J.M., and Zamora, D.L., 1997, Controlling knapweed on Montana rangeland: Bozeman, Montana State University Extension Service, Circular 311.
- Lindberg, K., Denstadli, J.M., Fredman, P., Heldt, T., and Vuorio, T., 2001, Skiers and snowboarders in Södra Jämtlandsfjälle—Are there recreation conflicts?: Queensland, Australia, Technical Report, Gold Coast, Griffith University.
- Lime, D.W., 1975, Backcountry river recreation—Problems and opportunities: Naturalist, v. 26, p. 1–6.
- Lime, D., 1995, Principles of carrying capacity for parks and outdoor recreation areas—Acta Environmentalica Universitatis Comemiane, v. 4, p. 21–29.
- Lime, D., and Stankey, G.H., 1971, Carrying capacity—Maintaining outdoor recreation quality: Recreation Symposium Proceedings, U.S. Department of Agriculture, Forest Service, p. 174–184.
- Lucas, R.C., 1964a, The recreational capacity of the Quetico-Superior Area, Research Paper LS-15: St. Paul, Minn., U.S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station.
- Lucas, R.C., 1964b, Wilderness perception and use—The example of the Boundary Waters canoe area: Natural Resources Journal, v. 3, p. 394–411.
- Lucas, R.C., 1981, Redistributing wilderness use through information supplied to visitors: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Research Paper INT-277.
- Mace, R.D., Waller, J.S., Manley, T.L., Ake, K., and Wittinger, W.T., 1999, Landscape evaluation for grizzly bear habitat in western Montana, Conservation Biology, v. 13, no. 2, p. 367–377.
- Madsen, J., 1985, Impact of disturbance on field utilization of pink-footed geese in West Jutland, Denmark: Biological Conservation, v. 33, p. 53–63.
- Magill, A., 1988, Natural resource professionals—The reluctant public servants: The Environmental Professional, v. 10, p. 295–303.
- Manfredo, M.J. (ed.), 1992, Influencing human behavior—Theory and applications in recreation tourism, and natural resource management: Champaign, Ill., Sagamore Publishing, Inc.

- Manfredo, M.J., and Bright, A.D., 1991, A model for assessing the effects of communication on recreationists: *Journal of Leisure Research*, v. 23, no. 1, p. 1–20.
- Manfredo, M.J., Driver, B.L., and M.A. Tarrant, M.A., 1996, Measuring leisure motivation—A meta-analysis of the recreation experience preference scales: *Journal of Leisure Research*, v. 28, p. 188–213.
- Manfredo, M.J., Vaske, J.J., and Decker D.J., 1995, Human dimensions of wildlife management: Basic concepts *in* *Wildlife and recreationists—Coexistence through management and research*: Washington, D.C., Island Press, p. 17–31.
- Manfredo, M.J., Vaske, J.J., and Sikorowski, L., 1996, Human dimensions of wildlife management *in* *Natural resource management—The human dimension*: Boulder, Colo., Westview Press, p. 53–72.
- Manning, Robert E., 1999, *Studies in outdoor recreation—Search and research for satisfaction*: Corvallis, Oregon State University Press, 374 p.
- Manning, R., and Lime, D., 1996, Crowding and carrying capacity in the national park system—Toward a social science research agenda—Crowding and congestion in the national park system—Guidelines for management and research: St. Paul, University of Minnesota Agriculture Experiment Station, v. 86, p. 27–67.
- Manning, R., and Ciali, C., 1981, Recreation and river type—Social-environmental relationships: *Environmental Management*, v. 5, p. 109–120.
- Manning, R., Lime, D., Freimund, W., and Pitt, D., 1996, Crowding norms of front country sites—A visual approach to setting standards of quality: *Leisure Sciences*, v. 18, p. 39–59.
- Manning, R., and Potter, F., 1982, Wilderness encounters of the third kind—Proceedings of the Third Annual Conference of the Wilderness Psychology Group: Morgantown, West Virginia University, p. 1–14.
- Marion, J., Roggenbuck, J., and Manning, R.E., 1993, Problems and practices in backcountry recreation management—A survey of National Park Service managers: Denver, Colo., U.S. National Park Service, Natural Resources Report NPS/NRVT/NRR-93112.
- Martin, D.C., 1992, The effect of three signs and a brochure on visitor’s removal of pumice at Mount St. Helens *in* *Vandalism—Research, prevention, and social policy*: Portland, Oregon, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-293, p. 121–31.
- Mathews, G.V.T., 1982, The control of recreational disturbance in managing wetlands and their birds—A manual of wetland and waterfowl management: Proceedings 3rd Technical Meeting on Western Palearctic Migratory Bird Management, October 12–15, 1982, Federal Republic of Germany, Biologische Station Rieselfelder Münster, p. 325–330.
- Matt, C., and Aumiller, L., 2002, A win-win situation—Managing to protect brown bears yields high wildlife-viewer satisfaction at McNeil River State Game Sanctuary *in* *Wildlife viewing—A management handbook*: Corvallis, Oregon State University Press, p. 351–363.
- McCool, S.F., and Christensen, N.A., 1996, Alleviating congestion in parks and recreation areas through direct management of visitor behavior *in* *Crowding and congestion in the National Park System, Guidelines for management and research*: St. Paul, Minn., Department of Forest Resources and Minnesota Agricultural Experiment Station, University of Minnesota, MAES Misc. Pub. 86–100, p. 67–83.
- McCool, S.F., and Cole, D.N., (compilers), 1997, Proceedings—Limits of acceptable change and related planning processes—Progress and future directions, May 20–22, 1997: Odgen, Utah, University of Montana, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-GTR-371,
- McCool, S.F., 1977, Perspectives on managing the off-road recreation vehicle: *Western Wildlands*, v. 4, no. 2, p. 26–31.
- McLaren, M.A., and Green, J.E., 1985, The reactions of muskoxen to snowmobile harassment: *Arctic*, v. 38, no. 3, p. 188–193.

- Morton, J.M., 1995, Management of human disturbance and its effects on waterfowl *in* Waterfowl habitat restoration, enhancement and management in the Atlantic Flyway (3d ed.): Dover, Del., Environmental Management Committee, Atlantic Flyway Council Technical Section, and Delaware Division of Fish and Wildlife, p. F59–F86,
- Morton, J.M., 1996, Effects of human disturbance on the behavior and energetics of nonbreeding sanderlings: Blacksburg, Virginia Polytechnic and State University [Dissertation].
- Morton, J.M., Kirkpatrick, R.L., Vaughan, M.R., and Stauffer, D.F., 1989b, Habitat use and movements of American black ducks in winter: *Journal of Wildlife Management*, v. 53, p. 390–400.
- Nielsen, J.M., and Shelby, B., 1977, River running in the Grand Canyon—How much and what kind of use *in* Proceedings—River Recreation Management and Research Symposium: St. Paul, Minn., U.S. Department of Agriculture, Forest Service, General Technical Report NC-28, p. 168–177.
- Oliver, S.S., Roggenbuck, J.W., and Watson, A.E., 1985, Education to reduce impacts in forest campgrounds: *Journal of Forestry*, v. 83, no. 4, p. 234–236.
- Olson, T., and Gilbert, B., 1994, Variable impacts of people on brown bear use of an Alaskan river: *International Conference on Bear Research and Management*, v. 9, p. 97–106.
- Owens, N.W., 1977, Responses of wintering Brent geese to human disturbance: *Wildfowl*, v. 28, p. 5–14.
- Peterson, G.E., 1977, Recreation preferences of urban teenagers—The influence of cultural and environmental attributes *in* Children, nature, and the urban environment—Proceedings of a Symposium Fair, U.S. Department of Agriculture, Forest Service, General Technical Report NE-30, p. 113–121.
- Peterson, G., and deBettencourt, J., 1979, Flow metering of wilderness travel in the Quetico-Superior—New findings and research needs: *Modeling and Simulation*, v. 10, p. 1335–1340.
- Peterson, G., and Lime, D., 1980, Recreation policy analysis in wilderness management—A case study of the Quetico-Superior—Proceedings of the Third Annual Applied Geography Conference, Kent, Ohio, Kent State University, p. 4–13.
- Pomerantz, G.A., Decker, D.J., Goff, G.R., and Purdy, K.G., 1988, Assessing impact of recreation on wildlife—A classification scheme: *Wildlife Society Bulletin*, v. 16, p. 58–62.
- Potter, F., and Manning, R.E., 1984, Application of the wilderness travel simulation model of the Appalachian Trail in Vermont: *Environmental Management*, v. 8, p. 543–550.
- Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges: Fort Collins, Colo., U.S. Department of the Interior, Fish and Wildlife Service, Office of Information Transfer, 57 p.
- Raveling, D.G., 1979, The annual cycle of body composition of Canada geese with special reference to control of reproduction: *Auk*, v. 96, p. 234–252.
- Richens, V.B., and Lavinge, G.R., 1978, Response of white-tailed deer to snowmobiles and snowmobile trails in Maine: *Canadian Field-Naturalist*, v. 92, no. 4, p. 334–344.
- Rodgers Jr., J.A., and Smith, H.T., 1995, Set-back distances to protect nesting bird colonies from human disturbance in Florida: *Conservation Biology*, v. 9, p. 89–99.
- Rodgers Jr., J.A., and Smith, H.T., 1997, Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida: *Wildlife Society Bulletin*, v. 25, no. 1, p. 139–145.
- Roggenbuck, J.W., 1992, Use of persuasion to reduce resource impacts and visitor conflicts *in* Influencing human behavior—Theory and applications on recreation, tourism, and natural resources management: Champaign, Ill., Sagamore Publishing Inc., p. 149–208.
- Roggenbuck, J.W., and Berrier, D.L., 1981, Communications to disperse wilderness campers: *Journal of Forestry*, v. 79, p. 295–297.
- Roggenbuck, J.W., and Berrier, D.L., 1982, A comparison of the effectiveness of two communication strategies in dispersing wilderness campers: *Journal of Leisure Research*, v. 14, no. 1, p. 77–89.
- Roggenbuck, J., and Ham, S., 1986, Use of information and education in recreation management *in* A literature review—The President’s Commission on American Outdoors: Washington, D.C., U.S. Government Printing Office, p. M-59–M-71.

- Roggenbuck, J.W., and Manfredo, M.J., 1990, Choosing the right route to wilderness education *in* Managing America's enduring wilderness resource: St. Paul, Tourism Center, Minnesota Extension Service and Minnesota Agricultural Experiment Station, p. 103–112.
- Roggenbuck, J.W., and Schreyer R.M., 1977, Relations between river trip motivations and perceptions of crowding, management preferences, and experience satisfaction *in* Proceedings–River recreation management and research symposium: St. Paul, Minn., U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, General Technical Report NC-28, p. 359–364.
- Rokeach, M., 1973, The nature of human values: N.Y., Free Press.
- Romesburg, H., 1974, Scheduling models for wilderness recreation: *Journal of Environmental Management*, v. 4, p. 159–177.
- Rosen, P.C., and Lowe, C.H., 1994, Highway mortality of snakes in the Sonoran Desert of southern Arizona: *Biological Conservation*, v. 68, p. 143–148.
- Ross, T., and Moeller, G., 1974, Communicating rules in recreation areas: U.S. Department of Agriculture, Forest Service, Research Paper NE-297.
- Rowell, A., 1986, A wilderness travel simulation model with graphic presentation of travel data *in* Lucas, R., comp., Proceedings, National Wilderness Research Conference–Current Research, Intermountain Research Station, U.S. Department of Agriculture, Forest Service: Ogden, Utah, General Technical Report INT-212, p. 478–482.
- Shechter, M., and Lucus, R., 1978, Simulation of recreational use for park and wilderness management: Baltimore, Md., John Hopkins University Press.
- Schomaker, J., 1984, Writing quantifiable river recreation management objectives *in* Proceedings, The 1984 National River Recreation Symposium, p. 249–253.
- Schreyer, R., and Nielsen, M.L., 1978, Westwater and desolation canyons–Whitewater river recreation: Logan, Utah, Institute for the Study of Outdoor Recreation and Tourism, Utah State University.
- Shelby, B., 1980, Contrasting recreational experiences–Motors and oars in the Grand Canyon: *Journal of Soil and Water Conservation*, v. 35, p. 129–131.
- Shelby, B., and Heberlein, T.A., 1986, Carrying capacity in recreation setting: Corvallis, Oregon State University Press.
- Simpson, K., 1987, The effects of snowmobiling on winter range use by mountain caribou: Nelson, B.C., Canada, Wildlife Working Report WR-25, Wildlife Branch.
- Smith, V., and Headly, R., 1975, The use of simulation models in wilderness management: Amsterdam, North Holland, Management Science Application to Leisure Time.
- Smith, V., and Krutilla, J., 1974, A simulation model for the management of low density recreational areas: *Journal of Environment Economics and Management*, v. 1, p. 187–201.
- Smith, V., and Krutilla, J., 1976, Structure and properties of wilderness travel simulator: Baltimore, Md., Johns Hopkins University Press for Research for the Future, Inc.
- Snyder, H.A., and Snyder, N.R., 1974, Increased mortality of Cooper's hawks accustomed to man: *Condor*, v. 76, p. 215–216.
- Stankey, G.H., 1973, Visitor perception of wilderness recreation carrying capacity: Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Research Paper INT-142,.
- Stankey, G.H., and Schreyer, R., 1987, Attitudes towards wilderness and factors affecting visitor behavior–A state of knowledge review *in* Proceedings, National Wilderness Research Conference–Issues, state-of-knowledge, future directions: Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station.
- Stankey, G.H., and Baden, J., 1977, Rationing wilderness use–Methods, problems and guidelines: Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Research Paper INT-192,

- Stankey, G.H., Cole, D.N., Lucas, R.C., Peterson, M.E., and Frissell, S.S., 1985, The limits of acceptable change (LAC) system for wilderness planning: Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report IN-176.
- Stankey, G.H., and Manning, R., 1986, Carrying capacity of recreation settings—Literature review: Washington, D.C., The President’s Commission on America’s Outdoors, U.S. Government Printing Office, p. M-47–M-57.
- Sumner, E. L., 1936, Special report on a wildlife study in the High Sierra in Sequoia and Kings Canyon National Parks and adjacent territory, Washington, D.C.: National Park Service Records, National Archives.
- Taylor, R.B., 2004, The effects of off road-vehicles on ecosystems: Texas Parks and Wildlife, <http://www.tpwd.state.tx.us/texaswater/rivers/orvecosystempaper.pdf>, (accessed Nov. 24, 2004).
- Thomas, V.G., 1983, Spring migration—The prelude to goose reproduction and a review of its implication in Fourth Western Hemispheric Waterfowl and Waterbird Symposium: Ottawa, Ontario, Canadian Wildlife Service, p. 73–81.
- Thompson, J.D., 1969, Feeding behavior of diving ducks on Keokuk Pool, Mississippi River: Ames, Iowa, Iowa State University, 79 p., [M.S. thesis].
- Thompson, D., 1973, Feeding ecology of diving ducks on Keokuk Pool, Mississippi River: *Journal of Wildlife Management*, v. 37, p. 367–381.
- Tyler, N.J.C., 1991, Short-term behavioral responses of Svalbard reindeer—*Rangifer tarandus platyrhynchus*—to direct provocation by a snowmobile: *Biological Conservation*, v. 56, p. 179–194.
- U.S. Fish and Wildlife Service, 1990, A review of secondary uses occurring on National Wildlife Refuges: 232 p.
- Vande Kamp, M., Johnson, D., and Swearingen, T., 1994, Deterring minor acts of noncompliance—A literature review: Seattle, Wash., Cooperative Park Studies Unit, College of Forest Resources, University of Washington, Technical Report NPS/PNRUN/NRTR–92/08.
- Vander Stoep, G., and Roggenbuck, J., 1996, Is your park being loved to death?—Using communication and other indirect techniques to battle the park “love bug” in *Crowding and congestion in the National Park System—Guidelines for research and management*: St. Paul, University of Minnesota Agricultural Experiment Station Publication, v. 86, p. 85–132.
- Van Wagtenonk, J., and Colio, P., 1986, Trailhead quotas—Rationing use to keep wilderness wild: *Journal of Forestry*, v. 84, p. 22–24.
- Vaske, J.J., Carothers, P., Donnelly, M.P., and Baird, B., 2000, Recreation conflict among skiers and snowboarders: *Leisure Sciences*, v. 22, p. 297–313.
- Vaske, J.J., Deblinger, R.D., and Donnelly, M.P., 1992, Barrier beach impact management planning—Findings from three locations in Massachusetts: *Canadian Water Resources Association Journal*, v. 17, p. 278–290.
- Vaske, J.J., Decker, D.J., and Manfredi, M.J., 1995, Human dimensions of wildlife management—An integrated framework for coexistence in *Wildlife and recreationists—Coexistence through management and research*: Washington, D.C., Island Press, p. 71–79, 372 p.
- Vaske, J.J., and Donnelly, M.P., 2002, Generalizing the encounter-norm-crowding relationship: *Leisure Sciences*, v. 24, p. 255–269.
- Vaske, J.J., Donnelly, M., and Deblinger, R., 1990, Norm activation and the acceptance of behavioral restrictions among over-sand vehicle users in *Proceedings, 1990 Northeastern Recreation Research Symposium*, U.S. Department of Agriculture, Forest Service, General Technical Report NE-145, p. 153–159.
- Vaske, J.J., Donnelly, M.P., Wittmann, K., and Laidlaw, S., 1995, Interpersonal versus social value conflict: *Journal of Leisure Research*, v. 17, p. 205–222.
- Vaske, J.J., Fulton, D.C., and Manfredi, M.J., 2001, Human dimensions considerations in wildlife management planning in *Human dimensions of wildlife management in North America*: Bethesda, Md., The Wildlife Society, p. 91–108.

- Vaske, J.J., Graefe, A., Shelby, B., and Heberlein, T., 1986, Backcountry encounter norms—Theory, method, and empirical evidence: *Journal of Leisure Research*, v. 18, p. 137–153.
- Wagar, J.A., 1964, The carrying capacity of wild lands for recreation: Washington, D.C., Society of American Foresters, Forest Science Monograph 7.
- Wall, G., and Wright, C., 1977, The environmental impact of outdoor recreation: Waterloo, Ontario, University of Waterloo, Department of Geography, Publication Series no. 11.
- Waller, A.J., Sime, C.A., Bissell, G.N., and Dixon, B., 1999, Semi-aquatic mammals *in* Effects of recreation on Rocky Mountain wildlife—A review for Montana: Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, p. 5.1–5.25.
- Wang, B., and Manning, R., 1999, Computer simulation modeling for recreation management—A study on carriage road use in Acadia National Park, Maine, USA: *Environmental Management*, v. 23, p. 193–203.
- Webb, R.H., 1983, Compaction of desert soils by off-road vehicles *in* Environmental effects of off-road vehicles—Impacts and management in arid regions: N.Y., Springer-Verlag, p. 51–79.
- Webster, L., 1997, The effects of human related harassment on caribou: Williams Lake, B.C., Canada, Unpublished Report to Jim Young, Senior Wildlife Biologist, Ministry of Environment, 28 p.
- White-Robinson, R., 1982, Inland and saltmarsh feeding of wintering Brent geese in Essex: *Wildfowl*, v. 33, p. 113–118.
- Whittaker, D., Anderson, L., and Mosby, J., 1990, Susitna Basin recreation user survey results: Anchorage, Alaska, Alaska Department of Natural Resources, Report to Alaska Department of Natural Resources.
- Whittaker, D., 1997, Capacity norms on bear viewing platforms D Whittaker, *Human Dimensions of Wildlife*, vol. 2, p. 37-49.
- Whittaker, D., and Shelby, B., 1991, Developing good standards: Criteria, characteristics, and sources, *in* Defining wilderness quality—The role of standards in wilderness management, A workshop proceedings: Portland, Ore., U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-305, p. 6-12.
- Widner, C.J., and Roggenbuck, J.W., 1999, Reducing theft of petrified wood at Petrified Forest National Park: *Journal of Interpretation Research*, v. 5, no. 1, p. 1–18.
- Wilcove, D., Bean, M., and Lee, P.C., 1992, Fisheries management and biological diversity: *Transactions of the 57th North American Wildlife and Natural Resources Conference*, v. 57, p. 373–383.
- Wilshire, H.G., 1983, The impact of vehicles on desert soil stabilizers *in* Environmental effects of off-road vehicles—Impacts and management in arid regions: N.Y., Springer-Verlag, p. 31–50.
- Wood, A.K., 1993, Parallels between old-growth forest and wildlife population management: *Wildlife Society Bulletin*, v. 21, p. 91–95.
- Yarmoloy, C., Bayer, M., and Geist, V., 1988, Behavior response and reproduction of mule deer, *Odocoileus hemios*, does following experimental harassment with an all-terrain vehicle: *Canadian Field-Naturalist*, v. 10, p. 425–429.
- Zande, A., Van Der, N., Ter Keurs, W.J., and Vander Weijden, W.J., 1980, The impact of roads on the densities of four bird species in an open field habitat—Evidence of a long-distance effect: *Biological Conservation*, v. 18, p. 299–321.

Annotated Bibliography

Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: *Environmental Management*, v. 11, no. 1, p. 45–52.

The study examines the effects of off-road vehicles (ORVs) on the dune system of the Fire Island National Seashore, New York, USA. The experimental approach was adopted in order to evaluate the environmental effects of ORVs in this zone. Control and impact sites were established in two similar locations. Vehicle impacts were applied at the equivalent rate of one vehicle pass per week. Monitoring of dune vegetation, through sequential quadrant surveys and construction of seaward limit maps, showed a significant loss of vegetation resulting from ORV impacts. Loss of vegetation resulted in an alteration of the natural profile, which could increase dune-erosion during storm wave attacks.

Keywords: vegetation, habitat alteration, off-road vehicle, recreation, sand dune

Anderson, D.H., Lime, D.W., and Wang, T.L., 1998, *Maintaining the quality of park resources and visitor experiences—A handbook for managers*, TC-777, St. Paul: University of Minnesota Extension Tourism Center, 149 p.

This handbook provides a comprehensive step-by-step approach for identifying, monitoring, managing, and mitigating recreational impacts. The content of the handbook begins with an explanation of the decision process and which additional resources are included to aid in any of five stages: (1) problem awareness, (2) problem specification, (3) strategy and tactic selection, (4) plan implementation, and (5) monitoring. Worksheets are provided in the handbook for the problem specification, strategy and tactic selection, and plan implementation stages. In addition to planning, the body of the handbook is intended to act primarily as a sourcebook, providing tactics and actions designed to address specific impacts. A significant contribution of this handbook is the identified causes of unacceptable impacts. This is followed by a discussion of management tactics designed to address the source of the identified impacts. Each tactic presented includes a discussion of the: purpose, description, cost to visitor, cost to management, effectiveness, and a selected reference is provided.

Keywords: impacts, management solutions, planning

Basman, C.M., Manfredo, M.J., Barro, S.C., Vaske, J.J., and Watson, A., 1996, Norm accessibility—An exploratory study of backcountry and frontcountry recreational norms: *Leisure Sciences*, v. 18, p. 177–191.

This study investigates which recreation norms are accessible from memory in response to two types of recreation settings: frontcountry and backcountry. The participants of the study were shown images of the two aforementioned recreation cues, and then asked to complete a questionnaire. The questionnaire inquired about user's previous experiences, knowledge, and frequency of visitation levels in these areas as well as elicit salient norms or those norms that have been brought to mind. The results indicated that the number of salient norms reported was influenced by previous experience, frequency, level of knowledge, and that the norm accessibility is an important indicator of predicting behavior of recreationists.

Keywords: norms, saliency, backcountry, frontcountry, norm accessibility

Boyle, S.A., Samson, F.B., 1983, Nonconsumptive outdoor recreation—An annotated bibliography of human-wildlife interactions: U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C., Special Scientific Report: Wildlife, no. 252, 113 p.

This annotative bibliography identifies 166 articles relating to human-wildlife interactions with nonconsumptive recreationists. Of the 166 articles identified, 81% of non-consumptive recreation activities negatively impacted wildlife. Despite the number of literature reviewed, impacts to wildlife species included primarily only direct impacts such as: death, displacement, increased heart rate, and nest abandonment. Unfortunately, long term affects were not identified. Included with each citation is a summarization of relevant information and descriptors consisting of species names and subject keywords. Also provided are indexes to authors, species, keywords, and geographic regions; an annotated list of keywords; and a list of bibliographies on related topics.

Keywords: wildlife-disturbance, recreation, nonconsumptive

Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: Wildlife Society Bulletin, v. 13, no. 2, p. 110–116.

This paper reviews available information on the effects of nonconsumptive outdoor recreation on wildlife. It is noted that wildlife is affected through sight and sound of recreationists, pollution from motorized boats, and recreational facilities. Waterfowl behavioral changes and movements to less disturbed areas in response to boating have been documented. To determine if biological impacts to certain species have occurred, changes in wildlife behavior must be critically examined. Some species are more sensitive to disturbance than others because of colonial behavior, unique breeding patterns, restricted distribution, or rigid habitat requirements. To set priorities, managers must be able to determine what species may be most affected by which recreational activities, at what intensities, and at what time in the annual cycle.

Keywords: wildlife, impacts, recreation, nonconsumptive

Cole, D.N., 1994, Wilderness threats matrix—A framework for assessing impacts, Research Paper INT-475, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

This report presents the wilderness threats matrix as a comprehensive framework for assessing threats to wilderness. The wilderness threats matrix assesses threats by identifying potential threats to wilderness (column) and wilderness attributes (rows), forming a matrix, which represents impacts of each threat on each attribute. The threats matrix is intended to aid wilderness planners, managers, and researchers. Planners can use the matrix during the scoping process in describing the current management situation, in developing assumptions about the future, and in assessing the impacts of alternative management actions. The matrix priorities can be used for research and management applications for individual wilderness areas, on a regional level, and the National Wilderness Preservation System. Included in the description of the framework is an example of one of these applications, an assessment of the perceived significance of threats to wilderness in the Forest Service's Northern Region (northern Idaho and Montana). Using a team of wilderness experts, the significance of and knowledge about threats were assessed and identified as recreation use and its management, livestock grazing and its management, mining, fire and its management, exotic species introductions and invasions, water projects, atmospheric pollutants, and practices on adjacent land. The primary wilderness attributes of concern are air, aquatic systems, rocks and landforms, soils, vegetation, animals, ecosystems and landscapes, cultural resources, and opportunities for wilderness experiences.

Keywords: management threats matrix, frameworks, impacts, indicators

Cole, D.N., 1989, Low-impact recreational practices for wilderness and backcountry, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-265, 131 p.

This report, intended as a sourcebook, discusses low-impact recreational practices that are designed to minimize wilderness and backcountry recreational impacts. The beginning of the report discusses specific recreational impacts (e.g., trail degradation, litter, crowding, inappropriate campsite behavior, and human waste). This is followed by a description of a number of practices designed to minimize impacts attributed to recreationists. Of the practices identified (trip preparation, conduct, appropriate backcountry travel, and campsite selection and behavior), a standard format is used to discuss their importance, rationale, costs to visitors, and recommendations. In addition to those suggested, practices that may be counter-productive are also described. This is followed by examples and a final section that discusses how to develop effective low impact visitor messages. The report is concluded with a discussion of important research gaps and limitations.

Keywords: backcountry, wilderness, low-impacts practices, camping

Cole, D.N., 1990, Ecological impacts of wilderness recreation and their management, p. 425–466, Hendee, J.C., Stankey, G.H., Lucas, R.C., (eds.): Wilderness Management, North American Press, Golden, Colo.

The chapter identifies and discusses the significance of recreational impacts on wilderness areas. There is also a discussion of the types of recreational impacts, including those that cause wildlife disturbance, although the majority of the chapter focuses on the management of campsites, trails, and pack, and saddle stock. Examples were largely drawn from large wilderness in the western United States. Impact is inevitable wherever recreational use is allowed. Therefore, consistent with the goal of providing recreational opportunities, management can only limit impact, not prevent it. Many available strategies and techniques help managers deal with each type of impact. Using several techniques simultaneously is more effective than using just one.

Keywords: wildlife-disturbance, outdoor recreation

Cole, D.N., 1996, Wilderness recreation use trends, 1965 through 1994, Research Paper INT-RP-488, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station 10 p. Leopold Publication, no. 282.

This study examines recreational trend in wilderness users from 1965 to 1994. Results for the study indicate that recreation use of the National Wilderness Preservation System (NWPS) has increased six fold since passage of the Wilderness Act and is increasing. Results from this study indicate that at least one-half of the areas in this wilderness system currently receive substantially more visitation, indicating that recreation use of wilderness is increasing. Even areas that were more heavily used in the past are experiencing increased use during the 1990's. This study identifies and compares use intensity, use per acre, and use of individual National Park service areas. The study discusses and compares trends found in other use studies and trend indicators that were used. Management and policy implications are also identified and discussed.

Keywords: wilderness, recreation, trends

Cole, D.N., 2004, Environmental Impacts of outdoor recreation in wildlands, 10th Anniversary ISSRM Book: Fort Collins, Colo., International Association for Society and Natural Resources, v.10, p. 107–116.

Much of the work in recreation ecology has led to the development of impact monitoring protocols, management strategies, and low-impact education messages, particularly in National Parks and wilderness areas. This chapter discusses the primary themes of recreation ecology, and how the field has developed, as well as the management significance of this topic. Despite the milestone, much of the literature has been descriptive. Lack of information about impacts at critical scales of analysis may explain our poor understanding of wildlife impacts. Despite this setback, factors that influence the magnitude of recreation impacts have been examined: *characteristics of use, environment, and management*, which all combine to influence the magnitude of recreation impact. The most important factors are *amount of use, type and behavior use, timing of use, resistance and resilience of the environment, and the spatial distribution of use*. Furthermore, monitoring methods are well developed for trails and campsite impact, but poorly developed for the impacts of grazing and impacts of wildlife and water bodies. The lack of information about wildlife impacts at critical scales of analysis is partially attributed to the poor understanding of the significance of wildlife impacts, despite the numerous studies conducted. Numerous studies have examined the short term effects of recreation use on wildlife but little is known about the long term effects.

Keywords: wildlife impacts, recreation ecology, recreational impacts

Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreationists on wildlife, Chapter 11 in Knight, R.L., Gutzwiller, K.J., (eds.) *Wildlife and recreationists—Coexistence through management and research*, Island Press, Washington D.C.

This chapter identified indirect wildlife disturbances caused by recreationists. The mere presence of recreationists has the ability to impact soil, vegetation, and aquatic systems. The significance and magnitude of recreational impact is related to the extensiveness, intensity, and timing of the activity. As a result of these impacts, recreation areas typically have vegetation that is less abundant, of a reduced stature, and with a different species composition than undisturbed areas. Impacts related to specific recreational activities are discussed. Indirect impacts and their effect on the availability and quality of habitat are also identified. These habitat changes can alter the type, distribution, and amount of food available to terrestrial and aquatic animals. Examples and management options were presented. Suggested management options included restrictions on use levels, restrictions on type of use and zoning uses, and restrictions on the spatial distribution of use.

Keywords: wildlife, disturbance, indirect impacts, recreation ecology

Cole, D.N., and McCool, S.F., 1998, Limits of acceptable change and natural resources planning—When is LAC useful, when is it not? in McCool, S.F., Cole, D.N., (Comps.), 1998, *Proceedings: Limits of acceptable change and related planning processes—Progress and future directions: May 20–22, 1997*, Missoula, Montana, General Technical Report INT-GTR-371, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 69–71.

Limits of Acceptable Change (LAC) was traditionally intended to serve as a recreation carrying capacity framework. This paper examines the strengths and weaknesses of LAC and attempts to identify situations where LAC can be applied and situations where it cannot. It was recognized that the LAC process has widespread applicability to issues other than recreation management and in places other than protected areas. In protected areas, LAC can be useful to evaluate a range of threats to resource conditions

and aid managers in evaluating impact. Authors note that LAC is particularly useful in situations where management goals are in conflict. The fundamental steps of LAC were discussed and examples were provided. These steps included: recognizing that goals are in conflict, identifying which goals can be compromised and by how much, adopt and monitor indicators, and standards that are obtainable, and make management decisions so standards are never violated. When dealing with conflicting management goals, authors noted that it is necessary to write standards for the most important (constraining) goals that are useful for judging the acceptability of future conditions.

Keywords: framework, Limits of Acceptable Change, carrying capacity, recreation

Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: *Leisure Sciences*, v. 24, p. 313–324.

In this study, backpackers were surveyed during a four-day Grand Canyon trip to gather evaluative standards on encounters. Each participant was evaluated per day of the trip, pre-trip, and post-trip, to assess variation across individuals, times and zones. The findings demonstrated that the backpackers felt encounters should vary substantially in the differing zones (four total), the corridor zone having the greatest amount while the wild zone having the least. In spite of this, there was a substantial variation in the standards provided among the participants and within each trip evaluation.

Keywords: backcountry management, carrying capacity, crowding norms, encounter standards, limits of acceptable change

Daigle, J.J., Hrubec, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: *Human Dimensions of Wildlife*, v. 7, p. 1–19.

This study is largely based on the theory of planned behavior which explains human action as being guided by: (1) beliefs about the likely consequences of the behavior, (2) beliefs about the normative expectations of others, (3) and the beliefs about factors that may control or hinder performance of the behavior. Benefits derived from participation are largely based on the theory that recreation is largely goal-oriented. This study applies the theory of planned behavior in order to explain the behavioral intentions of wildlife viewers, hunters, and other outdoor recreations. With the use of a mail survey (n = 395) authors compare respondents' beliefs about the consequences of hunting with the beliefs linked to wildlife viewing and outdoor recreation unrelated to wildlife. Respondents were also compared in terms of their general attitudes, subjective norms, and perceptions of control related to the three behaviors. Preferred activities were perceived as producing more desirable outcomes than less preferred activities, and they were associated with more favorable attitudes, subjective norms, and perceptions of control. By understanding the beliefs about the benefits rather than the benefits alone, a greater understanding of what is likely to influence attitudes, intentions, and behaviors can be gained. Overall, this article indicates that recreationists need to be served in different ways to optimize the types, quantity, and likelihood of realizing specific benefits. Furthermore, this study suggests that some activities are better suited than others to produce benefits for different types of individuals.

Keywords: attitudes, beliefs, hunting, outdoor recreation, values, wildlife viewing

Dawson, C.P., and Watson, A.E., 2000, Measures of wilderness trip satisfaction and user perceptions of crowding: *U.S. Department of Agriculture, Forest Service Proceedings, RMRS*, v. 15, no. 4, p. 93–98.

This study dealt with the general concept that user densities affect user perceptions, and consequently affect user trip satisfactions. Interviews and follow-up mail surveys were conducted on wilderness users to determine the density-crowding-satisfaction relationship. User perceptions of crowding were correlated with user satisfaction, but only a small proportion of the total variance was explained by the path analysis models utilized in this study. The authors stressed that future research should identify what contributes to wilderness trip satisfaction, since satisfaction often rates high despite perceptions of crowding.

Keywords: user densities, solitude, crowding, satisfaction

Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management, Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.

This paper examines ecological and social impacts of recreational users on barrier beaches. The ecological research described the magnitude of the wildlife impact, while the social research evaluated the public's acceptable of mitigation strategies. Combining the empirical data from both research disciplines yielded an effective management strategy that would not have occurred had the findings from either discipline been considered separately.

Keywords: impacts, indicators, social, ecological, recreation, barrier beaches

DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge: Appendix L, 114 p., *in* Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision: U.S. Department of the Interior, Fish and Wildlife Service, Portland, Oreg., v. 2.

This document largely contributes to the understanding of visitor use and wildlife disturbance issues by identifying and discussing impacts and mitigation measures associated with wildlife disturbances. The body of this document discusses: (1) an overview of impacts of human disturbances, (2) responses of wildlife disturbances, and (3) impacts and mitigation measures associated with wildlife dependent recreation. Particular attention is placed on the impacts and mitigation of impacts for waterfowl, hunting, fishing, wildlife viewing, photography, environmental education and interpretation, as well as associated activities such as walking, driving, boating and camping. In addition to providing an overview of wildlife disturbances associated with wildlife dependent recreation, this document encompasses a summary of peer reviewed articles, technical reports and papers, as well as related case studies and examples. Although this document was specifically designed for addressing waterbirds, the applications and concepts are universal. More importantly, this document provides guidance and direction relative to the comprehensive conservation plan (CCP) process.

Keywords: waterbirds, hunting, outdoor recreation, impacts, wildlife management, wildlife disturbance

Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: Human Dimensions of Wildlife, v. 2, p. 551–271.

Using a qualitative approach, this study examines the determinants of value orientations toward wildlife. Four major dimensions of 18 interviewees were explored as determinants of wildlife value orientations: socialization, experience, personal characteristics, and place. Results from the interviews

suggested that these dimensions were an appropriate way to organize the determinants of wildlife value orientations, despite the fact that combinations of the dimensions varied among respondents. Important influences of wildlife value orientations common to most respondents were family members (particularly fathers), and place of upbringing (rural or urban). Direct experiences with wildlife were also critical for some, but not all respondents. Religiosity and gender were not clearly verbalized by respondents, but these were articulated as having important influence on their wildlife values. Individuals with anthropocentric orientations differed from respondents with ecocentric orientations in terms of their wildlife value determinants, although these differences were observed in only a few instances.

Keywords: determinants of values, wildlife value orientations, socialization, experience, personal characteristics, place

Donnelly, M.P., Vaske, J.J., Whittaker, D., and Shelby, B., 2000, Toward an understanding of norm prevalence—A comparative analysis: *Environmental Management*, v. 25, p. 403–414.

A comparative analysis of 30 different studies was used to examine the prevalence of encounter norms in 56 evaluation contexts. The studies that were examined used a single item questionnaire to measure norm prevalence, which asked respondents to indicate a number of encounters they would tolerate. The results indicated that on average, three-fourths of the respondents were able to give a numeric value of an encounter norm. Of the four predictor variables examined (type of resource, type of activity, type of encounter, and question response format), three of them (type of resource, type of encounter, and question response format) explained 64% of the variance in norm prevalence. A relationship was not found to be significant between type of activity and norm prevalence.

Keywords: encounter norms, norm prevalence

Freimund, W.A., and Cole, D.N. (comps.), 2001, Visitor use density and wilderness experience—Proceedings June 1–3, 2000: Missoula, Mont., Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.

The papers in this proceeding were presented at a workshop for assessing progress and offering further ideas to contribute to the understanding of the relationship between visitor use/density and wilderness experiences. The workshop focused on ideas for future scientific contributions to better decisions about use limits. Participants were invited to present the papers included in this proceedings, to discuss progress to date on these issues, and to suggest research needs. Invited papers include reviews of previous research, discussion of issues related to use limitation, exploration of the solitude concept and of visitor conflict, and explanations of alternative research methodologies.

Keywords: carrying capacity, recreation management, solitude, use limits, visitor density, wilderness experience, research methods

Freimund, W.A., Vaske, J.J., Donnelly, M.P., and Miller, T.A., 2002, Using video surveys to access dispersed backcountry visitors' norms, *Leisure Sciences*, v. 24, p. 348–362.

This paper explores the use of Image Capture Technology (ICT) to manipulate VHS videotape questionnaires designed to measure norms. The study takes place in Gwaii Haanas National Park Reserve, British Columbia, a very diverse and remote, natural/cultural island attraction. The survey was designed to measure visitors' norms for the number of watercrafts, sound of aircrafts, and motorboats, and the approval of floating camping quarters. The ICT allowed for the video images to be manipulated so that all

participants had the same depiction of use. Participants of the study responded well to the video survey, suggesting that it helped them recall their previous experience at the location.

Keywords: image capturing technology, norms, evaluative standards.

Goff, G.R., Decker, D.J., and Pomerantz, G.A., 1988, A diagnostic tool for analyzing visitor impacts on wildlife refuges—A basis for a systematic approach to visitor management: Northeast Fish and Wildlife Conference, v. 45, no. 82.

Authors illustrate a systematic approach for analyzing visitor impacts on wildlife refuges. By surveying 22 refuge managers, detailed information regarding specific impacts of public use on wildlife species and habitats of special importance on the refuges were obtained. Telephone interviews during the initial phase of the study were used to develop the questionnaire. Through telephone interviews, 8 variables were identified, which were later used to describe 148 situations impacted by visitor activities. Authors suggest that refuge managers may be able to select visitor control measures that will mitigate negative impacts while maintaining relatively high visitor satisfaction levels through the use of the variables identified and applied in this study. Suggested management solutions identified in this study included a combination of visitor education, zoning activities, law enforcement, or restriction of activities.

Keywords: wildlife, management, disturbance, recreation

Graefe, A.R., Thapa, B., Confer, J.J., and Absher, J.D., 2000, Relationships between trip motivations and selected variables Allegheny National Forest visitors, U.S. Department of Agriculture, Forest Service Proceedings RMRS, v. 15, no. 4, p. 107–112.

Previous studies have attempted to study motivations of outdoor recreation users by using only open-ended responses. This study uses a combination of survey methods. The paper analyzes five motivation factors: social, escape, fun, nature, and learning, with two items to retain a single dimension close to home and challenge. The results of the study showed that motivations for wilderness and campground users were escape, fun, and challenge. Repeat visitors were more likely to mention close proximity to their home and escape than first time visitors. The benefit of this research is that it will allow managers to learn more about their visitors' needs and plan accordingly.

Keywords: motivations, frontcountry, backcountry

Higgenbottom, K., Green, R., and Northrope, C., 2003, A framework for managing the negative impacts of wildlife tourism on wildlife: Human Dimensions of Wildlife, v. 8, p. 1–24.

Because wildlife tourism attracts millions of tourists globally, often involving threatened species, this is of significant concern. This article presents a framework to provide guidance on establishing an effective program for managing negative wildlife impacts, as well as how to choose appropriate management actions and how to design a monitoring program. A number of previous frameworks are also discussed (Environmental Impact Assessment, Recreation Opportunity Spectrum, Limits of Acceptable Change, Visitor Impact Management, Tourism Optimization Management Model, and Experience-Based Management) and adopted as part of this framework. Examples of how a wildlife tourism system can be managed are illustrated using some of these approaches.

Key words: wildlife tourism, wildlife impacts, management frameworks, monitoring

Inglis, J.G., and Johnson, I.V., 1999, Crowding norms in a marine setting—A case study of snorkeling on the Great Barrier Reef: *Environmental Management*, v. 24, p. 369–381.

This study examines crowding norms of snorkelers in the Great Barrier Reef Marine Park, by using image-capturing techniques to depict different levels of use. Participants of the study consist of four response groups: a scuba-diving club, local residents, tourists, and university students from the United States. The response group was designed to represent different levels of marine recreation users in the park. The participants were shown photographs of various densities and asked to give their personal levels of acceptability. The results showed that of the experienced scuba divers, most preferred scenes without people or infrastructure, while novices considered *both* acceptable. Results also suggested that as recreationists mature, their tolerances for particular users decline, and they make efforts to avoid those users.

Keywords: recreation, snorkeling, crowding norms, image-capturing, marine settings

King, M.M., and Workman, G.W., 1986, Response of desert bighorn sheep to human harassment—Management implications: *Transactions of the North American Wildlife and Natural Resources Conference*, v. 51, p. 74–85.

This study explores the behavioral response of desert bighorn sheep to human disturbance. The study was conducted in southeastern Utah from 1981 to 1983 and examined the behavior of bighorn sheep from two areas with contrasting disturbance histories. Red Canyon bighorn have been exposed to greater levels of hunting pressure and vehicular traffic than have White Canyon bighorn. Response and distance fled by bighorn were recorded during harassment trials, which were deliberately induced by vehicles and hikers for both groups of bighorn. When bighorn remained in the presence of the harassing stimuli, actual time spent by bighorn in various behaviors, was recorded to determine group wariness and activity budgets under harassed conditions. Bighorn were also observed under un-harassed conditions to compare behavior under those two circumstances. Results revealed that behavioral responses of desert bighorn to encounters with humans were more severe, and thus more energy costly for animals that had been historically exposed to relatively high levels of human disturbance. Authors conclude that wildlife and land managers should include evaluation of past disturbance history in bighorn habitat and plan to minimize potentially harassing human activities in crucial habitat, particularly if bighorn have been exposed to high levels of human disturbance.

Keywords: disturbance, bighorn sheep, harassment

Knight, R.L., and Cole, D.N., 1991, Effects of recreational activity on wildlife in wildlands: *Transactions of the 56th North American Wildlife and Natural Resources Conference*, p. 238–247.

This paper address impacts on wildlife and attempts to summarize information about recreational impacts on wildlife. Authors propose a hierarchy of responses of wildlife to recreation, and describe factors that influence the nature and magnitude of these responses. A summary of recreational impacts on wildlife included a classification of four sources: harvest, habitat modification, pollution, and disturbance. Immediate responses to those impacts by wildlife include change in behavior or death. Long-term effects on individuals are also discussed including altered behavior (movements, feeding), altered vigor (energy expenditures), altered productivity, or death. Examples of each response are presented and discussed. Causal mechanisms, wildlife responses, and factors which influence responses are discussed and suggestions for controlling recreational disturbance are identified.

Keywords: wildlife disturbance, recreation, impacts

Knight, R.L., and Gutzwiller, K.J., eds., *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.

This book provides a thorough summary of the history, conflicts, and constraints associated with the management of wildlife and recreation. Chapters identify fundamental theoretical concepts, as well as specific issues relevant to recreational impacts on wildlife. The book provides an interdisciplinary perspective on wildlife management by addressing biological, ecological, and human dimensions applications and needs. By identifying the indirect and direct factors that influence wildlife responses, the physical and behavioral responses of wildlife, as well as the basic concepts used to identify impacts this text depicts the available management options as well as limitations. By providing a comprehensive review of contemporary wildlife and recreational issues, this book makes an excellent resource for managers and planners.

Keywords: wildlife disturbance, management, human dimensions, indicators, standards, frameworks

Leung, Y.F., and Marion, J.L., 1998, Evaluating spatial qualities of visitor impacts on recreation resources—An index approach: *Journal of Applied Recreation Research*, v. 23, no. 4, p. 367–389.

This study applied two descriptive spatial indices, the Gini (G) coefficient and the linear nearest-neighbor (LR) index, in order to expand the use of spatial information in visitor impact evaluations. This study used both spatial indices to evaluate a trail-impact, assessment data set from Great Smoky Mountains National Park. Balanced evaluations of visitor impacts are integral to the management of parks and recreation resources. The study revealed that the capability of the two indices in quantifying spatial distribution patterns of impact problems are applicable at both the micro (trail) and macro (park) level. Due to a lack of spatial examinations, as revealed in a review of the literature, suggests that spatial qualities of visitor impacts have rarely been examined. The applications, and uses of spatial information, and indices in park and recreation resource management are identified and discussed.

Keywords: spatial strategies, impacts, management

Leung, Y.F., and Marion, J.F., 1999, Spatial strategies for managing visitor impacts in national parks: *Journal of Park and Recreation Administration*, v. 17, no. 4, p. 20–38.

This paper identifies basic spatial strategies for managing visitor impacts in parks and protected areas. The need to contain resource and social impacts within acceptable limits has become an increasing management concern in national parks and protected areas. Based on previous recreation and park management literature, four spatial strategies were proposed: (1) spatial segregation (zoning and closures), (2) containment, (3) dispersal, and (4) configuration through judicious spatial arrangement of facilities. Spatial segregation is typically used for shielding sensitive resources from visitor impacts, or for separating potentially conflicting types of use. This is frequently applied in the form of restrictions or closures to protect sensitive natural or cultural resources. Spatial containment is a strategy that is intended to minimize the aggregate extent of visitor impacts by confining use to limited designated or established locations. Spatial dispersal strategy, however seeks to spread visitor use, reducing the frequency of use to levels that avoid or minimize permanent resource impacts, or visitor crowding and conflict. These four spatial strategies can be implemented separately or in combination at varying spatial scales within a single park. In addition to typologies presented in this paper, it provides an empirical example of the diversity of implemented spatial strategies in managing visitor impacts. These examples help illustrate their application, and inform managers of the multitude of options. It was noted that the underlying causes of

management problems must be understood, including the role of influential factors (e.g., political, use-related, environmental, and managerial). Authors concluded that a combination of management strategies and actions may offer the most flexible and effective solution to visitor impact problems.

Keywords: spatial strategies, impacts, management

Lawson, S.R., and Manning, R.E., 2001, Solitude versus access—A study of tradeoffs in outdoor recreation using indifference curve analysis: *Leisure Sciences*, v. 23, p. 179–191.

There have been several methods used to help recreation managers make social carrying capacity decisions. This study examines tradeoffs of visitors' preference between solitude and access using the indifference curve analysis at Delicate Arch in Arches National Park. The indifference curve theory provides a representation of tradeoff decisions an individual makes when choosing a fixed level of income between two consumer goods. This model, originally developed for economic purposes, has two primary components; the individual's tastes and preferences, and his or her fiscal constraints. The findings of this study show that the indifference curve theory can be a valuable tool for managers, guiding the decision making process regarding the design and management of appropriate experiences.

Keywords: solitude, carrying capacity, crowding, indifference curves, paired comparison, Arches National Park

Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences—A contextual approach to normative research, *Leisure Sciences*, v. 24, p. 297–312.

It is noted that wilderness experiences are comprised of three attributes: social condition experience, resource condition, and management conditions imposed. Denali, however, considers the three in their revisions of their management of the wilderness park, and is concerned with how to manage involving potential tradeoffs. Lawson and Manning utilized a decision-making tool in their research to measure what “ought to be managed for”, rather than a conventional normative measure of how a single attribute is preferred to be managed, irrespective of the other conditions. Findings showed that Denali's visitors place great importance on utility over all other conditions despite the tradeoffs. Researchers also note that by asking respondents to consider the tradeoffs associated with wilderness management, stated choice analysis may be more capable of addressing the “oughtness” of wilderness management than would be with conventional normative approaches.

Keywords: norms, indicators of quality, standards of quality, wilderness management, stated choice analysis, Denali National Park and Preserve

Lucas, R.C., 1985, The management of recreational visitors in wilderness areas in the United States: p. 122–136, Bayfield, N.G., and Barrow, G.C., eds., *The ecological impacts of outdoor recreation on mountain areas in Europe and North America*. Recreation Ecology Research Group: Wye, Ashford, Kent, United Kingdom, 203 p.

This paper focuses on managing the quality of visitors' experiences in the U.S. wilderness system and impacts and management solutions are discussed. Problems include environmental impacts, crowding, littering and conflicts between different types of visitors. Most visitor management actions affect both visitor experiences and environmental impacts, with intricate interrelations and often with undesired side effects. Techniques discussed include use-rationing, party size limits, redistribution of use (dispersion), and visitor education. Visitor management techniques vary in effectiveness and visitor acceptability.

Authors note that little is known about major causal processes and present a significant gap in linking managing social and ecological aspects of recreation. Lack of monitoring was also noted as a significant research gap that hinders future research and management efforts.

Keywords: disturbance, recreation, management techniques, visitor satisfaction

Manfredo, M.J., Vaske, J.J., and Sikorowski, L., 1996, Human dimensions of wildlife management, p. 53–72, in Ewert, A., ed.: *Natural Resource Management, The Human Dimension*, Boulder, Colo., Westview Press.

This chapter identifies and defines what human dimensions of wildlife (HDW), is and how it plays an active role in the management of wildlife. The five step of the human dimensions decision making process are also discussed: 1) setting goals, 2) identifying problems and opportunities, 3) identifying objectives and standards, 4) developing management action alternatives, and 5) implementing and evaluating alternatives. To demonstrate applicability, a series of empirical examples were summarized for each stage in the model. The discussion was concluded with how this information may be used by management.

Keywords: human dimensions of wildlife, management, frameworks

Manning, R.E., and Lawson, S.R., 2002, Carrying capacity as “informed judgment”: The values of science and the science of values: *Environmental Management*, v. 30–32, p. 157–168.

Carrying capacity relies on management decisions that take into account science and values. This paper discusses how normative research addresses the “science of values” needed in park and wilderness management. Normative theory is currently being explored in a number of management contexts, and new applications are being adapted to address specific carrying capacity needs. Furthermore, this paper illustrates how visitor-based research can utilize normative theory and techniques to explore the acceptability of resource and social impacts related to visitor use. The concept of carrying capacity, along with the theoretical and methodological approaches described in this paper, can be extended to a large number of natural resource issues.

Keywords: carrying capacity, norms, management, standards of quality

Manning, R., Lawson, S., Newman, P., Laven, D., and Valliere, W., 2002, Methodological issues in measuring crowding-related norms in outdoor recreation: *Leisure Sciences*, v. 24, p. 339–348.

In this study three methodological issues are examined as they apply to measuring crowding-related norms: question format, starting point bias, and information bias. The results indicate that measures of crowding-related norms were not significantly affected by the methodological issues in this study. A more applicable finding of the research suggests that recreation visitors have a secure standard of appropriate use levels, and other recreation-related impacts. The study concluded with the thought that more research on methodological issues is needed to explore norms in outdoor recreation.

Keywords: crowding, norms, outdoor recreation, methodology

Manning, R.E., Valliere, W.A., and Wang B., 1999, Crowding norms–Alternative measurement approaches: *Leisure Sciences*, v. 21, p. 97–115.

Crowding-related research has focused heavily on personal and social norms, which are used to establish levels of acceptability within a recreation area. Through this research, several norm-

measurement approaches have been developed. This study focuses on three approaches: numerical versus visual approach, long versus short question format, and evaluative dimension. In particular the study examines crowding on the carriage roads of Acadia National Park, Maine. The results indicate that the current methods used for norm-measurement approaches may be too conservative. It also identified that a visual approach, the long question format, and the evaluative dimensions of acceptability to others, management actions, and absolute tolerance capitulate higher crowding norms.

Keywords: Acadia National Park, carrying capacity, crowding, crowding norms, standards of quality.

Marion, J.L., and Leung, Y.F., 1998, Trail resource impacts and examination of alternative assessment techniques, *Journal of Park and Recreation Administration*, v. 19, no. 3, p. 17–37.

This paper reviews trail impacts and different types of trail assessments, including inventory, maintenance, and condition assessment approaches. Since trails are a primary recreation resource for a number of activities, increased recreational use is a common source of a variety of resource impacts noteworthy of assessment. Managers are often required to use objective information on trails and their conditions to monitor trends, direct trail maintenance efforts, and evaluate the need for visitor management and resource protection actions. This paper discusses two assessment methods, point sampling and problem assessment, which are compared empirically from separate assessments of a 15-mile segment of the Appalachian Trail in Great Smoky Mountains National Park. Authors indicate that point sampling and problem assessment methods yield distinctly different types of quantitative information. The point sampling method is identified as providing more accurate and precise measures of trail characteristics that are continuous or frequent (e.g., tread width or exposed soil). However, the problem assessment method is found to be more user friendly, particularly for specific trail impact problems. The advantages and limitations of both methods are discussed in relation to a variety of management implications.

Keywords: trail impacts, recreation, monitoring

Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: *Human Dimensions of Wildlife*, v. 6, p. 277–290.

Due to the Utah Division of Wildlife Resources revised strategic goals, researchers developed an assessment to analyze management's attitudes regarding the public involvement. It was hoped that assessment results would guide internal and external strategic planning, and assist in the implementation of human dimensions to the state agency. It was concluded that management conveyed a greater need of authority in management decisions and that current public involvement procedures are useful but not adequate. Therefore, management of the UWDR was deemed taciturn in fully embracing human dimensions through sharing more power.

Keywords: human dimensions, public involvement, wildlife managers, wildlife management, collaboration

Noe, F.P., Hammitt, W.E., and Bixler, R.D., 1995, Park user perceptions of resource and use impacts under varied situations in three national parks: *Journal of Environmental Management*, v. 49, no. 3, p. 323–336.

On-site user perceptions of resource and use impacts were investigated at three national parks in the southeastern United States. The major purpose of the research was to investigate the symbolic meaning that different groups of park visitors assign to specific impact situations involving the perception of five categories of impacts: litter, erosion, dead trees and animals, crowding and congestion, and commercial encroachment. Respondents were asked to rate the degree of acceptance for the five types of impacts that exist in various settings and conditions. An on-site intercept interview and mail questionnaire resulted in 971 cases for analysis. Results indicated that park user perceptions and tolerance for impacts vary widely, and that within changing situations there are degrees of acceptability and unacceptability. Finally, there are margins of relative differences between clustered groups of respondents and how they respond to impact situations.

Keywords: impacts, human dimensions, recreation

Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges: Human Dimensions Research Unit Department of Natural Resources, Cornell University, Ithaca, N.Y. and U.S. Fish and Wildlife Service, Office of Information Transfer, Fort Collins, Colo., 57 p.

This document examines a framework for considering public use and associated impacts for National Wildlife Refuges (NWR) in the Northeast Region of FWS. Authors begin with a discussion of the consumptive vs. nonconsumptive impacts, arguing that it is not an appropriate classification system. A more in-depth classification system, which focuses on visitor impacts, is presented. A brief evaluation of NWR policies are discussed, and survey results from a NWR manager questionnaire are identified. The survey was conducted in order to obtain a preliminary listing of species that were being impacted by visitor use in the Northeast Region, and a guide to information sources for mitigating visitor use impacts are presented and discussed.

Keywords: disturbance, recreation, impacts, frameworks, management, Region 5, National Wildlife Refuge

Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management—An integrative approach to wildlife management: *Human Dimensions of Wildlife*, v. 8, p. 81–95.

This paper presents adaptive impact management (AIM) as a structured decision making process to guide management actions. This framework has seven primary components: situational analysis, objective setting, development of system model(s), identification, and selection of management alternatives, actual management interventions, monitoring, and refinement of models and eventually interventions. The fundamental difference between AIM and conventional adaptive management is that AIM is based on stakeholder-identified objectives of management as defined by impacts on society, rather than conditions of a wildlife population or habitat.

Emphasis of AIM is placed on stakeholder involvement in management and shared learning among scientists, managers, and stakeholders. An example of AIM is presented using black bear management in New York. Benefits and costs of AIM are also discussed and presented.

Keywords: adaptive management, impacts, stakeholders, wildlife management, values

Saarinen, J., 1998, Cultural influences on wilderness encounter responses: *International Journal of Wilderness*, v. 4, no. 1, p. 28–32.

In 1992, backpackers in the Urho Kekkonen National Park were interviewed to determine whether cultural influences affect wilderness encounters. Through on-site interviews and questionnaires, the study assessed the attitudes of the backpackers towards meeting others. The responses to encounters with other people were dependent upon whether the encounter was in front-country or wilderness zones, the size of group encountered, and whether the group encountered was foreign or domestic. The researchers concluded that the backpackers found their interactions to be pleasant with those in smaller groups and that particular cultural customs could apply.

Keywords: crowding, encounters, norms, carrying capacity

Shelby, B., Vaske, J.J., and Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations –Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.

Data of 35 studies were compared to explore questions relating to carrying capacity. The purpose of this study was to conduct a comparative analysis to investigate what might be learned from the process which may highlight other issues beyond those of individual studies. Potential subjects included trends over time, factors affecting recreation experiences outside the individual user, and information on potential utility of further research on carrying capacity in the setting and in nearby locations. Management may also benefit from these comparative analyses to develop standards for improving the environmental and recreational quality in settings. Results suggested that crowding varies by time, resource availability, accessibility and convenience, and management strategy. However, regional factors did not appear to effect crowding, nor did they effect the type of activity studied or methodology for collecting the data (on-site survey or mailed questionnaire). Researchers suggest that future studies should utilize the nine-point response scale for its useful comparative ability and to continue expanding its database.

Keywords: crowding, carrying capacity, comparative/aggregate/meta analysis, evaluative standards, limits of acceptable change

Sime, C.A., 1999, Domestic dogs in wildlife habitats, p. 8.1–8.17 *in* Joslin, G., and Youmans, H., coordinators, *Effects of recreation on Rocky Mountain wildlife—A review for Montana: Committee on Effects of Recreation on Wildlife*, Montana Chapter of The Wildlife Society, 307 p.

The presences of domestic dogs in wildlife settings have the potential to disturb, harass, displace, or even kill wildlife. This is attributed to the fact that domestic dogs at some level, still maintain instincts to hunt and/or chase wildlife. Given the appropriate stimulus, those instincts can be triggered in many different settings. Regardless of whether domestic dogs chase wildlife, the mere presence of dogs including dogs with people, dogs on-leash, or loose dogs, has been shown to disrupt many wildlife species. While dog related impacts to wildlife likely occur at the individual scale, impacts on wildlife populations are unknown. Authors suggest the following considerations when evaluating recreational impacts of dogs in wildlife habitats: species biology, reproductive potential, abundance, density, distribution, degree of habitat specificity, or reliance on certain habitat components, and predisposition and sensitivity to disturbance by other agents. While this paper focuses primarily on impacts to ungulates, guidelines presented may be useful management tools for all wildlife.

Keywords: dogs, wildlife disturbance, impacts, management

Tarrant, M.A., 1999, Variability of the perceived crowding scale—A research note: *Leisure Sciences*, v. 21, p. 159–164.

This study addresses existing questions about Heberlein and Vaske's perceived crowding scale regarding the stability across method of administration (on-site versus mail-back), time (elapsed time between on-site contact and receipt of mail-back), and location (put-in and take-out). Specifically, the study examines these effects on recreational boaters on the Nantahala River. The boaters completed a short on-site survey in which perceived crowding levels were measured. Shortly after that, an additional mail-back survey was sent out to the same respondents. The results of the survey indicated that the method of administration and location influenced perceived crowding; however, time did not have a significant effect.

Keywords: perceived crowding, whitewater boating, norms

Tarrant, M.A., and Donald, B.K., 1996, A crowding-based model of social carrying capacity: Applications for white water boating use: *Journal of Leisure Research*, v. 28, p. 155–68.

One of the requirements of an outdoor recreation manager is to control acceptable levels of change. This most commonly takes the form of carrying capacity limitations based on physical constraints. This study's objective was to develop a model of perceived crowding that managers could potentially use to set social carrying capacities for white water boating. Unlike similar studies, encounter norms were not included and only 4 types of independent variables were used: total daily use levels by user-type, water release level, time of day boaters reached the final stretch of the river, and type of day.

Keywords: social carrying capacities, crowding, white water boating

Taylor, A.R., and Knight, R.L., 2003, Wildlife responses to recreation and associated visitor perceptions: *Ecological Applications*, v. 13, no. 4, p. 951–963.

In this article, researchers examined the potential of recreationists to disturb wildlife at Antelope Island National Park. In this study, the responses of antelope, bison, and mule deer were examined in correlation with presence of hikers and mountain bikers. Species probability of flushing was examined in relation to areas of influence along trails and off trail recreation within 100m of trails. In addition to the biological components, human dimensions attributes were obtained by surveying 640 recreationists. Approximately 50% of recreationists felt that their presence was not having an effect on wildlife. In general it was perceived that it was acceptable to approach wildlife more closely than the studies' empirical data allowed. Recreationists also tended to blame other groups for stress to wildlife, rather than holding themselves responsible.

Keywords: wildlife responses, recreation, visitor impacts.

Vaske, J.J., and M.P., Donnelly, 2002, Generalizing the encounter-norm-crowding relationship: *Leisure Sciences*, v. 24, p. 255–269.

This article examines traditional crowding models in a comparative analysis of 13 different studies with a variety of locations and activities. As in previous norm literature, it is suggested that norms vary by type of resource, activity, and encounter. Findings conclude that the relationship did exist and suggested that they can be generalized for a wide variety of situations. The results showed that as encounters exceeded normative tolerance limits, crowding increased significantly. The measurement of recreation encounters (conflict, no conflict), crowding (9 point Likert Scale, not at all crowded to extremely crowded), and individual tolerances (individuals highest number they could tolerate) were used to observe this relationship.

Keywords: encounters, crowding, norms

Vaske, J.J., Donnelly M.P., and Herberlein, T.A., 1980, Perception of crowding and resource quality by early and more recent visitors: *Leisure Sciences*, v. 3, p. 367–381.

It is indicated by previous literature that recreationists' current evaluation of the natural setting is heavily determined by their previous experiences in that setting. Given the increasing popularity and subsequent environmental impact these areas are receiving, it is thought that each generation will experience different conditions. This study evaluated the relationship, in years, between the boaters' first trip and a current trip, to the Apostle Islands National Lakeshore. The results showed that those who had been to the area before, user levels increased perceived the greatest environmental damage. The paper shows the importance of individuals values rather than simply focusing on evaluations of current visitors.

Keywords: perceived crowding, resource quality, expectations, reported contacts

Wagar, J.A., 1964, The carrying capacity of wild lands for recreation, *Forest Science–Monograph 7*: Society of American Foresters, *Forest Science Monograph 7*, 23 p.

This paper analyzes the recreational carrying capacity problem and management procedures to modify these reciprocal impacts. The study includes an analysis of the social, ecological, and managerial considerations involved in the administrative decisions to limit recreational use. The author also discusses the effects of crowding on satisfaction of the needs and motivations of recreationists. Ecological considerations include an experiment in which recreational foot traffic was simulated on a series of vegetated plots. Management considerations include zoning, engineering, interpretation, and persuasion. Ten conclusions are given, including (1) recreational carrying capacity is not an absolute value inherent in the ecology and characteristics of each land area; (2) accepting limitation of use is only one of the costs that can be paid for quality recreation; (3) for some kinds of recreation, management procedures may permit high rates of use without a reduction in quality; and (4) relationships between vegetation, visitor use, and site factors can be described and used as tools for predicting the impact of visitors on recreation areas.

Keywords: carrying capacity, recreation, recreation impacts, management

Watson, A.E., Cole, D.N., Turner, D.L., and Reynolds, P.S., 2000, *Wilderness recreation use estimation–A handbook of methods and systems*, General Technical Report RMRS-GTR-56, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 198 p.

This hand book is intended to serve as a convenient resource for wilderness managers and others who have the responsibility of monitoring and describing visitor use in wilderness. It is a comprehensive manual on estimation techniques and procedures that are essential to accurately measure visitor use-related characteristics and conditions. Guidelines enable the manager to evaluate options and decide on a use estimation system that meets the needs of a specific area and set of circumstances. This handbook provides relevant information on setting objectives, making decisions about what to monitor, developing a sampling plan, collecting the needed information, and computing basic statistics to provide input into management decisions. Documented evidence shows that managers of units within the U.S. National Wilderness Preservation System are making decisions without reliable information on the amount, types, and distribution of recreation use occurring at these areas.

Keywords: National Wilderness Preservation System, visitation, visitor use, visitor use estimation

William, S.P., and Cole, D.N., 2001, Number of encounters and experience quality in Grand Canyon backcountry—Consistently negative and weak relationships: *Journal of Leisure Research*, v. 33, p. 106–120.

Recreational carrying capacity and crowding have become perhaps the most studied topics in outdoor recreation research. While there is general agreement that this research has improved our understanding of the complex relationship between use density and the quality of recreation experiences, there are divergent opinions about the extent to which this research (empirical data) has improved management decisions about use limits. Wagar counters previous research and hypothesizes that increases of recreational experiences will only occur if their quality exceeds the cost for less recreational encounters (use-limiting restrictions). William and Cole concur and conclude that indeed the popular empirical paradigms do not contribute to a better understanding of the trade-offs inherent in decisions about restricting access.

Keywords: situational effects, crowding, solitude, experience quality

Index for Annotated Bibliography

Adaptive management

Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management—An integrative approach to wildlife management: *Human Dimensions of Wildlife*, v. 8, p. 81–95.

Attitudes

Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: *Human Dimensions of Wildlife*, v. 6, p. 277–290.

Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: *Human Dimensions of Wildlife*, v. 7, p. 1–19.

Backcountry

Basman, C.M., Manfreda, M.J., Barro, S.C., Vaske, J.J., and Watson, A., 1996, Norm accessibility—An exploratory study of backcountry and frontcountry recreational norms: *Leisure Sciences*, v. 18, p. 177–191.

Cole, D.N., 1989, Low-impact recreational practices for wilderness and backcountry: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-265, 131 p.

Graefe, A.R., Thapa, B., Confer, J.J., and Absher, J.D., 2000, Relationships between trip motivations and selected variables Allegheny National Forest visitors: U.S. Department of Agriculture, Forest Service Proceedings RMRS, v. 15, no. 4, p. 107–112.

Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: *Leisure Sciences*, v. 24, p. 313–324.

Barrier beaches

Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management: *Transactions of the Northeast Recreation Research Conference*, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132: p. 49–56.

Beliefs

Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: *Human Dimensions of Wildlife*, v. 7, p. 1–19.

- Bighorn sheep
- King, M.M., and Workman, G.W., 1986, Response of desert bighorn sheep to human harassment–Management implications: Transactions of the North American Wildlife and Natural Resources Conference, v. 51, p. 74–85.
- Camping
- Cole, D.N., 1989, Low-impact recreational practices for wilderness and backcountry: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-265, 131 p.
- Carrying capacity
- Cole, D.N., and McCool, S.F., 1998, Limits of acceptable change and natural resources planning–When is LAC useful, when is it not? *in* McCool, S.F., and Cole, D.N., Comps., 1998, Proceedings–Limits of acceptable change and related planning processes–Progress and future directions: May 20–22, 1997, Missoula, Mont., General Technical Report INT-GTR-371, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 69–71.
- Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: *Leisure Sciences*, v. 24, p. 313–324.
- Freimund, W.A., Cole, D.N., comps., 2001, Visitor use density and wilderness experience: Proceedings: June 1–3, 2000, Missoula, Montana, [Proceedings] RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.
- Lawson, S.R., and Manning, R.E., 2001, Solitude versus access–A study of tradeoffs in outdoor recreation using indifference curve analysis: *Leisure Sciences*, v. 23, p. 179–191.
- Manning, R.E., and Lawson, S.R., 2002, Carrying capacity as “informed judgment”–The values of science and the science of values: *Environmental Management*, v. 30–32, p. 157–168.
- Manning, R.E., Valliere, W.A., and Wang B., 1999, Crowding norms–Alternative measurement approaches: *Leisure Sciences*, v. 21, p. 97–115.
- Saarinen, J., 1998, Cultural influences on wilderness encounter responses: *International Journal of Wilderness*, v. 4, no. 1, p. 28–32.
- Shelby, B., and Vaske, J.J., Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations–Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.
- Wagar, J.A., 1964, The carrying capacity of wild lands for recreation: *Forest Science–Monograph 7*, Society of American Foresters, 23 p.

- Collaboration
- Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: *Human Dimensions of Wildlife*, v. 6, p. 277–290.
- Comparative/Aggregate/Meta analysis
- Shelby, B., Vaske, J.J., and Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations—Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.
- Crowding/Crowding norms/Perceived crowding
- Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: *Leisure Sciences*, v. 24, p. 313–324.
- Dawson, C.P., and Watson, A.E., 2000, Measures of wilderness trip satisfaction and user perceptions of crowding: U.S. Department of Agriculture, Forest Service Proceedings, *RMRS*, v. 15, no. 4, p. 93–98.
- Inglis, J.G., and Johnson, I.V., 1999, Crowding norms in a marine setting—A case study of snorkeling on the Great Barrier Reef: *Environmental Management*, v. 24, p. 369–381.
- Lawson, S.R., and Manning, R.E., 2001, Solitude versus access—A study of tradeoffs in outdoor recreation using indifference curve analysis: *Leisure Sciences*, v. 23, p. 179–191.
- Manning, R.E., Valliere, W.A., and Wang B., 1999, Crowding norms—Alternative measurement approaches: *Leisure Sciences*, v. 21, p. 97–115.
- Manning, R., Lawson, S., Newman, P., Laven, D., and Valliere, W., 2002, Methodological issues in measuring crowding-related norms in outdoor recreation: *Leisure Sciences*, v. 24, p. 339–348.
- Saarinen, J., 1998, Cultural influences on wilderness encounter responses: *International Journal of Wilderness*, v. 4, no. 1, p. 28–32.
- Shelby, B., Vaske, J.J., and Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations—Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.
- Tarrant, M.A., 1999, Variability of the perceived crowding scale—A research note: *Leisure Sciences*, v. 21, p. 159–164.
- Tarrant, M.A., and Donald, B.K., 1996, A crowding-based model of social carrying capacity—Applications for white water boating use: *Journal of Leisure Research*, v. 28, p. 155–68.
- Vaske, J.J., Donnelly M.P., and Herberlein, T.A., 1980, Perception of crowding and resource quality by early and more recent visitors: *Leisure Sciences*, v. 3, p. 367–381.

Crowding/Crowding
norms/Perceived crowding
(cont'd)

Vaske, J.J., and Donnelly, M.P., 2002, Generalizing the encounter-norm-crowding relationship: *Leisure Sciences*, v. 24, p. 255–269.

William, S.P., and Cole, D.N., 2001, Number of encounters and experience quality in Grand Canyon backcountry—Consistently negative and weak relationships: *Journal of Leisure Research*, v. 33, p. 106–120.

Disturbance

Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreationists on wildlife, Chapter 11 in Knight, R.L., and Gutzwiller, K.J., eds.: *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.

Goff, G.R., Decker, D.J., and Pomerantz, G.A., 1988, A diagnostic tool for analyzing visitor impacts on wildlife refuges—A basis for a systematic approach to visitor management: *Northeast Fish and Wildlife Conference*, v. 45 p. 82.

Lucas, R.C., 1985, The management of recreational visitors in wilderness areas in the United States, p. 122–136, Bayfield, N.G., Barrow, G.C., eds.: *The ecological impacts of outdoor recreation on mountain areas in Europe and North America*: Recreation Ecology Research Group, Wye, Ashford, Kent, United Kingdom, 203 p.

King, M.M., and Workman, G.W., 1986, Response of desert bighorn sheep to human harassment—Management implications: *Transactions of the North American Wildlife and Natural Resources Conference*, v. 51, p. 74–85.

Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges: *Human Dimensions Research Unit Department of Natural Resources, Cornell University, Ithaca, N.Y. and U.S. Fish and Wildlife Service, Office of Information Transfer, Fort Collins, Colo.*, 57 p.

Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences—A contextual approach to normative research: *Leisure Sciences*, v. 24, p. 297–312.

Boyle, S.A., and Samson, F.B., 1983, *Nonconsumptive outdoor recreation—An annotated bibliography of human-wildlife interaction*, U.S. Fish and Wildlife Service, Washington D.C., Special Science Report No. 252, 113 p.

Cole, D.N., 1990, Ecological impacts of wilderness recreation and their management, p. 425–466, Hendee, J.C., Stankey, G.H., and Lucas, R.C., eds.: *Wilderness Management*, North American Press, Golden, Colo.

DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., in *Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision*, v. 2, U.S. Fish and Wildlife Service, Region 1, Portland, Oreg.

- Disturbance (cont'd)
- DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.
- Knight, R.L., and Cole, D.N., 1991, Effects of recreational activity on wildlife in wildlands, Transactions of the 56th North American Wildlife and Natural Resources Conference, p. 238–247.
- Knight, R.L., and Gutzwiller, K.J., eds., Wildlife and recreationists—Coexistence through management and research: Island Press, Washington D.C.
- Sime, C.A., 1999, Domestic dogs in wildlife habitats, p. 8.1–8.17 *in* Joslin, G. and Youmans, H., coordinators, Effects of recreation on Rocky Mountain wildlife: A review for Montana, Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, 307 p.
- Dogs
- Sime, C.A., 1999, Domestic dogs in wildlife habitats, p. 8.1–8.17 *in* Joslin G. and Youmans, H., coordinators, Effects of recreation on Rocky Mountain wildlife: A review for Montana, Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, 307 p.
- Ecological
- Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management: Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132: p. 49–56.
- Encounters
- Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: Leisure Sciences, v. 24, p. 313–324.
- Donnelly, M.P., Vaske, J.J., Whittaker, D., and Shelby, B., 2000, Toward an understanding of norm prevalence—A comparative analysis: Environmental Management, v. 25, p. 403–414.
- Saarinen, J., 1998, Cultural influences on wilderness encounter responses: International Journal of Wilderness, v. 4, no. 1, p. 28–32.
- Vaske, J.J., and Donnelly, M.P., 2002, Generalizing the encounter-norm-crowding relationship: Leisure Sciences, v. 24, p. 255–269.
- Evaluative standards
- Freimund, W.A., Vaske, J.J., Donnelly, M.P., and Miller, T.A., 2002, Using video surveys to access dispersed backcountry visitors' norms: Leisure Sciences, v. 24, p. 348–362.

- Evaluative standards (cont'd) Shelby, B., Vaske, J.J., and Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations: Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.
- Experience/Experience quality Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: *Human Dimensions of Wildlife*, v. 2, p. 551–271.
- William, S.P., and Cole, D.N., 2001, Number of encounters and experience quality in Grand Canyon backcountry—Consistently negative and weak relationships: *Journal of Leisure Research*, v. 33, p. 106–120.
- Management frameworks Cole, D.N., 1994, Wilderness threats matrix—A framework for assessing impacts. Research Report INT-475, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.
- Cole, D.N., and McCool, S.F., 1998, Limits of acceptable change and natural resources planning—When is LAC useful, when is it not? *in* McCool, S.F., and Cole, D.N., comps., 1998, Proceedings—Limits of acceptable change and related planning processes—Progress and future directions, May 20–22, 1997, Missoula, Mont., General Technical Report, INT-GTR-371, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 69–71.
- Higgenbottom, K., Green, R., and Northrope, C., 2003, A framework for managing the negative impacts of wildlife tourism on wildlife: *Human Dimensions of Wildlife*, v. 8, p. 1–24.
- Knight, R.L., and Gutzwiller, K.J., eds., *Wildlife and recreationists—Coexistence through management and research*: Island Press: Washington D.C.
- Manfredo, M.J., Vaske, J.J., and Sikorowski, L., 1996, Human dimensions of wildlife management, p. 53–72, *in* Ewert, A., ed.: *Natural Resource Management—The Human Dimension*: Boulder, Colo., Westview Press.
- Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges, Human Dimensions Research Unit Department of Natural Resources, Cornell University, Ithaca, N.Y. and U.S. of Fish Wildlife Service Office of Information Transfer, Fort Collins, Colo., 57 p.
- Frontcountry Basman, C.M., Manfredo, M.J., Barro, S.C., Vaske, J.J., and Watson, A., 1996, Norm accessibility—An exploratory study of backcountry and frontcountry recreational norms: *Leisure Sciences*, v. 18, p. 177–191.

- Frontcountry (cont'd) Graefe, A.R., Thapa, B., Confer, J.J., and Absher, J.D., 2000, Relationships between trip motivations and selected variables Allegheny National Forest visitors: U.S. Department of Agriculture, Forest Service Proceedings RMRS, v. 15, no. 4, p. 107–112.
- Habitat alteration Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: *Environmental Management*, v. 11, no. 1, p. 45–52.
- Harassment King, M.M., and Workman, G.W., 1986, Response of desert bighorn sheep to human harassment—Management implications: *Transactions of the North American Wildlife and Natural Resources Conference*, v. 51, p. 74–85.
- Human dimensions Knight, R.L., and Gutzwiller, K.J., eds.: *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.
- Manfredo, M.J., Vaske, J.J., and Sikorowski, L., 1996, Human dimensions of wildlife management, p. 53–72, *in* Ewert A., Ed.: *Natural Resource Management, The Human Dimension*, Boulder, Colo., Westview Press.
- Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: *Human Dimensions of Wildlife*, v. 6, p. 277–290.
- Noe, F.P., Hammitt, W.E., and R.D., Bixler, 1995, Park user perceptions of resource and use impacts under varied situations in three national parks: *Journal of Environmental Management*, v. 49, no. 3, p. 323–336.
- Hunting Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: *Human Dimensions of Wildlife*, v. 7, p. 1–19.
- DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., *in* Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2, U.S. Fish and Wildlife Service, Region 1, Portland, Oreg.
- DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.

Image capture technology

Freimund, W.A., Vaske, J.J., Donnelly, M.P., and Miller, T.A., 2002, Using video surveys to access dispersed backcountry visitors' norms: *Leisure Sciences*, v. 24, p. 348–362.

Impacts (indirect, trail, visitor, wildlife)

Anderson, D.H., Lime, D.W., and Wang, T.L., 1998, Maintaining the quality of park resources and visitor experiences—A handbook for managers, TC-777, St. Paul: University of Minnesota Extension Tourism Center, 149 p.

Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: *Wildlife Society Bulletin*, v. 13, no. 2, p. 110–116.

Cole, D.N., 1994, Wilderness threats matrix—A framework for assessing impacts, Research Report INT-475, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Cole, D.N., 2004, Environmental Impacts of outdoor recreation in wildlands, 10th Anniversary ISSRM Book, Fort Collins, Colo.: International Association for Society and Natural Resources, v. 10, p. 107–116.

Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreationists on wildlife, Chapter 11 in Knight, R.L., and Gutzwiller, K.J., eds, *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.

Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management, *Transactions of the Northeast Recreation Research Conference*, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.

DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., *in* Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2, Department of the Interior, U.S. Fish and Wildlife Service, Region 1, Portland, Oreg.

DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.

Higgenbottom, K., Green, R., and Northrope, C., 2003, A framework for managing the negative impacts of wildlife tourism on wildlife: *Human Dimensions of Wildlife*, v. 8, p. 1–24.

Knight, R.L., and Cole, D.N., 1991, Effects of recreational activity on wildlife in wildlands: *Transactions of the 56th North American Wildlife and Natural Resources Conference*, p. 238–247.

Impacts (indirect, trail, visitor, wildlife) (cont'd)

Leung, Y.F., and Marion, J.F., 1999, Spatial strategies for managing visitor impacts in national parks:, *Journal of Park and Recreation Administration*, v. 17, no. 4, p. 20–38.

Leung, Y.F., and Marion, J.L., 1998, Evaluating spatial qualities of visitor impacts on recreation resources—An index approach: *Journal of Applied Recreation Research*, v. 23, no. 4, p. 367–389.

Marion, J.L., and Leung, Y.F., 1998, Trail resource impacts and examination of alternative assessment techniques: *Journal of Park and Recreation Administration*, v. 19, no. 3, p. 17–37.

Noe, F.P., Hammitt, W.E., and R.D., Bixler, 1995, Park user perceptions of resource and use impacts under varied situations in three national parks: *Journal of Environmental Management*, v. 49, no. 3, p. 323–336.

Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges: Human Dimensions Research Unit Department of Natural Resources, Cornell University of Ithaca, N.Y. and U.S. Fish Wildlife Service, Office of Information Transfer, Fort Collins, Colo., 57 p.

Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management: An integrative approach to wildlife management: *Human Dimensions of Wildlife*, v. 8, p. 81–95.

Sime, C.A., 1999, Domestic dogs in wildlife habitats p. 8.1-8.17 in Joslin, G. and Youmans, H., coordinators, *Effects of recreation on Rocky Mountain wildlife—A review for Montana*, Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, 307 p.

Taylor, A.R., and Knight, R.L., 2003, Wildlife responses to recreation and associated visitor perceptions: *Ecological Applications*, v. 13, no. 4, p. 951–963.

Indicators

Cole, D.N., 1994, Wilderness threats matrix—A framework for assessing impacts, Research Report INT-475, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management, Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.

Knight, R.L., Gutzwiller, K.J., eds.: *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.

- Indifference curves
- Lawson, S.R., and Manning, R.E., 2001, Solitude versus access—A study of tradeoffs in outdoor recreation using indifference curve analysis: *Leisure Sciences*, v. 23, p. 179–191.
- Limits of acceptable change
- Cole, D.N., and McCool, S.F., 1998, Limits of acceptable change and natural resources planning—When is LAC useful, when is it not? *in* McCool, S.F., and Cole, D.N., Comps., 1998, Proceedings—Limits of acceptable change and related planning processes—Progress and future directions, May 20–22, 1997, Missoula, Mont., General Technical Report INT-GTR-371, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 69–71.
- Cole, D.N., and Stewart, W.P., 2002, Variability of user-based evaluative standards for backcountry encounters: *Leisure Sciences*, v. 24, p. 313–324.
- Shelby, B., Vaske, J.J., and Heberlein, T.A., 1989, Comparative analysis of crowding in multiple locations—Results from fifteen years of research: *Leisure Sciences*, v. 11, p. 269–291.
- Low-impact practices
- Cole, D.N., 1989, Low-impact recreational practices for wilderness and backcountry: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-265, 131 p.
- Management
- Goff, G.R., Decker, D.J., and Pomerantz, G.A., 1988, A diagnostic tool for analyzing visitor impacts on wildlife refuges—A basis for a systematic approach to visitor management: *Northeast Fish and Wildlife Conference* v. 45, no. 82.
- Knight, R.L., and Gutzwiller, K.J., eds., *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.
- Leung, Y.F., and Marion, J.L., 1998, Evaluating spatial qualities of visitor impacts on recreation resources—An index approach: *Journal of Applied Recreation Research*, v. 23, no. 4, p. 367–389.
- Leung, Y.F., and Marion, J.L., 1999, Spatial strategies for managing visitor impacts in national parks: *Journal of Park and Recreation Administration*, v. 17, no. 4, p. 20-38.
- Manfredo, M.J., Vaske, J.J., and Sikorowski, L., 1996, Human dimensions of wildlife management, p. 53–72, *in* Ewert, A., ed.: *Natural Resource Management: The Human Dimension*, Boulder, Colo., Westview Press.
- Manning, R.E., and Lawson, S.R., 2002, Carrying capacity as “informed judgment”—The values of science and the science of values: *Environmental Management*, v. 30–2, p. 157–168.

- Management (cont'd)
- Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, A guide to managing human activity on National Wildlife Refuges—Human Dimensions Research Unit Department of Natural Resources, Cornell University, Ithaca, N.Y. and U.S. Fish and Wildlife Service, Office of Information Transfer, Fort Collins, Colo., 57 p.
- Sime, C.A., 1999, Domestic dogs in wildlife habitats, p. 8.1–8.17 *in* Joslin, G. and Youmans, H., coordinators, Effects of recreation on Rocky Mountain wildlife—A review for Montana: Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society, 307 p.
- Wagar, J.A., 1964, The carrying capacity of wild lands for recreation, Forest Science—Monograph 7: Society of American Foresters, 23 p.
- Management solutions
- Anderson, D.H., Lime, D.W., and Wang, T.L., 1998, Maintaining the quality of park resources and visitor experiences—A handbook for managers, TC-777, St. Paul: University of Minnesota Extension Tourism Center, 149 p.
- Management techniques
- Lucas, R.C., 1985, The management of recreational visitors in wilderness areas in the United States, p. 122–136, Bayfield, N.G., and Barrow, G.C., eds.: The ecological impacts of outdoor recreation on mountain areas in Europe and North America, Recreation Ecology Research Group, Wye, Ashford, Kent, UK. 203 p.
- Management threats matrix
- Cole, D.N., 1994, Wilderness threats matrix—A framework for assessing impacts: Research Report INT-475, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.
- Marine settings
- Inglis, J.G., and Johnson, I.V., 1999, Crowding norms in a marine setting—A case study of snorkeling on the Great Barrier Reef: Environmental Management, v. 24, p. 369–381.
- Methodology
- Manning, R., Lawson, S., Newman, P., Laven, D., and Valliere, W., 2002, Methodological issues in measuring crowding-related norms in outdoor recreation: Leisure Sciences, v. 24, p. 339–348.
- Monitoring
- Higgenbottom, K., Green, R., Northrope, C., 2003, A framework for managing the negative impacts of wildlife tourism on wildlife: Human Dimensions of Wildlife, v. 8, p. 1–24.

Monitoring (cont'd)	Marion, J.L., and Leung, Y.F., 1998, Trail resource impacts and examination of alternative assessment techniques: <i>Journal of Park and Recreation Administration</i> , v. 19, no. 3, p. 17–37.
Motivations	Graefe, A.R., Thapa, B., Confer, J., and Absher, J.D., 2000, Relationships between trip motivations and selected variables Allegheny National Forest visitors: U.S. Department of Agriculture, Forest Service, <i>Proceedings RMRS</i> , v. 15, no. 4, p. 107-112.
National Parks	
Acadia National Park	Manning, R.E., Valliere, W.A., and Wang B., 1999, Crowding norms–Alternative measurement approaches: <i>Leisure Sciences</i> , v. 21, p. 97–115.
Arches National Park	Lawson, S.R., and Manning, R.E., 2001, Solitude versus access–A study of tradeoffs in outdoor recreation using indifference curve analysis: <i>Leisure Sciences</i> , v. 23, p.179–191.
Denali National Park and Preserve	Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences–A contextual approach to normative research: <i>Leisure Sciences</i> , v. 24, p. 297–312.
National Wilderness Preservation System	Watson, A.E., Cole, D.N., Turner, D.L., and Reynolds, P.S., 2000, Wilderness recreation use estimation–A handbook of methods and systems: General Technical Report RMRS-GTR-56, Ogden, Utah, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 198 p.
National Wildlife Refuge	<p>Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, <i>A guide to managing human activity on National Wildlife Refuges: Human Dimensions Research Unit Department of Natural Resources, Cornell University, Ithaca, N.Y. and U.S. Fish Wildlife Service, Office of Information Transfer, Fort Collins, Colo., 57 p.</i></p> <p>DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds–A literature review of impacts and mitigation measures <i>in</i> Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2: Portland, Oreg., prepared for Stillwater National Wildlife Refuge, U.S. Fish and Wildlife Service, Appendix L, 114 p.</p> <p>DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.</p>

- Nonconsumptive
- Boyle, S.A., and Samson, F.B., 1983, Nonconsumptive outdoor recreation—An annotated bibliography of human-wildlife interactions: U.S. Fish and Wildlife Service, Washington D.C., Special Science Report: Wildlife, no. 252, 113 p.
- Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: *Wildlife Society Bulletin*, v. 13, no. 2, p. 110–116.
- Norms
- Basman, C.M., Manfredo, M.J., Barro, S.C., Vaske, J.J., and Watson, A., 1996, Norm accessibility—An exploratory study of backcountry and frontcountry recreational norms: *Leisure Sciences*, v. 18, p. 177–191.
- Donnelly, M.P., Vaske, J.J., Whittaker, D., and Shelby, B., 2000, Toward an understanding of norm prevalence—A comparative analysis: *Environmental Management*, v. 25, p. 403–414.
- Freimund, W.A., Vaske, J.J., Donnelly, M.P., and Miller, T.A., 2002, Using video surveys to access dispersed backcountry visitors' norms: *Leisure Sciences*, v. 24, p. 348–362.
- Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences—A contextual approach to normative research: *Leisure Sciences*, v. 24, p. 297–312.
- Manning, R.E., and Lawson, S.R., 2002, Carrying capacity as “informed judgment”—The values of science and the science of values: *Environmental Management*, v. 30–2, p. 157–168.
- Manning, R., Lawson, S., Newman, P., Laven, D., and Valliere, W., 2002, Methodological issues in measuring crowding-related norms in outdoor recreation: *Leisure Sciences*, v. 4, p. 339–348.
- Saarinen, J., 1998, Cultural influences on wilderness encounter responses: *International Journal of Wilderness*, v. 4, no. 1, p. 28–32.
- Tarrant, M.A., 1999, Variability of the perceived crowding scale—A research note: *Leisure Sciences*, v. 21, p. 159–164.
- Vaske, J.J., and Donnelly, M.P., 2002, Generalizing the encounter-norm-crowding relationship: *Leisure Sciences*, v. 24, p. 255–269.
- Off-road vehicles
- Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: *Environmental Management*, v. 11, no. 1, p. 45–52.
- Outdoor recreation
- Manning, R., Lawson, S., Newman, P., Laven, D., and Valliere, W., 2002, Methodological issues in measuring crowding-related norms in outdoor recreation: *Leisure Sciences*, v. 24, p. 339–348.

Outdoor recreation (cont'd)	<p>Cole, D.N., 1990, Ecological impacts of wilderness recreation and their management, p. 425–466, Hendee, J.C., Stankey, G.H., and Lucas, R.C., eds.: Wilderness Management, North American Press, Golden, Colo.</p> <p>Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: <i>Human Dimensions of Wildlife</i>, v. 7, p. 1–19.</p> <p>DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., <i>in</i> Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2, U.S. Fish and Wildlife Service, Portland, Oreg.</p> <p>DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.</p>
Paired comparisons	<p>Lawson, S.R., and Manning, R.E., 2001, Solitude versus access—A study of tradeoffs in outdoor recreation using indifference curve analysis: <i>Leisure Sciences</i>, v. 23, p. 179–191.</p>
Personal characteristics	<p>Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: <i>Human Dimensions of Wildlife</i>, v. 2, p. 551–271.</p>
Place	<p>Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: <i>Human Dimensions of Wildlife</i>, v. 2: p. 551–271.</p>
Planning	<p>Anderson, D.H., Lime, D.W., and Wang, T.L., 1998, Maintaining the quality of park resources and visitor experiences—A handbook for managers, TC-777, St. Paul: University of Minnesota Extension Tourism Center, 149 p.</p>
Public involvement	<p>Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: <i>Human Dimensions of Wildlife</i>, v. 6, p. 277–290.</p>

Recreation

Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: *Environmental Management*, v. 11, v. 1, p. 45–52.

Boyle, S.A., and Samson, F.B., 1983, Nonconsumptive outdoor recreation—An annotated bibliography of human-wildlife interactions: U.S. Fish and Wildlife Service, Washington D.C., Special Science Report: Wildlife, no. 252, 113 p.

Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: *Wildlife Society Bulletin*, v. 13, no. 2, p. 110–116.

Cole, D.N., 1996, Wilderness recreation use trends, 1965–1994, Research Paper INT-RP-488, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, 10 p., Leopold Publication No. 282.

Cole, D.N., and McCool, S.F., 1998, Limits of acceptable change and natural resources planning—When is LAC useful, when is it not? *in* McCool, S.F., and Cole, D.N., Comps., 1998, Proceedings—Limits of acceptable change and related planning processes—Progress and future directions, May 20–22, 1997, Missoula, Mont. General Technical Report INT-GTR-371, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 69–71.

Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management: Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y., April 3–5, 1988, Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.

Goff, G.R., Decker, D.J., and Pomerantz, G.A., 1988, A diagnostic tool for analyzing visitor impacts on wildlife refuges—A basis for a systematic approach to visitor management: Northeast Fish and Wildlife Conference, v. 45, 82 p.

Inglis, J.G., and Johnson, I.V., 1999, Crowding norms in a marine setting—A case study of snorkeling on the Great Barrier Reef: *Environmental Management*, v. 24, p. 369–381.

Knight, R.L., and Cole, D.N., 1991, Effects of recreational activity on wildlife in wildlands: Transactions of the 56th North American Wildlife and Natural Resources Conference, p. 238–247.

Lucas, R.C., 1985, The management of recreational visitors in wilderness areas in the United States, p. 122–136 Bayfield, N.G., and Barrow, G.C., eds., *The ecological impacts of outdoor recreation on mountain areas in Europe and North America: Recreation Ecology Research Group*, Wye, Ashford, Kent, United Kingdom, 203 p.

Marion, J.L., and Leung, Y.F., 1998, Trail resource impacts and examination of alternative assessment techniques: *Journal of Park and Recreation Administration*, v. 19, no. 3, p. 17–37.

- Recreation (cont'd)
- Noe, F.P., Hammitt, W.E., and Bixler, R.D., 1995, Park user perceptions of resource and use impacts under varied situations in three national parks: *Journal of Environmental Management*, v, 49, no. 3, p. 323–336.
- Purdy, K.G., Goff, G.R., Decker, D.J., Pomerantz, G.A., and Connelly, N.A., 1987, *A guide to managing human activity on National Wildlife Refuges*, Human Dimensions Research Unit Department of Natural Resources: Cornell University, Ithaca, N.Y. and U.S. Fish Wildlife Service, Office of Information Transfer, Fort Collins, Colo., 57 p.
- Taylor, A.R., and Knight, R.L., 2003, Wildlife responses to recreation and associated visitor perceptions: *Ecological Applications*, v. 13, no. 4, p. 951–963.
- Wagar, J.A., 1964, The carrying capacity of wild lands for recreation: *Forest Science–Monograph 7*, Society of American Foresters, Forest Science Monograph 7, 23 p.
- Recreation ecology
- Cole, D.N., 2004, Environmental Impacts of outdoor recreation in wildlands, 10th Anniversary ISSRM Book, Fort Collins, Colo., International Association for Society and Natural Resources, v. 10, p. 107–116.
- Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreationists on wildlife, Chapter 11 in Knight, R.L., and Gutzwiller, K.J., eds., *Wildlife and recreationists–Coexistence through management and research*: Island Press, Washington D.C.
- Recreation management
- Freimund, W.A., and Cole, D.N., comps., 2001, Visitor use density and wilderness experience–Proceedings, June 1–3, 2000, Missoula, Mont., Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.
- Recreational impacts
- Cole, D.N., 2004, Environmental Impacts of outdoor recreation in wildlands, 10th Anniversary ISSRM Book, Fort Collins, Colo.: International Association for Society and Natural Resources, v. 10, p. 107–116.
- Reported contacts
- Vaske, J.J., Donnelly M.P., and Herberlein, T.A., 1980, Perception of crowding and resource quality by early and more recent visitors: *Leisure Sciences*, v. 3, p. 367–381.

Research methods	Freimund, W.A., and Cole, D.N., comps., 2001, Visitor use density and wilderness experience—Proceedings, June 1–3, 2000, Missoula, Mont., Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.
Resource quality	Vaske, J.J., Donnelly M.P., and Herberlein, T.A., 1980, Perception of crowding and resource quality by early and more recent visitors: <i>Leisure Sciences</i> , v. 3, p. 367–381.
Saliency	Basman, C.M., Manfredo, M.J., Barro, S.C., Vaske, J.J., and Watson, A., 1996, Norm accessibility—An exploratory study of backcountry and frontcountry recreational norms: <i>Leisure Sciences</i> , v. 18, p. 177–191.
Sand dunes	Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: <i>Environmental Management</i> , v. 11, no. 1, p. 45–52.
Satisfaction	Dawson, C.P., and Watson, A.E., 2000, Measures of wilderness trip satisfaction and user perceptions of crowding: U.S. Department of Agriculture, Forest Service Proceedings, RMRS, v. 15, no. 4, p. 93–98. Lucas, R.C., 1985, The management of recreational visitors in wilderness areas in the United States, p. 122–136, Bayfield, N.G., and Barrow, G.C., eds., <i>The ecological impacts of outdoor recreation on mountain areas in Europe and North America</i> : Recreation Ecology Research Group, Wye, Ashford, Kent, United Kingdom, 203 p.
Situational effects	William, S.P., and Cole, D.N., 2001, Number of encounters and experience quality in Grand Canyon backcountry—Consistently negative and weak relationships: <i>Journal of Leisure Research</i> , v. 33, p. 106–120.
Snorkeling	Inglis, J.G., and Johnson, I.V., 1999, Crowding norms in a marine setting—A case study of snorkeling on the Great Barrier Reef: <i>Environmental Management</i> , v. 24, p. 369–381.

Social impacts	Deblinger, R.D., Vaske, J.J., and Donnelly, M.P., 1989, Integrating ecological and social impacts into barrier beach management, Transactions of the Northeast Recreation Research Conference, Saratoga, N.Y. April 3–5, 1988: Northeast Forest Experiment Station Technical Report NE-132, p. 49–56.
Socialization	Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: Human Dimensions of Wildlife, v. 2, p. 551–271.
Solitude	<p>Dawson, C.P., and Watson, A.E., 2000, Measures of wilderness trip satisfaction and user perceptions of crowding, U.S. Department of Agriculture, Forest Service Proceedings, RMRS, v. 15, no. 4, p. 93–98.</p> <p>Freimund, W.A., and Cole, D.N., comps., 2001, Visitor use density and wilderness experience—Proceedings June 1–3, 2000, Missoula, Mont. Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.</p> <p>Lawson, S.R., and Manning, R.E., 2001, Solitude versus access—A study of tradeoffs in outdoor recreation using indifference curve analysis: Leisure Sciences, v. 23, p. 179–191.</p> <p>William, S.P., and Cole, D.N., 2001, Number of encounters and experience quality in Grand Canyon backcountry—Consistently negative and weak relationships: Journal of Leisure Research, v. 33, p. 106–120.</p>
Spatial strategies	<p>Leung, Y.F., and Marion, J.L., 1998, Evaluating spatial qualities of visitor impacts on recreation resources—An index approach: Journal of Applied Recreation Research, v. 23, no. 4, p. 367–389.</p> <p>Leung, Y.F., and Marion, J.F., 1999, Spatial strategies for managing visitor impacts in national parks: Journal of Park and Recreation Administration, v. 17, no. 4, p. 20–38.</p>
Stakeholders	Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management—An integrative approach to wildlife management: Human Dimensions of Wildlife, v. 8, p. 81–95.
Standards / Standards of quality	Knight, R.L., and Gutzwiller, K.J., eds., Wildlife and recreationists—Coexistence through management and research: Island Press, Washington D.C.

Standards / Standards of quality (cont'd)	<p>Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences—A contextual approach to normative research: <i>Leisure Sciences</i>, v. 24, p. 297–312.</p> <p>Manning, R.E., and Lawson, S.R., 2002, Carrying capacity as “informed judgment”—The values of science and the science of values: <i>Environmental Management</i>, v. 30–2, p. 157–168.</p> <p>Manning, R.E., Valliere, W.A., and Wang B., 1999, Crowding norms—Alternative measurement approaches: <i>Leisure Sciences</i>, v. 21, p. 97–115.</p>
Stated choice analysis	<p>Lawson, S.R., and Manning, R.E., 2002, Tradeoffs among social, resource, and management attributes of the Denali Wilderness experiences—A contextual approach to normative research: <i>Leisure Sciences</i>, v. 24, p. 297–312.</p>
Trends	<p>Cole, D.N., 1996, Wilderness recreation use trends, 1965–1994, Research Paper INT-RP-488, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, 10 p., Leopold Publication, No. 282.</p>
Use limits	<p>Freimund, W.A., and Cole, D.N., comps., 2001, Visitor use density and wilderness experience—Proceedings, June 1–3, 2000, Missoula, Mont., Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.</p>
User densities	<p>Dawson, C.P., and Watson, A.E., 2000, Measures of wilderness trip satisfaction and user perceptions of crowding: U.S. Department of Agriculture, Forest Service Proceedings, RMRS, v. 15, no. 4, p. 93–98.</p>
Values	<p>Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: <i>Human Dimensions of Wildlife</i>, v. 7, p. 1–19.</p> <p>Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: <i>Human Dimensions of Wildlife</i>, v. 2, p. 551–271.</p> <p>Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management— An integrative approach to wildlife management: <i>Human Dimensions of Wildlife</i>, v. 8, p. 81–95.</p>

Vegetation	Anders, F.J., and Leatherman, S.P., 1987, Effects of off-road vehicles on coastal foredunes at Fire Island, N.Y., USA: <i>Environmental Management</i> , v. 11, no. 1, p. 45–52.
Visitation	Watson, A.E., Cole, D.N., Turner, D.L., and Reynolds, P.S., 2000, Wilderness recreation use estimation—A handbook of methods and systems: General Technical Report RMRS-GTR-56, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 198 p.
Visitor use estimation	Watson, A.E., Cole, D.N., Turner, D.L., and Reynolds, P.S., 2000, Wilderness recreation use estimation—A handbook of methods and systems: General Technical Report RMRS-GTR-56, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 198 p.
Waterbirds	<p>DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., <i>in</i> Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2, U.S. Fish and Wildlife Service, Portland, Oreg.</p> <p>DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.</p>
Whitewater boating	<p>Tarrant, M.A., 1999, Variability of the perceived crowding scale—A research note: <i>Leisure Sciences</i>, v. 21, p. 159–164.</p> <p>Tarrant, M.A., and Donald, B.K., 1996, A crowding-based model of social carrying capacity—Applications for white water boating use: <i>Journal of Leisure Research</i>, v. 28, p. 155–68.</p>
Wilderness	<p>Cole, D.N., 1989, Low-impact recreational practices for wilderness and backcountry: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-265, 131 p.</p> <p>Cole, D.N., 1996, Wilderness recreation use trends, 1965–1994, Research Paper INT-RP-488, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, 10 p., Leopold Publication No. 282.</p>

- Wilderness experience
- Freimund, W.A., and Cole, D.N., comps., 2001, Visitor use density and wilderness experience—Proceedings, June 1–3, 2000, Missoula, Mont., Proceedings RMRS-P-20, Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 67 p.
- Wildlife
- Boyle, S.A., and Samson, F.B., 1985, Effects of nonconsumptive recreation on wildlife—A review: *Wildlife Society Bulletin*, v. 13, no. 2, p. 110–116.
- Cole, D.N., and Landres, P.B., 1995, Indirect effects of recreationists on wildlife, Chapter 11 in Knight, R.L., and Gutzwiller, K.J., eds. *Wildlife and recreationists—Coexistence through management and research*: Island Press, Washington D.C.
- Goff, G.R., Decker, D.J., and Pomerantz, G.A., 1988, A diagnostic tool for analyzing visitor impacts on wildlife refuges—A basis for a systematic approach to visitor management: *Northeast Fish and Wildlife Conference*, v. 45, no. 82.
- Wildlife management
- DeLong, A.K., 2002, Managing visitor use and disturbance of waterbirds—A literature review of impacts and mitigation measures—prepared for Stillwater National Wildlife Refuge, Appendix L, 114 p., in Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision, v. 2, U.S. Fish and Wildlife Service, Portland, Oreg.
- DeLong, A. and Adamcik, R.S. in press, Managing the impacts of visitor use on waterbirds: A literature review of impacts and mitigation measures, U.S. Fish and Wildlife Service.
- Mortenson, K.G., and Krannich, R.S., 2001, Wildlife managers and public involvement—Letting the crazy aunt out: *Human Dimensions of Wildlife*, v. 6, p. 277–290.
- Riley, S.J., Siemer, W.F., and Decker, D.J., 2003, Adaptive impact management—An integrative approach to wildlife management: *Human Dimensions of Wildlife*, v. 8, p. 81–95.
- Wildlife responses
- Taylor, A.R., and Knight, R.L., 2003, Wildlife responses to recreation and associated visitor perceptions: *Ecological Applications*, v. 13, no. 4, p. 951–963.
- Wildlife tourism
- Higgenbottom, K., Green, R., and Northrope, C., 2003, A framework for managing the negative impacts of wildlife tourism on wildlife: *Human Dimensions of Wildlife*, v. 8, p. 1–24.

Wildlife value orientations

Deruiter, D., and Donnelly, M.P., 2002, A qualitative approach to measuring determinants of wildlife value orientations: *Human Dimensions of Wildlife*, v. 2, p. 551–271.

Wildlife viewing

Daigle, J.J., Hrubes, D., and Ajzen, I., 2002, A comparative study of beliefs, attitudes, and values among, hunters, wildlife viewers, and other outdoor recreationists: *Human Dimensions of Wildlife*, v. 7, p. 1–19.