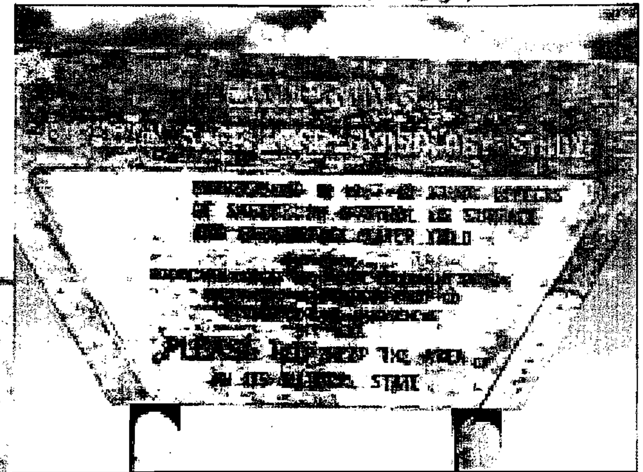

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Stratton Sagebrush Hydrology Study Area: An Annotated Bibliography of Research Conducted 1968 to 1990

By Leah M. Burgess and Kathryn A. Schoenecker

Open-File Report 2004-1291

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Stratton Sagebrush Hydrology Study Area: An Annotated Bibliography of Research Conducted 1968 to 1990

By Leah M. Burgess[1] and Kathryn A. Schoenecker[2]

Research Summary

This annotated bibliography provides an overview of research projects conducted on the Stratton Sagebrush Hydrology Study Area (Stratton) since its designation as such in 1967. Sources include the Rocky Mountain Forest and Range Experiment Station records storage room, Laramie, Wyoming, the USGS and USFS online reference libraries, and scientific journal databases at the University of Wyoming and Colorado State University. This annotated bibliography summarizes publications from research conducted at Stratton during the prime of its tenure as a research lab from 1968 to 1990. In addition, an appendix is included that catalogues all data on file at the Rocky Mountain Forest and Range Experiment Station in Laramie, Wyoming. Each file folder was searched and its contents recorded here for the researcher seeking original data sets, charts, photographs and records.

Acknowledgments

This project was funded by the U.S. Geological Survey (USGS), in support of partnership science with the U.S. Department of the Interior, Bureau of Land Management. We would like to acknowledge the U.S. Department of Agriculture, Forest Service Rocky Mountain Research Lab in Laramie, Wyoming for providing generous access to research documents, as well as use of their facilities and photocopying equipment. We thank two reviewers, Dr. Dave Swift, Colorado State University, and Art Allen, USGS -FORT, for their meticulous and thorough reviews.

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[2] Ecologist in the Ungulate Ecology Project, United States Geological Survey- Biological Resources Discipline, Fort Collins Science Center, Colorado.

Introduction

The Stratton Sagebrush Hydrology Study Area (Stratton) is located in southcentral Wyoming, about 30 km west of the town of Saratoga. The 7,000-acre site is a high elevation sagebrush steppe ecosystem, with five watersheds instrumented for research within its boundary. Beginning in 1968, studies have been conducted on a wide range of topics related to the hydrology of sagebrush lands, and effects of sagebrush control on hydrologic function of both individual plants and entire watersheds. Several studies were conducted on effects of spraying the herbicide 2,4-D (2,4-dichlorophenoxyacetic acid), including effects on soils, plants, water quality and quantity, and aquatic and terrestrial wildlife. The reader will find those and many more studies in this document, including research on snow fences and blowing snow, snowmold fungus on mountain big sagebrush, precipitation and stream gage development, and weather station instrumentation. The body of work resulting from Stratton is impressive, and we should not go further without mentioning David L. Sturges, the prolific and apparently energetic individual who published many articles from his research conducted at Stratton, and whose scientific methodology and documentation are extremely thorough and complete. The legacy left from the former research scientists at Stratton is a great gift to the future of studies in sagebrush steppe, and some of their data will be used as baseline information for continuing research. This annotated bibliography is one step in the process of preserving and making accessible the information gained by more than 20 years of active research in sagebrush hydrology and ecosystem function in a high elevation sagebrush steppe.

How to Use This Bibliography

Publication summaries are numbered alphabetically by author. Publications by the same author(s) are ordered by date from the oldest to the most recent. Each publication summary is followed by a keyword list that may be referenced by publication number in the Keyword Index beginning on page 4. The Keyword Index is organized by general topic heading, with specific keywords and the call number of the publications they appear with listed below. The appendix appears directly after the bibliography. File folder titles and content descriptions in the appendix are organized exactly as they are encountered in the records storage room at the U.S.D.A. Forest Service Rocky Mountain Research Lab in Laramie, Wyoming. The Stratton Sagebrush Hydrology Study Area is referred to as "Stratton" throughout this document.

Keywords by Topic

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Wildlife

Bibliography

1. Bird, K.G., 1977, Extending service intervals for drum-type meteorological instruments: Research Note RM-350. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado, 3 p.

A technical description is presented of how to modify solar radiation data recorders at remote locations to get the same resolution as 8-day drum recorders in a unit that only needs to be serviced monthly. The test site was the Stratton. The drive gears on two solar radiation recorders were modified to change the drum rotation period from 8 days to 7.33 days which provided an offset between recording periods, so recordings would not directly overlap on the chart from week to week. The modification works best when recording cycling data such as temperature and humidity that change predictably over the course of one day, so data are more easily discerned from one day to the next.

Keywords: data recorder

2. Braun, C.E., Baker, M.F., Eng, R.L., Gashwiler, J.S., and Schroeder, M.H., 1976, Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna: The Wilson Bulletin, vol. 88, no. 1, p. 165–171.

This summary report explores the historical expanse of sagebrush lands, the control of big sagebrush by mechanical, biological and chemical methods, and the effects of such control on the wildlife components of sagebrush landscapes, particularly on avifauna. Birds that are sagebrush obligates include sage grouse (*Centrocercus urophasianus*), sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), and Brewer's sparrow (*Spizella breweri*). M.H. Schroeder and D.L. Sturges conducted a study at Stratton on the effects of 2,4-dichlorophenoxyacetic acid (2,4-D) spraying on Brewer's sparrow nesting and reproduction. This paper references that study as well as similar studies on effects of sagebrush control on Brewer's sparrow and sage grouse. The authors make seven general recommendations for management of sagebrush. In summary, they recommend careful consideration of all ecosystem aspects when using sagebrush control as a management tool because sagebrush landscapes are valuable and desirable for domestic livestock as well as wildlife.

Keywords: big sagebrush, Brewer's sparrow, herbicide, sagebrush control, sage grouse

3. Burke, I.C., Reiners, W.A., Sturges, D.L., and Matson, P.A., 1987, Herbicide treatment effects on properties of mountain big sagebrush soils after fourteen years: Soil Science Society of America Journal, vol. 51, p. 1337–1343.

The authors documented soil chemical properties at Stratton in plots treated with 2,4-dichlorophenoxyacetic acid (2,4-D) and untreated control plots. Spraying 2,4-D is used as a method to control sagebrush in order to increase grass production on rangelands. Experimental plots were sprayed at Stratton in 1970 for research purposes, and this study was conducted 14 years later to look at soil chemical changes in the conversion of a shrubland dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) to a grassland community. Researchers noted that the kill by 2,4-D was quite effective as treated plots were largely void of live sage 14 years after treatment. Study results showed no differences in total carbon, sodium, magnesium, cation exchange capacity, base saturation, bulk density, or potential N mineralization rates between treated and untreated plots at any depth. There was no increase in surface N in the converted grassland, and total soil profile content of N did not differ between treatments. In untreated sagebrush sites, net N mineralization was higher under shrubs than under interspaces. In treated sites, N mineralization did not differ under shrub skeletons versus interspaces. Overall N mineralization was higher under live shrubs in untreated sites than dead shrubs in treated sites. The C/N ratio did increase from 10:1 in untreated plots to 15:1 in grass plots at the surface and at 3 other depths, suggesting more favorable C mineralization substrates in sagebrush plots. In summary, the authors found site fertility to be essentially unaffected by 2,4-D treatment in the absence of grazing 14 years after spraying, but the cycling and spatial distribution of elements in soil profiles had changed.

Keywords: big sagebrush, herbicide, nitrogen mineralization, sagebrush control, soil chemical properties

4. Burke, I.C., 1989, Control of nitrogen mineralization in a sagebrush steppe landscape: Ecology, vol. 70, no. 4, p. 1115– 1126.

Burke hypothesized that substrate availability and soil microclimate (ecosystem controls that operate at different time scales) interact to control N mineralization in the sagebrush steppe ecosystem at Stratton. A conceptual model containing five premises about the control of sagebrush properties related to N turnover was statistically tested. Static properties controlling N turnover included plant species groups, total soil nutrient pools, and soil texture. Dynamic properties controlling N turnover were soil moisture and temperature, and available nutrients. Soils were sampled between and under shrub canopies of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), Wyoming big sagebrush (*A. t.* ssp. *wyomingensis*), and black sagebrush (*A. nova*). Net N mineralization rates were estimated using a buried bag technique. Results showed soil microclimate plays a major role in N mineralization. Ninety percent of N mineralization occurred during spring and summer when soil temperatures are high and moisture is sufficient. During that same timeframe, organic matter played an important role in controlling N mineralization, and its effect was regulated by soil microclimate.

Keywords: big sagebrush, nitrogen mineralization, sagebrush steppe, soil microclimate, soil moisture, soil nutrients

5. Burke, I.C., Reiners, W.A., and Schimel, D.S., 1989, Organic matter turnover in a sagebrush steppe landscape: Biochemistry, vol. 7, p. 11–31.

Nutrient turnover and availability was studied in soils taken from Stratton that were amended with ^{15}N and incubated in a laboratory. Soils were collected in three vegetation types and at between- and under-shrub positions at the surface (0–5 cm) and the subsurface (5–15 cm). Fractions measured during the 30 day incubation period included ammonium, nitrate, microbial biomass nitrogen (N), total N, inorganic ^{15}N, microbial ^{15}N, total ^{15}N recovery, available phosphorus (P), microbial biomass P, total P, mineralized carbon (C), microbial biomass C, and total C. Most of those fractions were higher in soils from mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) sites. Soils of Wyoming big sagebrush (*A. t.* ssp. *wyomingensis*) and black sagebrush (*A. nova*) sites had lower amounts of nutrient fractions. The authors found that microsite and landscape difference had significant bearing on nutrient turnover and availability in soil. Soils in areas with the highest organic matter accumulation (mountain big sagebrush sites) had greater potential for high respiration and N mineralization rates. Soils in sites under mountain big sagebrush experienced more favorable microclimatic conditions than those under shorter shrubs, which accumulated lower organic matter. Soils under black sagebrush had higher microbial efficiencies in the first five days of incubation than soil from better microhabitats. The response of organically richer soils was likely limited by the pool of active material in the soil. The authors hypothesized that microbial activity probably occurred over a longer time period in more organic matter-rich soils, which may have reduced the proportion of unstable organic matter relative to the total organic matter pool over time. Soils poorer in organic matter were probably initially limited by soil microclimate, but after a long period of microbial activity they would also be limited by soil organic matter pools. Soil microbes at sites rich in organic matter tended to be more substrate-limited than soils with less organic matter.

Keywords: big sagebrush, microbial biomass, mountain big sagebrush, nitrogen mineralization, soil nutrients

6. Burke, I.C., Reiners, W.A., and Olson, R.K., 1989, Topographic control of vegetation in a mountain big sagebrush steppe: Vegetation, vol. 84, no. 2, p. 77–86.

Authors mapped and described vegetation associations at Stratton, sampled variations in soil microclimate, and performed canonical correlation analyses to determine relationships of vegetation associations and topographic variables. They found that fetch and fetch angle were the most important variables affecting vegetation associations at Stratton. Fetch and fetch angle determine wind exposure. Wind in turn is strongly related to snow distribution, soil moisture, and soil temperature, which are important factors that control species composition and primary productivity. Slopes with moderate wind exposure included taller sagebrush species (*Artemisia tridentata* ssp.

vaseyana), while sites most exposed to wind contained the low-lying black sagebrush (*A. nova*) and cushion plants. Topographic depressions and leeward slopes contained nivation hollows (wet meadow areas of high snow build-up), and aspen stands. The authors describe the potential of this type of analysis as enhancing the ability to predict vegetation distribution using topographic variables at large scales and under different climate regimes.

Keywords: sagebrush steppe, soil microclimate, topography

7. Coppinger, K.D., Reiners, W.A., Burke, I.C., and Olson, R.K., 1991, Net erosion on a sagebrush steppe landscape as determined by Cesium-137 distribution: Soil Science Society of America Journal, vol. 55, p. 254–258.

Cesium-137 was used to determine mechanisms and patterns of soil redistribution at Stratton. An inert chemical, Cs-137 adheres well to soil particles. It was produced as fall-out during the 1950's and 1960's during nuclear testing, and is assumed to have been evenly distributed across the landscape. The authors hoped to determine factors contributing to soil removal and redistribution by sampling Cs-137 levels in soils at various landscape positions. They found Cs-137 levels did not vary among 6 different landscape units (determined by slope length and gradient, and fetch length and angle). However, there was more Cs-137 under shrubs than between shrubs at 3 of the 6 landscape units. Results suggest fluvial erosion does not have much effect on Cs-137 transport, at least in the 25–35 year time frame the study addresses. In addition, wind did not appear to influence redistribution of Cs-137 at a landscape scale. However, the data suggested wind does serve to transport Cs-137 from between shrub positions to under shrub positions, which occurred at 3 different elevations along a slope. The authors concluded Cs-137 would be more useful in erosion studies on areas such as cultivated fields, where erosion is measurable and at least 30 to 40 years has passed since the Cs-137 fallout event.

Keywords: big sagebrush, erosion, sagebrush steppe

8. Fletcher, R., 1980, Managing sagebrush lands–What's best? *in* Forestry Research West, U.S. Department of Agriculture, Forest Service, Ft. Collins, Colorado, 3 p.

This paper presents a brief overview of some of the research done at Stratton regarding effects of sagebrush control on soil, water, vegetation, and biological resources. The author mainly cites the work of David L. Sturges (see Sturges citations, this publication). Main points of the paper include change in soil moisture, snow accumulation, vegetation response, stream contamination, and wildlife impacts as a result of 2,4-dichlorophenoxyacetic acid (2,4-D) application. Ten years of post-herbicide treatment data indicate that soil water use is reduced by 10% during the 5^{th}–10^{th} years after treatment at 3–6 feet soil depths on sprayed sagebrush sites. Effects of sagebrush removal on soil water use in soils shallower than 3 feet is mitigated by increased roots that result from enhanced grass production after 2,4-D treatment. Snow accumulation was less on sprayed sites in the early part of winter until the snow depth reached the top of the sagebrush (skeleton) stands. Thereafter, the topography and wind controlled snow accumulation regardless of treatment. Snowmelt rate was also similar in treated and non-treated stands. Grass production doubled and was 2.6 times that of untreated sites 3 years after spraying, while total above-ground biomass production was down 29% the year after treatment, and down 23% three years after treatment. In 1976, Sane Creek was sprayed with 2,4-D in a paired watershed study. A 100' wide buffer zone was left on either side of the sprayed stream. The highest level of 2,4-D detected in the stream was 5 ppb directly after spraying (the author notes 1,000 ppb is the minimum level harmful to aquatic organisms). Brewer's sparrow (*Spizella brewerii*) nesting and reproduction success following chemical sagebrush control was researched at Stratton, and results showed that during the first year of treatment, production of eggs and young in sprayed and unsprayed stands were similar. However, in the 2^{nd} and 3^{rd} years post-treatment, bird densities in treated sagebrush stands were 67% and 99% lower respectively than in non-treated stands.

Keywords: Brewer's sparrow, herbicide, sagebrush steppe, snow accumulation, soil water, vegetation production

9. Hess, W.M., Nelson, D.L., and Sturges, D.L., 1985, Morphology and ultrastructure of a snowmold fungus on sagebrush (*Artemisia tridentata*): Mycologia, vol. 77, no. 4, p. 637–645.

A snowmold fungus was discovered growing on stands of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) at Stratton. The authors conducted an in-depth lab investigation of the fungus to thoroughly describe its characteristics, although a positive species identification is not given. The paper describes the characteristics of the fungus when grown *in vitro* on a sagebrush host at different temperatures. At -4 °C and 1 °C, the fungus has similar characteristics: knobby tubercles on hyphal walls, many deposition vesicles and multimembrane organelles, and abundant glycogen. When cultured at 20 °C, the fungus is very different in appearance. The tubercles are no longer apparent, cell walls and septa are thicker, glycogen is aggregated and lipid bodies are more prominent. The authors hypothesize these changes may be adaptations which enable the fungus to survive high summer heat and desiccation of their host's leaves.

Keywords: mountain big sagebrush, snowmold

10. Johnson, K.L., and Tabler, R.D., 1973, An enclosed weir for small streams in snow country: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note RM-238, p. 1–8.

This technical paper describes construction of a V-notch weir streamgage that is enclosed so it can remain serviceable during extreme winter conditions without operators having to excavate snow. The paper describes the structure in detail, which includes a multiple pipe arch with closed openings at the ends that is fitted over a cut-off wall independent of the structure. An instrument shelter is located adjacent to the pipe arch, and is easily accessible in winter. The design described here and located at Stratton is said to reduce time of construction by 50% and total cost of construction by 40% over conventional designs.

Keywords: snow accumulation, streamflow, weir gage

11. Matson, P.A., Volkmann, C., Coppinger, K.D., and Reiners, W.A., 1991, Annual nitrous oxide flux and soil nitrogen characteristics in sagebrush steppe ecosystems: Biogeochemistry, vol. 14, p. 1–12.

In this companion study to Burke (1989), nitrous oxide flux and soil nitrogen were studied from soil samples taken at Stratton in six dominant vegetation types: mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), Wyoming big sagebrush (*A. t.* ssp. *wyomingensis*), black sagebrush (*A. nova*), antelope bitterbrush (*Purshia tridentata*), quaking aspen (*Populus tremuloides*), and grassy riparian areas. Early in the growing season, net nitrate production was highest in mountain big sagebrush stands. Later in the season, there were no consistent differences in nitrous oxide fluxes among types. The approximate overall average annual fluxes for the region, weighted by the aerial extent of each vegetation type, was 0.21 kg N_2O-N $ha^{-1}y^{-1}$, which is twice the simulated annual flux from shortgrass prairie, but is comparable to temperate zone forests and prairies. The authors calculated an estimated total annual nitrous oxide flux of U.S. sagebrush steppe, and compared that with estimated fluxes of other vegetation types of the world. They concluded semi-desert ecosystems contribute a relatively small flux of nitrous oxide to the global atmosphere.

Keywords: big sagebrush, mountain big sagebrush, nitrogen mineralization

12. Nelson, D.L., and Sturges, D.L., 1986, A snowmold disease of mountain big sagebrush: Phytopathology, vol. 76, p. 946–951.

While conducting other research at Stratton, researchers discovered many mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) were perishing from an apparent snowmold. Lab and field experiments were performed by the authors to determine the type and characteristics of the fungus, what type of field conditions promote its spread, and its effectiveness in killing sagebrush. Lab tests concluded the mold is most likely an Ascomycete due to the form of the mycelium. The fungi have a unique knobby type of hyphae easily identified in the lab as the same mold that occurred on the shrubs at Stratton. The pathogenicity test showed the fungus needed at least 130 days to completely cover the host plant at 1° C. Above 20° C, the cultured snowmold fungus grew slowly and abnormally. Due to the snowmold's ability to grow at low temperatures, the authors hypothesized it may be able to outcompete other fungi which require warmer growing environments. Temperatures within the snowpack at Stratton were shown to be favorable for growth of the snowmold fungus for at least the last 60 days of the cold season. The longer the period in which snowmelt occurs, the more of an advantage the snowmold had. Hence mountain big sagebrush in draws or depressions where more snow accumulates and snowmelt is prolonged are more susceptible to the snowmold fungus. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and black sagebrush (*A. nova*) were largely unaffected by the snowmold at Stratton because they occur on more xeric, windswept sites where snow does not accumulate as heavily as more mesic sites where mountain big sagebrush occurs.

Keywords: big sagebrush, snowmold, snow accumulation, snow melt

13. Reiners, W.A., Strong, L.L., Matson, P.A., Burke, I.C., and Ojima, D.S., 1989, Estimating biogeochemical fluxes across sagebrush-steppe landscapes with thematic mapper imagery: Remote Sensing of the Environment, vol. 28, p. 121–129.

Thematic Mapper (TM) satellite imagery was used to predict biogeochemical processes across a sagebrush landscape (Stratton was the main study location). The authors adapted the CENTURY model to simulate the flux of carbon, nitrogen, and other elements from live plants to plant residues, through 3 functional forms in soil organic matter, to available inorganic pools, and back to plants. Simulated nitrogen (N) mineralization rates were paired with ecosystem classifications to create maps of N mineralization on a monthly and annual basis across the sagebrush steppe. Four vegetation types were mapped using TM and ground-truthed at Stratton, including Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), mountain big sagebrush (*A. t.* ssp. *vaseyana*), black sagebrush (*A. nova*) and a grass type. Researchers found mountain big sagebrush lands, while only covering 42% of Stratton, accounted for 60% of the nitrogen mineralization of the 3 sagebrush types. Results indicated that any major changes in the mountain big sagebrush type could affect overall N mineralization of a sagebrush landscape.

Keywords: big sagebrush, mountain big sagebrush, nitrogen mineralization, sagebrush steppe

14. Schmid, J.M., Mitchell, J.C., Schroeder, M.H., 1973, Bark beetle emergence cages modified for use as pit traps: Research Note RM-244, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 2 p.

Authors describe a method for converting a collecting device to capture emerging bark beetles into a pit trap. The collecting device consists of a cylindrical screen cage over a funnel. The modification involved separating the leg stands and screening from the funnel, and then soldering a rectangular piece of sheet metal on it to form a cylinder slightly larger than the outside diameter of the upper part of the funnel. At the collection site, the sheet metal cylinder and funnel were placed in a hole dug just wide enough to accommodate the cylinder and deep enough so the lip of the funnel was level with the ground. Authors tested the new pit traps in the field at Stratton in 1972, and collected numerous insect, arachnid, and small mammal species. Traps can be constructed for about $5 each.

Keywords: pit trap

15. Schroeder, M.H., 1970, The effects of sagebrush eradication on selected wildlife populations [1968, 1969, and 1970 reports]: Annual progress reports U02386, Work Order 101.2, U.S. Fish and Wildlife Service, Wildlife Research Work Unit, Denver Wildlife Research Center, 21 p.

The author describes wildlife surveys that were conduced for three consecutive years at Stratton before one watershed was treated with the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) to remove sagebrush. The goal of the research was to document the existing wildlife populations before treatment in order to make comparisons of the untreated watershed to the treated watershed, and to compare the treated watershed to itself post treatment. The author conducted counts for relative abundance of pronghorn antelope (*Antilocapra americana*), sage grouse (*Centrocercus urophasianus*), small mammal trapping, rabbit (*Leporidae* spp.) pellet counts, abundance of badger (*Taxidea taxus*) and rodent diggings, and songbird surveys. Each year methodology was improved and new surveys were added.

Keywords: badger, herbicide, pronghorn, sagebrush control, sage grouse, small mammal

16. Schroeder, M.H., 1972, Vesper sparrow nests abandoned after snow: The Wilson Bulletin, vol. 84, no. 1, p. 98-99.

The author describes a situation where 3 Vesper sparrow nests were found in June 1970 at Stratton, each containing 4 eggs. Nests were located under partially dead sagebrush plants. An unseasonable snowstorm deposited 4-6 inches of snow on the nesting area, accompanied by extreme low air temperatures. Twelve days later researchers visited nest sites again and all were abandoned. The eggs had spoiled but were still intact, and all were fertile. The author concluded the nest abandonment was due to accumulated snow.

Keywords: snowdepth, Vesper sparrow

17. Schroeder, M.H., and Sturges, D.L., 1975, The effect on the Brewer's Sparrow of spraying big sagebrush: Journal of Range Management, vol. 28, no. 4, p. 294–297.

This study looked at effects of 2,4-dichlorophenoxyacetic acid (2,4-D) spraying on nest success and habitat selection of Brewer's sparrow (*Spizella breweri*), a big sagebrush dwelling species. The authors found nest success was not affected by 2,4-D the year of treatment, as similar numbers of fledglings occurred in both treated and untreated sagebrush. However, habitat selection was affected in the years after treatment (once dead big sagebrush had lost their leaves). A sprayed 80-acre plot bordering Stratton and two 40-acre unsprayed plots within Stratton were surveyed for singing male Brewer's sparrows and compared. On sprayed plots, birds were 67% less dense than on a similar untreated area one year after treatment, and were 99% less dense than 2 untreated areas 2 years after treatment. No nests were observed in sprayed sagebrush the two years after treatment.

Keywords: big sagebrush, Brewer's sparrow, herbicide, sagebrush control

18. Schroeder, M.H., and Sturges, D.L., 1980, Spraying of big sagebrush with 2,4-D causes negligible stream contamination: Journal of Range Management, vol. 33, no. 4, p. 311–312.

Contamination of streams adjacent to big sagebrush lands sprayed with 2,4-dichlorophenoxyacetic acid (2,4-D) was documented on Sane Creek watershed at Stratton. The watershed was sprayed in May, 1976 at a rate of 2.2kg acid equivalent of 2,4-D/ha. An adjacent watershed, Loco Creek, was not sprayed and was used as the treatment control. On Sane Creek, a 60 m by 300 m buffer strip was left along the creek for wildlife habitat purposes. Snow was still present in much of the main channel at the time of treatment. After spraying, the maximum amount of 2,4-D detected in Sane Creek was 5 ppb. The average amount of 2,4-D found in the snow within the buffer strip on Sane Creek was 35 ppb. The authors report levels of 2,4-D found in the stream and snowpack in this study are far below the 1000 ppb level thought to be toxic to fish.

Keywords: big sagebrush, herbicide, sagebrush control, water quality

19. Sturges, D.L., 1973, Soil moisture response to spraying big sagebrush the year of treatment: Journal of Range Management, vol. 26, no. 6, p. 444–447.

This study monitored soil moisture in big sagebrush (*Artemisia tridentata*) stands at Stratton before and during the year of treatment with 2,4-dichlorophenoxyacetic acid (2,4-D). Neutron moisture meters were used to determine soil moisture at six depths within the soil profile down to 6 feet. This study differed from most previous studies on effects of herbicides on soil moisture in that it took measurements deeper in the soil profile. This factor proved to be significant, as the greatest change in soil moisture withdrawal was discovered at soil depths between 2 and 6 feet, where live big sagebrush roots draw a lot of water. Sagebrush kill due to the 2,4-D treatment was estimated at 95% overall. In sprayed plots, 83% of the total reduction in soil moisture loss occurred at depths over 2 feet. Overall, soil moisture depletion was reduced by 24% in plots sprayed with 2,4-D between the treatment date (June 24, 1970) and the end of that growing season (September 30).

Keywords: big sagebrush, herbicide, sagebrush control, soil moisture

20. Sturges, D.L., 1973, The hydrology of big sagebrush lands: State-of-the-art: Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 76 p.

This paper presents a summary of hydrology characteristics at Stratton Sagebrush Hydrology Study Area, and documents effects of big sagebrush control on the hydrologic regime. It is a lengthy document so main headings will be summarized here. Chapter One describes the physical setting and individual characteristics of big sagebrush. Chapter Two covers selected hydrologic features of mountain big sagebrush, including precipitation, water infiltration, sediment transport, and water yield characteristics where they occur. Chapter Three describes hydrologic response of rangelands to sagebrush control practices. Response of grass, forb, and total herbaceous production following sagebrush control are discussed. The author also describes hydrologic characteristics including ground cover and soil moisture response, snow accumulation, sediment transport and streamflow regime. Water yield improvement as a result of sagebrush control is reported in Chapter Four. About a 15% gain in water yield can be expected in the most favorable situation as a result of sagebrush control, but where soil moisture can't be recharged through precipitation (in much of the dry, shallow-soiled sagebrush range) often water yield does not increase with treatment. Wind and blowing snow are discussed in this chapter, as well as the usefulness of snow fences in increasing snow retention in windblown areas. The fifth chapter summarizes the previous four.

Keywords: big sagebrush, herbicide, hydrology, mountain big sagebrush, sagebrush control, soil moisture, water yield

21. Sturges, D.L., 1975, Hydrologic relations on undisturbed and converted big sagebrush lands: The status of our knowledge: U.S. Department of Agriculture Forest Service Research Paper RM-140, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 23 p.

This summary paper covers physiology and management of big sagebrush, as well as the hydrologic features and water yield characteristics of big sagebrush lands. It also compares water yield characteristics of a forest site with a big sagebrush site. Changes in hydrology of big sagebrush lands converted to grassland types are discussed in detail. Vegetative response to conversion is also illustrated, including changes in sagebrush, grass, forb and above-ground biomass production. Ground cover and soil moisture response, snow accumulation, sediment transport, streamflow regime, and water yield improvement as a result of sagebrush control are also described.

Keywords: big sagebrush, hydrology, precipitation, sagebrush control, soil moisture, water yield

22. Sturges, D.L., 1975, Oversnow runoff events affect streamflow and water quality, p. 105–117 *in* Snow management on the Great Plains Symposium, Bismarck, N.D., July 1975.

The phenomenon termed "oversnow flow" was observed and measured at Stratton during 1970 and 1973. Oversnow flow occurs in windblown areas with high snowpack and usually occurs in intermittent stream channels. When sudden warming events occur in these areas, and there is an insufficient channel below the snow surface to transport water, it runs over the top of the snowpack and sometimes forms channels through the snow. Peak flows during oversnow events at Sane Creek were over 4 times what they were in years when oversnow flow did not occur. Oversnow flow also increased water yield efficiency. In 1970 and 1973, snowmelt run-off accounted for 20% of winter precipitation, whereas in years without oversnow flow, run-off was only 5%. In addition, total annual streamflow during years with oversnow flow was much larger than it was in years without. The total annual flow derived from snowmelt run-off was twice what it was in years with no oversnow flow. Sediment transport also increased with increased snowmelt run-off. At peak flow during oversnow flow, maximum suspended sediment load was 862 ppm as opposed to a maximum of 20 ppm during years with no oversnow flow. Deposition of bedload sediment was 6 and 12 times the normal rate of deposition during the 2 oversnow flow years.

Keywords: oversnow flow, runoff, sediment transport, streamflow

23. Sturges, D.L., 1975, Sediment transport from big sagebrush watersheds: Watershed Management Symposium, ASCE Irrigation and Drainage Division, Logan, Utah, August 11–13, 1975, p. 728–738.

Daily sediment loads were measured at Sane and Loco Creeks at Stratton from spring 1974 through winter 1975. A weir V-notch streamgage was located on each creek and had been recording data for 7 years prior to this study. Sturges found that during high runoff events, sedimentation increased in sagebrush steppe no matter how stable the watershed. Overall suspended sediment levels and bedload transport on Sane and Loco Creeks were relatively low. Suspended sediment averaged 11 ppm throughout winter months, and peaked with maximum snowmelt runoff in spring at 300 ppm before leveling off to an average of 20 ppm during summer months. During oversnow runoff events, where runoff occurs at such a rate that it forms a channel on top of the snow rather than percolating through to the ground, suspended sediment concentration reached 862 ppm. Bedload deposition during those events which occurred in 1970 and 1973 was 12 and 6 times higher than average, respectively. A major point of this paper is that land managers should expect some sedimentation when heavy runoff events occur, regardless of the condition of the land.

Keywords: big sagebrush, sediment transport, streamflow, watershed

24. Sturges, D.L., 1977, Snow accumulation and melt in sprayed and undisturbed big sagebrush vegetation: U.S. Department of Agriculture Forest Service Research Note RM-348, Rocky Mountain Forest and Range Experiment Station, 6 p.

Big sagebrush treatment plots were sprayed in June 1970 with 2,4-dichlorophenoxyacetic acid (2,4-D) resulting in a 95% kill of sagebrush. The following year remaining plants were sprayed for a more complete kill. There was no difference in snow accumulation between sprayed and unsprayed plots the year of treatment. There was higher snow accumulation in unsprayed plots than sprayed plots early in the snow season of the 2nd and 3rd years. As snow deposition increased, the effects of vegetation for entrapping snowfall and windblown snow decreased. Snow accumulation was affected more by topography than vegetation. No significant difference in snowmelt rates resulted between sprayed and unsprayed plots. Daily snowmelt measurements showed that snowmelt accelerated rapidly once sagebrush had protruded through the snow surface. Vegetation absorbs short-wave solar radiation and reradiates it as long-wave radiation, which is more easily absorbed by snow and results in faster snowmelt.

Keywords: big sagebrush, herbicide, sagebrush control, snow accumulation, snowmelt

25. Sturges, D.L., 1977, Soil moisture response to spraying big sagebrush: A seven-year study and literature interpretation: U.S. Department of Agriculture Forest Service, Research Paper RM-188, Rocky Mountain Forest and Range Experiment Station, 12 p.

This paper expands on an earlier paper (Sturges 1973) describing effects of spraying 2,4-dichlorophenoxyacetic acid (2,4-D) on big sagebrush lands. Soil moisture measurements were taken the year before treatment up to 5 years after treatment. The author developed an equation to estimate percent reduction in fall soil moisture deficit for 2,4-D treated mountain big sagebrush sites with deeper soils (reported in the text as $y = 35.57e^{-0.259t}$, and later corrected with an attached *errata* statement to $y = 27.46^{-0.259t}$). Soil moisture withdrawal was the lowest immediately after treatment due to absence of live sagebrush roots drawing water from the soil. Gains in soil moisture retention over the 5-year period occurred in treated stands between 91 and 183 cm in the soil profile, below where herbaceous species' roots have much influence, but within the sagebrush rooting zone. The author reviews several previous soil moisture studies in big sagebrush stands and highlights two issues in their methodologies. First, many studies do not identify big sagebrush to the subspecies level, i.e., *Artemisia tridentata* ssp. *wyomingensis, tridentata* or *vaseyana.* Wyoming big sagebrush occurs on shallower soils and usually more windblown sites with less precipitation than basin and mountain big sagebrush, which makes a difference when measuring soil moisture recharge from summer precipitation in treated and untreated sites. Also, the author notes that most researchers did not measure below the upper meter of the soil profile, thereby missing valuable data related to soil moisture withdrawal in the sagebrush rooting zone, between 1 and 2 meters below the soil surface, where Sturges discovered the most significant and long-term change.

Keywords: big sagebrush, herbicide, mountain big sagebrush, roots, sagebrush control, soil moisture

26. Sturges, D.L., 1977, Soil water withdrawal and root characteristics of big sagebrush: The American Midland Naturalist, vol. 98, no. 2, p. 257–274.

This publication documents the volume of soil around mountain big sagebrush and Wyoming big sagebrush that is important to an individual plant for soil water withdrawal, depending on its root volume. Sturges looked at individual plants at three locations along a hillside: bottom, mid-slope, and top of slope at Stratton. Seven neutron moisture meters were placed in the soil around each sagebrush plant. Root volume was measured by digging trenches along 3 individual plants at each location and harvesting roots. Roots were separated by size class, and weighed. The volume of soil at or below 91 cm in the soil profile containing roots for plants at the lower, middle and upper slope positions was 37, 34, and 39% respectively. Sagebrush has a competitive advantage for obtaining moisture from soil deeper than 91 cm because most herbaceous species roots don't extend that deep. Sagebrush also has a dense system of lateral roots near the soil surface that help it take advantage of brief warm season precipitation events. Approximately 36% of the root system of big sagebrush is in the upper 30.5 cm of soil and within 61 cm of the shrub's trunk. Competition for soil water between herbaceous plants and big sagebrush can be most severe at locations very near the shrub.

Keywords: big sagebrush, roots, soil water

27. Sturges, D.L., and Trlica, M.J., 1978, Rootweights and carbohydrate reserves of big sagebrush: Ecology, vol. 59, no. 6, p. 1282–1285.

Big sagebrush plants were studied at 3 positions on a slope at Stratton. At the bottom and near the top of the slope, sagebrush roots extended laterally into the 91–122 cm sample area. Lateral spread of roots mid-slope was 30 cm greater than the other 2 locations. Root weight was highest in the soil surface layer at all locations. Roots at the slope top extended into the 122–152 cm soil sample zone. Roots at the mid- and bottom slope extended 183–213 cm down into the soil. Total non-structural carbohydrate concentrations were highest in plants at the bottom of the slope, at 6.6%, and lowest in plant roots near the slope's top at 3.8%. Total sagebrush root carbohydrate reserves did not differ by slope location.

Keywords: big sagebrush, carbohydrate reserves, roots

28. Sturges, D.L., 1979, Hydrologic relations of sagebrush lands: The sagebrush ecosystem: A symposium April 27–28, 1978, Utah State University, Logan, p. 86–100.

This paper presents an overview of hydrologic relations of individual sagebrush plants and sagebrush landscapes at a small number of sagebrush hydrology study sites including Stratton. The author outlines climate, hydrology, evapotranspiration, snow accumulation, snowmelt, and water infiltration characteristics for individual plants and sagebrush stands. He makes a case for identifying big sagebrush to the subspecies level for greater accuracy in scientific research on hydrology of big sagebrush lands, and recommends increased attention to bacterial quality of water and soil stability in sagebrush watersheds where livestock grazing is present.

Keywords: big sagebrush, hydrology, livestock grazing, mountain big sagebrush, sediment transport, snow accumulation, snowmelt, water quality, watershed

29. Sturges, D.L., 1980, Soil water withdrawal and root distribution under grubbed, sprayed, and undisturbed big sagebrush vegetation: Great Basin Naturalist, vol. 40, no. 2, p. 157–164.

This study compared differences in soil water withdrawal and root weights under grubbed, 2,4-dichlorophenoxyacetic acid (2,4-D) sprayed, and undisturbed big sagebrush at Stratton. During the 1st spring after treatment, soil water recharge by snowmelt was complete under sprayed and undisturbed big sagebrush, but only occurred to 61cm under grubbed plants. At the end of summer, below 46 cm, more water remained in soils under grubbed sagebrush compared to undisturbed vegetation. Below 91 cm, more water remained in soils under sprayed vegetation than undisturbed vegetation. In the surface 122 cm of soil, seasonal water withdrawal was 24.3, 21.4, and 16.2 cm in undisturbed, sprayed, and grubbed vegetation, respectively. Average weight of roots (taken by a soil core method) did not differ significantly by treatment. The authors concluded the soil water regime at 91cm and above in the soil profile was not affected by sagebrush control once other herbaceous vegetation flourished. The new herbaceous vegetation drew approximately the same amount of water formerly used by sagebrush roots.

Keywords: big sagebrush, herbicide, roots, soil moisture

30. Sturges, D.L., 1982, A study of certain hydrologic characteristics of big sagebrush watersheds in southern Wyoming (Stratton sagebrush hydrology study area) July 1, 1967–September 30, 1981, final report: U.S. Department of the Interior, Bureau of Land Management, Unpublished report, 70 p.

This document summarizes all research efforts that took place at Stratton from 1967 to 1981. It gives a thorough site description of the study area complete with maps, discusses grazing history and use, and outlines biological, hydrological, meteorological, and vegetation studies. A list of publications derived from the body of research conducted during this period is at the end of the document, and those publications are cited in this annotated bibliography. One main project described in the document include the spraying of 2,4-dichlorophenoxy acetic acid (2,4-D), and its effects on birds, mammals, insects, algae, hydrologic function, water quality, soils, and vegetation. Researchers also discovered a snowmold fungus, which occurred on mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) in sites where snow accumulation was heavy. This mold led to mortality of mountain big sagebrush in those sites. The paper also lays out the hydrologic studies initiated during the study period, including a hydrologic measurement project which set up weir blade streamflow measurement stations on 5 drainages in the study area. Weather stations were also set-up on the site, and a pan-evaporation study was conducted from 1979 to 1981.

Keywords: big sagebrush, herbicide, hydrology, livestock grazing, mountain big sagebrush, snowmold, soil moisture, water quality, watershed, weir gage

31. Sturges, D.L., 1983, Long-term effects of big sagebrush control on vegetation and soil water: Journal of Range Management, vol. 36, no. 6, p. 760–765.

Vegetation and soil water depletion levels in response to 2,4-dichlorophenoxyacetic acid (2,4-D) treatment were studied for several years. The author found vegetation production shifted from mostly sagebrush to mostly grass after treatment, and sprayed forbs decreased significantly after 0,1 and 3 years. Total yield of vegetative production was significantly reduced by 2,4-D treatment until the 10^{th} and 11^{th} years after treatment. Grass production was not enough to compensate for lost sagebrush production, even though grass production was 2.4 times greater the year after treatment than prior to treatment. Soil moisture withdrawal from the surface 1.8m of soil was 31% less on sprayed plots during the first year of treatment; after 3 years, that percentage stabilized at 7% for several years. After the first year of treatment, soil moisture withdrawal was less from 0.9 to 1.8m in the soil profile. The increased grass production made up for the loss of sagebrush roots at shallower soil depths, but loss of sagebrush roots deeper in the profile was not compensated for, hence soil moisture was higher. Sturges also presents an equation to relate sagebrush control to seasonal water depletion in soils at various depths.

Keywords: big sagebrush, herbicide, soil moisture, soil water, vegetation production

32. Sturges, D.L., 1984, Comparison of precipitation as measured in gages protected by a modified alter shield, Wyoming shield, and stand of trees: Western Snow Conference presentation, April 17–20, 1984, Sun Valley, Idaho, p. 57–67.

Three types of precipitation gages were tested at sites near Stratton. The Wyoming shield gage was placed on open sagebrush land 970m upwind of a forest protected gage located in a lodgepole pine (*Pinus contorta*) stand. The forest gage had a modified Alter shield. Another gage protected by a modified Alter shield was 5.2 km north of the lodgepole forest gage site in a planted spruce (*Picea sp.*) and aspen (*Populus tremuloides*) stand at an old homestead. Results showed the Wyoming shield gage consistently under-measured precipitation compared to the Alter shield gage in forest sites, suggesting the greater wind protection granted by the trees was important for accurate snow catch. In exposed locations during winter, both the Wyoming shield and Alter shield did not measure precipitation amounts accurately. Between October and May, the Wyoming shield had a 42% undercatch of precipitation and the modified Alter had 32% undercatch. The author points out using these gage types for winter precipitation could result in erroneous data.

Keyword: precipitation, precipitation gage, snow accumulation

33. Sturges, D.L., and Nelson, D.L., 1986, Snow depth and incidence of a snowmold disease on mountain big sagebrush, *in* MacArthur, D.E., and Welch, B.L., eds.: Symposium on the biology of *Artemisia* and *Chrysothamnus*, July 9–13, 1984, Provo, Utah, General Technical Report INT-200, 1986, p. 215–221.

The prevalence of a snowmold fungus which occurred in mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) stands at Stratton was positively related to snow depth. Snowmold was measured at 6 depths: <60cm, 61–90cm, 91–120cm, 121–150cm, 151–180cm, and >180cm. There was a low incidence of snowmold at depths <60cm, but its incidence increased sharply as snow depth increased to 120 cm. Snow appeared to have to be at least 60cm deep for the snowmold to have sufficient time to grow during the snowmelt stage. At shallower depths, snow melted off too fast, not allowing time for the snowmold to flourish. The authors could not discern a sporulating stage, but the fungus definitely showed a pathogenicity to sagebrush (especially mountain big sagebrush) in the lab. Between

1969 and 1980, canopy cover of mountain big sagebrush declined 34% in stands affected by the snowmold. The authors hypothesized that Wyoming big sagebrush and black sagebrush (*Artemisia tridentata* ssp. *wyomingensis* and *A. nova*) are less susceptible to the snowmold because they grow on windier sites where less snow accumulates, so the prolonged snowmelt conditions which favor the fungus do not often occur in those stands.

Keywords: mountain big sagebrush, snow depth, snowmold

34. Sturges, D.L., 1986, Responses of vegetation and ground cover to spraying a high elevation, big sagebrush watershed with 2,4-D: Journal of Range Management, vol. 39, no. 2, p. 141–146.

This publication presents findings from a herbicide application research project at Stratton. In 1976, Sane Creek watershed was aerial-sprayed with 2,4-dichlorophenoxyacetic acid (2,4-D) to control sagebrush growth, while Loco Creek, an adjacent watershed, was undisturbed but monitored alongside of Sane Creek for comparison before and after treatment. This study contains a particularly thorough set of data recorded from 1968 to 1981, and is one part of a project which also looked at effects of 2,4-D aerial spraying on biological organisms and hydrological attributes and functions. Results presented here concern the effects on vegetative cover and composition. Sturges found that spraying 2,4-D increased grass production by 135% and decreased mountain big sagebrush production by 71% in the 5 years after treatment. Forb production remained similar before and after treatment on Sane Creek, most likely due to the early application of herbicide. Overall biomass production on Sane Creek was not different than on Loco Creek after treatment, but composition was significantly different. Grass species comprised a much larger and sagebrush a much smaller proportion of vegetation production. Hydrologic cover is a term referring to the sum of basal vegetation cover plus litter cover, which can indicate rainfall run-off potential. The higher the hydrologic cover value, the lower the potential for rainfall run-off. The hydrologic cover value increased on Sane Creek in the years after spraying compared to Loco Creek where it stayed the same. This higher value on Sane Creek watershed was due to increased litter cover and reduced bare soil after spraying.

Keywords: big sagebrush, herbicide, hydrologic cover, vegetation production

35. Sturges, D.L., 1989, Response of mountain big sagebrush to induced snow accumulation: Journal of Applied Ecology, vol. 26, p. 1035–1041.

This publication describes effects of a 3.8m tall snowfence along North Draw on mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) at Stratton. Mountain big sagebrush at a downwind distance of 3.2 times the height of the snowfence (3.8m) perished by the third year of the study as a result of prolonged soil saturation, which decreased oxygen in soils available for root growth. Snow depth at a downwind distance 3.2 times the height of the fence increased from 1.5m pre-fence to 4.6m post fence establishment. The snowfence also created more snow deposition upwind of the fence. At a distance of 3.9, 13.2, and 18.4 times the height of the fence upwind, snow deposition increased by 0.8, 0.3, and 0.1 m respectively. Snowpack at the 3.9 and 13.2 distances increased significantly. A critical snow depth threshold of less than 2.8 meters for mountain big sagebrush survival was supported by the data in this study. Sturges discovered mountain big sagebrush upwind of the snowfence was decreasing in abundance and vigor, but snow depths were not exceeding 2.8 meters. The cause of this decline was attributed to a snowmold fungus, probably an Ascomycete enabled by prolonged conditions of melting snow. Prolonged periods of spring snowmelt did exist as snowpack was augmented up to 70m upwind of the snowfence.

Keywords: big sagebrush, mountain big sagebrush, snow depth, snowfence, snowmold

36. Sturges, D.L., 1990, Icing affects fall discharge characteristics of a rangeland stream: 58th Western Snow Conference, April 17–19, 1990, Sacramento, California, 4 p.

This study evaluated daily streamflows of Loco Creek and Sane Creek at Stratton for 21 years to determine effects of ice formation on discharge. Both creeks are spring-fed creeks. Water temperature at each spring was approximately 4° C. Sane Creek did not experience ice formation in winter months, whereas Loco Creek did have icing events in the fall, until the stream channel was covered by snow, at which point stream ice melted. Data indicated streamflow at Sane Creek was very stable, with discharge not falling more than 10% on any day in 21 years. Discharge at Loco Creek was extremely variable, with discharge more than 25% below average on 55 days, and more than 50% below average on 16 days. This fluctuation was caused by ice formation in October and

November on Loco Creek, which held up streamflow. When the channel was covered with snow in the winter months, daily fluctuations in streamflow disappeared. When ice melted, streamflow was dramatically elevated at least 4 times above the average discharge rate for the day. The author concluded the large daily discharge fluctuations caused by icing events could be biologically important. Fish abundance and stability of algae and microinvertebrate populations were likely influenced by the highly variable water regime. Sediment loads may be increased due to frost action on exposed banks during low water levels, as well as varying stream velocities during snowmelt which can loosen substrates for transport.

Keywords: discharge, streamflow

37. Sturges, D.L., 1990, Snow fencing to increase streamflow on rangelands: Watershed planning and analysis in action: Symposium Proceedings of IR Conference, Watershed Management/IR Division/ASCE, Durango, Colorado, July 9–11, p. 145–154.

Results are presented from a snow fence study at Stratton involving Loco Creek and North Draw watersheds. A 3.8 meter high by 800 meter long snow fence was constructed parallel to North Draw in 1983 after spring runoff was complete. Loco Creek was monitored as the control watershed. Six years of post-fence data indicated that the snow fence increased water yield in North Draw by 127%, and surface snowmelt runoff lasted an average of 17 days longer than pre-fence runoff events. Snow accumulation in North Draw increased an average of 55% with the snow fence in place. The author estimated the amortized cost of water gained by installing a snow fence was $0.077 per cubic meter, or $95.00 per acre-foot.

Keywords: runoff, snowfence, snow accumulation, water yield

38. Sturges, D.L., 1992, Streamflow and sediment transport responses to snow fencing a rangeland watershed: Water Resources Research, vol. 28, no. 5, p. 1347-1356.

The author evaluated the effects of snow fencing a big sagebrush rangeland watershed within a paired watershed study design. The study, conducted at Stratton from 1974 to 1989, compared Loco Creek watershed to North Draw. The snow fence was established in North Draw watershed and was 800 m long and 3.8 m tall. The snow fence increased snow water storage by 78% and snowmelt runoff by 129%. Flow duration was lengthened by 33 days in the snow-fenced watershed. The proportion of the snowpack that appeared as streamflow was directly related to the size of the snowpack. Placement of the fence 38 m upwind of an incised channel that was the primary source of streamflow maximized water yield increase. The concentration of filtrable sediment and bed load transport were unaffected by treatment. Scientifically designed snow fence systems are a cost effective method of protecting highways from drifting snow, and can provide a source of livestock water or augment water supplies for local or downstream uses.

Keywords: big sagebrush, streamflow, sediment transport, snowfence, snowmelt, watershed

39. Sturges, D.L., 1993, Soil-water and vegetation dynamics through 20 years after big sagebrush control: Journal of Range Management, vol. 46, p. 161–169.

The author summarizes a 20-year study conducted at Stratton documenting effects of 2,4-dichlorophenoxyacetic acid (2,4-D) on soil-water and vegetation components in a mountain big sagebrush community. Grass production was doubled and soil water dynamics were greatly affected by 2,4-D treatment throughout the 20 year study period. The greatest change in soil water usage occurred between 0.9 and 1.8 meters in the soil profile. The loss of sagebrush roots at that level in treated stands resulted in decreased soil water withdrawal. In the surface 0.9 meters, however, soil moisture withdrawal was higher due to increased herbaceous production in the absence of competition from sagebrush. While grass production increased, the loss of production by forbs and sagebrush was greater than the increase in grass, hence net above-ground biomass production was less in the treated stands than in untreated stands. For management implications, the author proposed that an increase in litter and grass cover can create a positive change in hydrologic characteristics, because grass and litter are better able to entrap and utilize water resources that otherwise might run-off before absorption into the soil. In addition, in sites with deep soils, the amount of soil moisture withdrawal is less under treated sagebrush stands 0.9 meters below the soil surface, making more water available for recharging the soil profile.

Keywords: big sagebrush, mountain big sagebrush, herbicide, hydrologic cover, soil moisture, soil water, vegetation production

40. Sturges, D.L., 1994, High-elevation watershed response to sagebrush control in southcentral Wyoming: Research Paper RM-318, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 19 p.

This research paper summarizes 23 years (1968–1990) of monitoring watershed function in response to sagebrush control at Stratton. From 1968 to the late 1980's, hydrological measurements, vegetation productivity, sagebrush density, and snow accumulation data were recorded at Sane Creek and Loco Creek to compare the effects of herbicide application. Sane Creek watershed was sprayed with 2,4-dichlorophenoxyacetic acid (2,4-D) in 1976, while the control watershed, Loco Creek, was undisturbed. Results showed water yield did increase on Sane Creek watershed as a result of 2,4-D treatment. Where soils were deeper than 0.9 m, water yield increased 20% in the first 11 years after treatment. Sagebrush density was drastically reduced in the first few years after spraying, while grass production increased by more than 50% in the first 5 years after spraying, and was 1.5 times more in the 9th and 10th years. By the 11th year however, sagebrush density had increased and was equal to its pre-treatment density on Sane Creek watershed, and water yield returned to pretreatment levels. The author attributed sagebrush reestablishment to an incomplete sagebrush kill at the time of treatment and the establishment of new plants from seed. Total vegetation production did not change as a result of spraying, but the composition shifted from more sagebrush herbaceous production to more grass production following treatment. Change in forb production was negligible. The increase in grass production caused more litter covering the ground, thus bare ground was reduced in the treated watershed, a factor that improves the hydrologic performance of a watershed.

Keywords: big sagebrush, herbicide, hydrology, litter, sediment transport, streamflow, vegetation production, watershed, water yield

41. Tabler, R.D., and Sturges, D.L., 1986, Watershed test of a snowfence to increase streamflow: Cold Regions Hydrology Symposium, July 1986, American Water Resources Association, p. 53–61.

This paper presents preliminary results from a paired watershed snowfence project on Stratton. Pre-treatment stream gage data on North Draw was collected beginning in 1974, while data for Loco Creek, the control drainage, was collected beginning in 1967. The 800m long, 3.78m tall snow fence was erected on North Draw in 1983. This paper presents results after 2 years of monitoring. In the first year, snow accumulation was 54% greater than what would have occurred without the fence according to a predictive model developed by the researchers. Snow accumulation the second year of monitoring was 62% greater than the predicted amount without a snowfence. Snowmelt discharged was 232% and 242% greater in the 1st and 2nd years post-snowfence than estimated discharge without the fence in those years. Snow collected by the fence apparently had a higher water yield efficiency than normally occurred in the drainage. The increased snow accumulation would contribute an average additional water supply of 22.9 acre feet to the drainage. When the cost of the fence ($47,390.00) was averaged over a 25 year (estimated lifespan) period, the cost of the additional water per cubic meter was $0.06721.

Keywords: discharge, snowfence, streamflow

42. Van Haveren, B.P., 2000, Ground cover dynamics in a sagebrush steppe community: Bureau of Land Management, Resource Notes, vol. 19, p. 1–6.

This paper summarizes changes in ground cover and aerial vegetation cover data from transects monitored in Loco Creek watershed at Stratton from 1968 to 1981. In summary, there was no statistical difference in bare ground, although the data suggested a gradual numerical decline. Other ground cover components did not decline, and sagebrush canopy cover did not change between 1968 to 1981. A significant inverse relationship between bare ground and litter was apparent. Hydrologic cover (sum of litter, grass/sedge, forb, cushion plant, and shrub components of ground cover) was stable at the site throughout the 14 year observation period. There was a significant positive correlation between big sagebrush aerial cover and litter. The larger debris from sagebrush plants is more likely to withstand wind and weather than litter from finer herbaceous vegetation.

Keywords: big sagebrush, erosion, hydrologic cover, litter, sagebrush steppe

43. Van Haveren, B.P., 2001, Landscape stability indicators for sagebrush steppe ecosystems: Bureau of Land Management, Resource Notes, vol. 44, p. 1–4.

This document explains the importance of using ecological indicators to identify thresholds of change in sagebrush steppe ecosystems. The author cites hydrologic cover as an example of an ecological indicator in sagebrush steppe. Hydrologic cover is a term used by David L. Sturges in his research at Stratton to describe the sum of basal cover of live vegetation and litter cover. The author states hydrologic cover must be at least 70% to reduce rainfall runoff and soil erosion in plant communities in the western United States. He urges managers to pay particular attention to the litter component on sagebrush steppe lands. The topography of valleys also can determine susceptibility to geomorphic instability in sagebrush steppe. The author conducted research west of Stratton in 2 valleys in the North Fork of Savery Creek watershed to compare valley shapes. V-shaped valleys are narrow and hydrologically connected to hillsides, and are therefore less stable than wider U-shaped valleys which have wider floors and are often disconnected hydrologically from hillsides due to slope breaks.

Keywords: big sagebrush, ecological threshold, erosion, hydrologic cover, litter, sagebrush steppe

44. Van Haveren, B.P., 2003, Watershed protection on sagebrush steppe: Characteristics and importance of litter cover: Bureau of Land Management, Resource Notes, vol. 64, p. 1–5.

This document discusses the importance of litter in watershed protection, and points out that there is a relatively small amount of literature available on the subject. Data from David L. Sturges' long term studies at Stratton were used to illustrate the high percentage of ground cover that is litter in a sagebrush steppe ecosystem (a 14-year average of 46 %). The author describes roles of litter in ecosystem functions, including protecting surface soils from extreme temperatures, rainfall damage, surface runoff, and providing carbon and organic matter for mineral soil and micro-organisms. Seven classes of litter from high-elevation sagebrush steppe are described, including herbaceous, humic, animal feces and dead insects, woody parts of sagebrush and other shrubs, shrub and forb leaves, seeds and flower parts, and dead parts of cushion plants. Different values of litter types are discussed, with the persistent or woody types of litter being more stationary and providing more watershed protection service than litter derived from herbaceous vegetation.

Keywords: big sagebrush, hydrologic cover, litter, runoff, sagebrush steppe, soil nutrients, watershed

45. Winter, J.C., and Sturges, D.L., 1989, Improved procedures for installing and operating precipitation gages and alter shields on windswept lands: Research Note RM-489, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, 6 p.

The authors describe materials and methods to speed the installation of a recording precipitation gage and a modified Alter windshield. Techniques to improve the operating performance of gages in locations where blowing snow and cold temperatures are common are also described, as obtaining reliable precipitation data in windswept regions is problematic. Wind velocity near the gage orifice must be stilled sufficiently to allow particles to fall into the gage reservoir. The receiver funnel needs to be placed about 1 m above the ground surface where precipitation falls as rain, and the gage orifice needs to be level. The gage and Alter shield need to be independently supported so vibrations from the windshield are not transmitted to the gage. The total cost for materials -- for supporting the precipitation gage, for constructing the leveling plate, and for constructing support pieces for the modified Alter windshield -- was about $112 per gage.

Keywords: precipitation gage, topography

Appendix. Index of Data on File at the USDA Forest Service Rocky Mountain Research Lab, Laramie, Wyoming

How to Use this Index:

Following is a detailed account of the contents of each file of data collected at Stratton Sagebrush Hydrology Study Area from 1968 to 1990 and stored at the USDA Forest Service Rocky Mountain Research Lab, 22nd Street, Laramie Wyoming. Major headings and file folders are described in the order they are encountered in file cabinets at the research lab, so that someone looking for specific information should be able to go to the correct drawer and find information with minimal searching. Major topic headings are listed in bold all capital letters and correspond to green cardboard file dividers in the file cabinets with plastic labels that denote major data sections. Behind each major topic heading, are brown file folders with titles describing their contents. The titles on the file folders are written here verbatim as they appear on the folder (i.e., there is no standard format) and appear in italics here. Descriptions of file folder contents appear in regular type after the title. File cabinet locations are also noted. If files do not follow this format, there will be explanatory notes marked by asterisks in the document.

Example:

File Drawer #3, 2nd row of cabinets from the left. ← Physical location

Vegetation ← Topic heading

File folders →

Cold Creek production- data sheets from vegetation production clipping at Cold Creek, 1980 to 1995

Warm Springs production- data sheets and hand-calculated summaries from vegetation production clipping at Warm Springs Creek 1976, 1980, and 1983

← File content

Index

File Drawer #1

2[nd] row of file cabinets from left, top file drawer:

Runoff-Precipitation Relations of Sagebrush Lands

A quick pencil jotting of precipitation and runoff numbers from Stratton (1969–1974) and a watershed near Dubois, WY (1959–1971) (*topic heading and file folder are the same)

Sane Creek Spraying Study

Treatment and 2,4-D water content – water analysis reports from chemical analysis of Loco and Sane Creek water for 2,4-D contamination

Vegetation phenology – a hand-written narrative of Sane Creek vegetation the day it was sprayed with 2,4-D, 5/18/1976.

Climate

Precipitation Annual Summary – summary of monthly precipitation at Stratton for all years of study, 1968 to 1990

Temperature Annual Summary – summary of average monthly temperatures at Stratton from 1969 to 1985, with data sheets to 1989

Wind Analysis and Summary – annual monthly wind speeds and direction at Stratton, 1968 to 1982

Solar Radiation Annual Summaries – average monthly solar radiation and comparison of temperature and solar radiation for all 31 years of study at Stratton

Stratton Climatic Summaries – summary of average temperature and windspeed at Stratton, 1968 to 1990

Climatological Data A.D.P. – precipitation data from weather station 1968 to 1978, summarized for the BLM Rawlins Field Office

Stratton Climatological Data A.D.P – raw data sheets and summaries of climatic data from weather stations at Stratton

Stratton climate data to 7-track tape HP 982u Program – as stated

Solar radiation record 1986 – Actual recording chart from weather stations and summary for that year

Solar radiation record 1987 – Actual recording chart from weather stations and summary for that year

Solar radiation record 1988 – Actual recording chart from weather stations and summary for that year

Solar radiation record 1989 – Actual recording chart from weather stations and summary for that year

Pan Evaporation – data sheets from pan evaporation study, 1979 to 1981

Thermograph 1982 – thermograph charts from Sane and Loco Creeks

Thermograph 1983 – thermograph charts from Sane and Loco Creeks

Thermograph 1984 – thermograph charts from Sane and Loco Creeks

Thermograph 1985 – thermograph charts from Sane and Loco Creeks

Thermograph 1986 – thermograph charts from Sane and Loco Creeks

Thermograph 1987 – thermograph charts from Sane and Loco Creeks

Thermograph 1988 – thermograph charts from Sane and Loco Creeks

Thermograph 1989 – thermograph charts from Loco Creek

Hygro-thermograph 1985 – charts for Sane and Loco Creeks and North Draw weather station #2

Hygro-thermograph 1986 – charts for North Draw and weather station #2

Hygro-thermograph 1987 – charts for Sane and Loco Creeks and North Draw weather station #2

Hygro-thermograph 1988 – charts for Sane and Loco Creeks and North Draw weather station #2

Hygro-thermograph 1989 – charts for Sane and Loco Creeks and North Draw weather station#2

Temperature charts, Loco Cr. Sediment House – charts from 1976

Net radiation measurements made May 1979 – net radiation data sheets (digitized) from May 1979 at soil moisture plots in Sane and Loco Creeks and Middle Draw

Sane Cr. Air and Water Temperature – air temperature July 1987 to April 1988, water temperature April 1988 to July 1988

Sediment

Loco Cr. daily streamflow and sediment discharge – daily discharge and suspended sediments at Loco Creek 1974 to 1989, plotted charts and data sheets

Sane Cr. Daily streamflow and sediment discharge – annual suspended solid discharge and snowmelt discharge from 1973 to 1989, plotted charts and many hand-calculated sheets

North Draw suspended sediment and statistical analysis "V" vs. manual – V-notch suspended solid concentration vs. pumped suspended solid concentration, hand calculated sheets

North Draw yearly sediment discharge 0600 and 21800 sediment content – handwritten data sheets and calculations 1976 to 1989

North Draw suspended sediment ash content of sediment – v-notch weir summary North Draw organic/inorganic 1978 to 1989, hand-tallied data

Organic/Inorganic Sediment tests – fiberglass filter organic/inorganic test on Loco and Sane Creek 1978 to 1989 data sheets

Suspended sediment bottle weights – sample weights for 475 bottles 4/9/86

Suspended sediment Loco Creek 2-hour samples – charts and data sheets of suspended sediment and streamflow measurements every 2 hrs over 24 hours 1975 to 1980

Suspended sediment Sane Cr. 2-hour samples – charts and data sheets of suspended sediment and streamflow measurements every 2 hrs over 24 hours 1978 to 1980

Summary Pond Cross-sections – Loco and Sane Creek pond sediment accumulation data 1969–1990; sediment yields for South Draw, Middle Draw, and North Draw 1974 to 1989

Loco Creek Pond Cross-Sections – data sheets from Loco Creek 1969 to 1990

Sane Creek Pond Cross-Sections – data sheets from Sane Creek 1969 to 1990

North Draw Pond Cross-Sections – data sheets from North Draw 1974 to 1989

Middle Draw Pond Cross-Sections – data sheets from Middle Draw 1974 to 1989

South Draw Pond Cross-Sections – data sheets from South Draw 1974 to 1989

Ash Content and Bulk Density Loco Creek Pond Samples 1976, 1978 – data sheets and soil lab analysis bulk density, ash content, texture

Oversnow Run-off Sane Creek 5.73 snow samples with dirt trapped on surface snow – samples of sediment left by oversnow flow

Ground Cover

Ground Cover 1968 – Loco Creek and Sane Creek ground cover data and summaries

Ground Cover 1971 – Loco Creek and Sane Creek ground cover data and summaries

Sagebrush Age Determinations – data and frequency chart of sagebrush ages in an unknown watershed but in plots 1–15 (probably Sane Cr.?) shrubs were sanded and varnished, rings were counted February 1970

Location Line-Intercept Transects – line intercept transect locations for soil moisture study, data sheet date January 1969, detailed location info for 15 plots

Canopy cover measurements, field data – soil moisture plot sagebrush canopy cover line-intercept transect data 1969 to 1990 (intermittently measured)

Summary and Analysis Plot Vegetation Data on Sagebrush Characteristics – 1969, 1980, 1987, 1990 data from soil moisture plots sagebrush density in sprayed and undisturbed plots

Sagebrush Density, Size, Field Data – summary of sagebrush density in sprayed and unsprayed plots, 1969 to 1990 and summary of sagebrush characteristics in 1969

Sagebrush Characteristics Loco and Sane Creek – density and characteristics of sagebrush and Sane and Loco Creeks 1974, 1977, and 1987

Ground Cover 1980, 1981 – data measured at primary sample sites Loco Creek-1 to Loco Creek-40 data sheets and summary (Loco Creek 1981) Sane Creek Sane Creek-1–20 (1980)

Ground Cover 1977 and 1978 – tabulated ground cover data 1977 – Sane Creek, 1978 Loco Creek

Ground Cover 1974 – tabulated ground cover, combined samples from Loco and Sane Creeks, 14 sites at Loco Creek, 6 sites at Sane Creek

Precipitation Summaries for Stratton Study – Twin Groves, Sage Creek, Trapper Creek, Middlewood Hill, precipitation data for various dates at those sites

HP-20 ground cover programs – hand written instructions on how to use the HP-20 program to calculate statistics, includes some printouts

Biomass

Biomass summary – herbaceous production and percent composition of vegetation types at selected sampling sites at Sane and Loco reeks, 1968–1986

Random Location Vegetative Sampling Networks – the methodology and location of the randomly located vegetation sampling sites in Sane and Loco Creek watersheds. This folder would be useful in relocating plots

Tests of Meter vs. green, dry, herb weights – a comparison of electronic capacitance meter readings vs. green weight and dry weight of vegetation samples at Loco and Sane Creeks. There is a great photo of presumably Kendall Johnson doing capacitance meter work

Biomass 1968 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight, plus note from Kendall Johnson

Biomass 1969 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Biomass 1970 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight, E.C. meter broke down, only sampled 6 sites at Loco Creek and all of Sane Creek

Biomass 1971 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Biomass 1972 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Vegetation Production 1973 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1974 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1975 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1976 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1977 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1978 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1979 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1980 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1981 – biomass/vegetation production at Loco and Sane Creeks using E.C. meter and dry weight

Watershed Production 1985 – biomass/vegetation production at Loco and Sane Creeks using E.C meter and dry weight

Watershed Production 1986 – biomass/vegetation production at Loco and Sane Creeks using E.C meter and dry weight

Sagebrush Characteristics in Strips, North Draw W/S – vegetation canopy cover, sagebrush density, height, crown spread; sagebrush strip experiment at North Draw, line intercepts in 3 strips, 1974

74 cleared strips '73–'74 winter, '74–'75 Winter Snow Accum. – map of strip experiment, and snow depth data in cleared and un-cleared plots

Grazing Utilization

Narrative Watershed Grazing – hand written summaries of grazing activities (cattle and sheep numbers, season and location of use etc… from 1976 to 1990; very brief statements

Grazing Utilization 1989 – field data sheets describing observations of type, number and location of livestock

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Grazing Utilization 1987 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1986 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1985 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1984 – field data sheets describing observations of type, number and location of livestock. TA Ranch obtains allotment permit

Grazing Utilization 1983 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1982 – field data sheets describing observations of type, number and location of livestock

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Grazing Utilization 1974 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1973 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1972 – field data sheets describing observations of type, number and location of livestock

Grazing Utilization 1971 – field data sheets describing observations of type, number and location of livestock, and large spreadsheet of use

Grazing Utilization 1970 and earlier – field data sheets describing observations of type, number and location of livestock

Soil Moisture

HP9825 Watershed Soil Water Enter & Print Programs & Data & Program Tape – data cartridge and instructions on how to print out data of soil moisture between measurement dates on HP9825 calculator

1976–1981 Summer Print-out Sheets – print-outs Loco Cr., Sane Cr., and Middle Draw soils moisture at depths of 0-12 feet in 1' increments

Print-out sheets change in water content – print-outs for decrease in soil water content in 1 month intervals 1976 to 1984

1973 Soil Moisture Content – using Ft. Collins probe, soil moisture content data sheets

1974 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

1975 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

1976 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

1977 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

1978 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

1979 Soil Moisture Content – soil moisture access tube measurements, soil moisture by neutron probe, shield count averages, Loco Cr., Sane Cr., and Middle Draw

Fall Soil Moisture Content – 1969–1989 fall soil moisture data sheets

Summary Fall Moisture Content – Miscellaneous data print-out sheets for soil moisture content at Sane Cr., Loco Cr., and Middle Draw

Photos – Back of drawer #1 is a brown expandable file folder containing photos from permanent vegetation photo points on Sane and Loco Creek watersheds. There are color slides and black and white prints. Permanent photo points were established 6/18/1975 by D. Sturges and K. Bird. Description of how to recreate photo points included.

File Drawer #2

Second row of file drawer's from left, 2nd drawer down

Water Analyses

Water Conductivity and PH 1989 – data sheets for Loco Cr., Sane Creek, and North Draw

1988 Water Conductivity and PH – data sheets for Loco Cr., Sane Creek, and North Draw

Omni data wiring and set-up instructions – technical instructions for Omni data recorder

Streamflow and Sediment Sample Data – data for South Draw, Middle Draw, North Draw, and Loco and Sane Creeks, various years

Conductivity

Conductivity – data sheets for conductivity measurements at Loco Cr., Sane Cr., North, Middle, and South Draws, 1976–1987

1987 Water Conductivity – various watersheds, various dates, raw data

Spring temperatures Stratton W/S – water temperatures in Loco Cr. and Sane Cr. 1981–1985

Water temperature measurements during snowmelt – air and water temps 1985 North Draw, Middle Draw, South Draw, North Pipe, and Loco Creek

Druck, pH, conductivity, sensor vs. standard measurements – raw data Sane Creek and Loco Creek pH-conductivity match w/ Druck Sensor Model 930

In-situ A-35 comparisons Omni – Druck-A35 comparison- graphs of North Draw and Loco Creek

1989 Data logger Field Books – Loco Cr., Sane Cr., and North Draw raw data, Rite in the Rain notebooks containing conductivity and pH measurements

Water Analysis Wyoming Dept. Agr. 1989 – chemical content of Loco Cr. and Sane Cr. water analysis report from Wy. Department of Agriculture, and reference articles for stream chemistry

Water Analysis Wyoming Dept. of Agr. 1988 – chemical content of Loco Cr. and Sane Cr. water analysis report from Wy. Department of Agriculture

Water Analysis Wyoming Dept. of Agr. 1987 – chemical content of Loco Cr. and Sane Cr. water analysis report from Wy. Department of Agriculture

Druck Pressure Transd. calibration certification – Druck data logger information, installation dates, general info, some data

USGS Dissolved Organic Carbon SMS – 1987 and 1988 sampler readings USGS data print-outs for Loco Cr., Sane Cr., and North Draw weir, plus reference articles on dissolved organic carbon

Streamflow ADP print-outs – 1968 to 1990 streamflows for Sane Cr. and Loco Cr.

Streamflow Hydrographs – 1968 to 1990 hydrographs for Sane Cr. and Loco Cr.

Snowmelt-Groundwater Hydrograph Separation – snowmelt intervals, discharge periods, groundwater discharge, and hydrograph separations for Loco and Sane Creeks 1968 to 1990

Streamflow measurements – notes on weirs, channel measurements, csm measurements, flume information, cut-off wall information

Loco vs. Sane Creek Dec–Feb Run-off – compares average daily discharge/total discharge of Loco and Sane Creeks 1968–1982 data sheets, summaries

Oversnow run-off Sane Creek Analysis and Adjustment Procedures – 1970, 1973, 1983, 1984 calculations to adjust flows to take out oversnow flow effects

Recession Analysis Loco and Sane Creeks – "Recession" comparison of streamflow vs. suspended sediment- data sheets and graph

Loco vs. Sane Creek Post-snowmelt 90-day run-off – July–Oct 1968–1981 run-off comparison

North Draw-Loco Flow Duration – 1974–1985 snowmelt discharge data

North Draw Snow Ablation ND 1,2,5,8 – Sane Cr., Loco Cr., and North Draw snow ablation 1980 to 1985

Miscellaneous

Weir – plan drawings for a contained weir gage

North draw Weir Plans – blue prints for North Draw project

Middle Fork Weir Design – South Draw and Middle Draw weir design plans

BLM Study- MISC Notes, calculations – 1967 field data for the then-proposed Stratton Study Area, channel characteristics, watershed areas etc...

Time Record – Carpenter-empty

Accounting – costs of weir constructions, bills, misc. accounting documents

Seahorn BROS Purchase Agreement and Laramie LMBR – agreements for services

Seahorn Tickets 1967 – bills from trucking for backhoe, etc...

Seahorn Tickets 1971 – bills from trucking for backhoe, etc...

Weather Data – 1968 notes on weather station install and calendar with weather notes

Palmer Hydrograph Record – flood hygrograph chart and handwritten report of a convection storm event on 8/21/69 by D.L.Sturges

Theft MRI and Hygrothermograph North Draw – A typed report of a theft of meteorological instruments from North Draw weather station between 11/1 and 11/3/78

LOCO-SANE Statistical Analysis

Loco Creek- Sane Creek Data for time to accumulate 50% and 25% snowmelt discharge Water Resources Research Paper 1991–1968 to 1975 pre-treatment data and 1977 to 1987 post-treatment data analysis of treatment effect on minimum number of days required to get 25 and 50% of snowmelt discharge at Loco Creek and Sane Creek; discharge data sheets

Course sediment deposition Loco-Sane Cr. Statistical Analysis by Ft. Collins – changes in bedload sediment analysis post-1976 treatment, statistics performed by Ft. Collins lab

Loco-Sane Bedload Sediment Analysis – bedload sediment deposition at Loco Cr. and Sane Creek 1971 to 1990, and statistical analysis

Loco-Sane Creek Snow Course Data Analysis 1968–1989 – Loco Cr. and Sane Cr. snow course data and analysis

Loco-Sane vegetation production and % composition analysis – data cartridge before and after spraying (1976) vegetation data = % composition, production at Loco Cr. and Sane Cr. (data for JRM paper)

Loco-Sane vegetation Fort Collins Print-outs 1986 JRM Paper – statistical analysis and reviewer's comments for the 1986 JRM paper

Loco-Sane Ground Cover Analysis May 1986 – statistical analysis of post-treatment streamflow on Sane and Loco Creeks

Loco-SANE Ground Cover Analysis – statistical analysis of ground cover pre- and post-treatment at Sane and Loco Creeks

9825 Program tape Loco and Sane Creek Streamflow Data 5/86 – data cartridge and instructions on data analysis, data for 1986 Western Snow Conference and Alaska Cold Regions Symposium papers

LOCO-SANE Streamflow Analysis – BLM FINAL REPORT-statistics examples, data sheets

Streamflow Pretreatment Statistics Loco vs. Sane Creek – Streamflow data and statistics, Loco and Sane Creeks

LOCO-ND Statistical Analysis

Statistical Analysis by Rudy King and Jill Snow Fence Evaluations – a lot of data sheets and statistics print-outs for the snowfence study

North Draw Snow Fence Rick Jones Computer Graphics – raw data sheets on snow depth at the North Draw transects pre- and post-snowfence

Snowmelt Run-off Efficiency – calculations at North Draw run-off efficiency, North Draw water yields through flume, water storage calculations

Tabler 1986 Yield Efficiency calculations of reconciliation of difference w/DLS 1990 calculations – hand calculations and regression analysis

North Draw Daily Streamflow and Sediment Discharge – data from 1983–1989

Covariance Analysis Sturges on 9820 – Loco Cr. vs. North Draw, data printouts and snowfence treatment effects

Economic Analysis Water Development Costs for North Draw Snowfence – hand-figured costs analysis of project and general notes

Flow separation North Draw watershed above and below flume – hand-calculation of discharge rates at North Draw

Analysis Snow Fence Trapping Efficiency – Calculations of Precipitation and snowdrift length, water storage etc...

Water Storage North Draw Channel ND 3–9 Transects – channel snow accumulation at North Draw pre- and post-treatment, regression analysis

North Draw Snow Storage ND 1 and 2 vs. LC 9 and SC 6 – a comparison of snow catchments 1968 to 1990

Surface Snowmelt Run-off Computations Loco Cr. vs. North Draw Final Treatment Evaluation – data sheets and calculations with instructions on how to do snowmelt surface run-off on Loco Creek

Surface Snowmelt Run-off Computation: Loco Cr. vs. North Draw 1986 Alaska Symposium – hand-calculations and statistics printouts

Water-yield Adjustments North Draw and Loco Creek – hand-calculated flow adjustments for oversnow flow events at Loco Cr. and North Draw

Pre-treatment Calibrations Loco Creek vs. North Draw H2O, Snow, Runoff Length – data and calculations

Snowmelt Loco vs. North Draw Preliminary Calibration Streamflow – runoff pre-treatment calibration calculations for Loco Cr. and North Draw

North Draw Elevation and Snow Fence Survey Data Precip. Channel Length and Snow Courses apply to – descriptions of snow transects a North Draw, field information

North Draw Snow Fence Survey and Preliminary Statements Snow Transport – snowfence plans, construction notes, 2 original field notebooks, ground survey

Loco Creek Icing Effects Analysis 1990 Western Snow Conference

Programs 1990 Western Snow Conference – computer and hand-written calculations, statistics program methods for observing icing effects on streamflow in data tapes at Loco and Sane Creeks

Statistical Analysis 1990 Western Snow Conference – Loco and Sane Cr. computer and hand-written statistics

HP Data and Program Tapes – 5 cassette tapes

Miscellaneous

Survey data – 4 field notebooks, 2 engineering notebooks, South, North, and Middle Draw survey notes

Transformer oil PCB analysis – WY Dept. of Agriculture results say "oil is petroleum"

Saratoga Trailer Water Analysis – water lab test results of the field trailer's water quality

Formal Agreements and Drafts – Agreement articles between BLM and USFS, and BLM and Green Mt.-Sage Cr. Sheep Company

Construction-1968 – Loco and Sane Creek weirs (including Loco Multiplate Arch) construction plans, drawings, notes for Loco and Sane Creek weirs

#1 Weir plans (Loco Cr.) and pictures of stream gage construction – a photo-essay by Kendall Johnson of Loco Cr. weir gage construction

Weir plans #3 (Sane Creek) – plan drawings of Sane Cr. weir

Upper North Draw Stream gage – streamflow data, survey information, costs, and construction plans

Contained Weir BIOS and contracts – contracts and bids for weir construction

Manuals – Flood Hydrograph Recorder (Palmer Instruments), Belfort Weighing Rain Gage, Belfort Hygro-thermograph manuals

Loco Creek Weir Locational Survey 8/69 – map of Stratton and weir drawings

Mineral Entry Information – all treatment map and mining claim abstract

Geology MS thesis – Del Mauro, Gene L. 1953. Geology of Miller Hill and Sage Cr. Area, Carbon County, WY. 141 pp. excerpts only

Geologic Map of Carbon County – a very large geology map by J.L. Weitz and J.D. Love

General Mapping and Watershed Planimetered Areas – Middlewood Hill and Jack Cr. topographical maps, watershed area descriptions, other maps

Watershed Maps Hydrometeorological stations – maps of Stratton, several copies

Watershed Maps Cultural Features – maps of Stratton, several copies

Watershed Maps Topography – topographical maps of Stratton, several copies

Watershed Maps Soil Moisture Points Snow Transect Locations – Sane Cr. maps, several copies

Watershed Maps Vegetation Sampling Network – several copies, note corrections in Sane Cr. watershed sample point numbering

BLM Photogram metric work – aerial photo flight documents Wyoming Highway Department

8/8/73 Air Photo Flight – Maps and sketches showing flight path

Soil information for Section 17, North Draw Snow Fence BLM contracted Soil Survey – written description of soil types at North Draw site

SCS Soil Survey Report – a complete soil survey of Stratton with maps and soil descriptions

Watershed Maps Soil Mosaic – several soil surveys and aerial photo soil maps and soils descriptions

Watershed Maps Soil Survey – several maps, close-up soil maps

Middle Draw Ground Survey by Tabler – field notebook, survey drawings of Middle Draw watershed

1987 Aerial Flights Wyo. Highway Dept. – invoice only

Maps – miscellaneous notes and Stratton topographical maps

Inked maps – map transparencies of Stratton

Data on Middle Draw – (manila envelope), miscellaneous graphs and data

CSU photo work Middle Draw – profiles, snow depth data, flight lines

1974 Middle Draw Snow Ablation – hand-written notes and figures on snowmelt

Sane Creek Fall Soil Moisture Recharge Requirement – hand-written spreadsheets and maps

Stratton physiographic units – aerial photo copies with color pencil lines, extra maps

Sane Creek Hydrology Simulation Constants – Sane Cr. channel measurements, soil types, moisture content, recharge requirements, calculations for available soil water, aerial photos

1973 Simulation Sane Creek – hydrologic subunits, soil moisture and snowpack information

1974 Simulation Sane Creek – hydrologic subunits, soil moisture and snowpack information

Watershed Storage and Depletion, Loco and Sane Creeks Hydrologic Modeling – hand-calculated data sheets "recession analysis"

File Drawer #3

Second row of file drawer's from left, 3rd drawer down

Stratton Hydrology Study Soil Moisture Plots

Dave Sturges – study plan, moisture content of woody and herbaceous foliage, soil water, fuel moisture, solar radiation etc… data for Stratton 1975

Plot Location and Maps

Original Drawings – soil moisture study plot location maps

Plot Layout – Soil Moisture Withdrawal Study General Notes, 2,4-D treatment notes, exact locations of access tubes, notes on Artr phenology in sprayed plots 1969 and 1970, notes on drilling access tubes, plot layout

Plot Maps and Stratton Watersheds – maps and engineering field notebook

Drafted Figures for State-of-the-Art Paper – as title states

State-of-the-Art Paper Figures redrafted by Ft. Collins Publications – figure transparencies for the paper

Map – Large map of Stratton Plots, not in folder

Summer Precipitation

1969 Summer Precipitation – precipitation data, graphs (actual charts) for soil moisture withdrawal study

1970 Summer Precipitation – precipitation data, graphs (actual charts) for soil moisture withdrawal study

1971 Summer Precipitation – precipitation data, graphs (actual charts) for soil moisture withdrawal study

1972 Summer Precipitation – precipitation data, graphs (actual charts) for soil moisture withdrawal study

1973 Precipitation – precipitation data, graphs (actual charts) for soil moisture withdrawal study

Soil Moisture Data

HP 9825 Data Programs tape soil moisture plot study – 1 cassette tape, instructions on how to print from the 9825 calculator, data printouts

Program cards for 1665 – ANOVA of soil moisture study (Saratoga) Monroe calculator data cards and calculations

Surface foot calibration analysis – soil moisture plot calibration calculations for soil moisture withdrawal study

Neutron Probe Soil Moisture Calculation – drawings of probe, calibrations standards, calibration curve chart, data sheets

Surface Foot Calibration-Field Data Sheets – soil moisture by neutron probe, data sheets from 1969–1978

Field Data

Nov. 1968 Initial Measurement – 1968 soil moisture from neutron probe data

5/13/69–5/13&5/14/69 – soil moisture from neutron probe data

5/27/,5/28 – (1969) soil moisture data from neutron probe

6/5–6/69 – soil moisture data from neutron probe

6/18–6/19 – (1969) soil moisture data from neutron probe

7/10–7/11 – (1969) soil moisture data from neutron probe

7/21–7/22 – (1969) soil moisture data from neutron probe

8/7–8/8–8/25–8/26 – (1969) soil moisture data from neutron probe

8/25–8/26 – (1969) soil moisture data from neutron probe

9/10,11/69 – (1969) soil moisture data from neutron probe

9/29–9/30/69 – soil moisture data from neutron probe

5/27–29/70 – soil moisture data from neutron probe

6/15/70 – soil moisture data from neutron probe

6/22/70 – soil moisture data from neutron probe

7/1/70 – soil moisture data from neutron probe

7/8–7/9/70 – soil moisture data from neutron probe

7/22–23/70 – soil moisture data from neutron probe

8/4–8/5/70 – soil moisture data from neutron probe

8/19–20/70 Measurement-ANOVA scales plus – soil moisture data from neutron probe

9/2,3/70 – soil moisture data from neutron probe

9/16,17/70 – soil moisture data from neutron probe

Sept 30, Oct 1, 1970 – soil moisture data from neutron probe

'70–71 winter – soil moisture data from neutron probe

May 23 1971 – soil moisture data from neutron probe

6/10/71 – soil moisture data from neutron probe

June 23 – (1971) soil moisture data from neutron probe

7/5/71 – soil moisture data from neutron probe

7/20 – (1971) soil moisture data from neutron probe

8/3/71 – soil moisture data from neutron probe

8/17/71 – soil moisture data from neutron probe

8/31 – (1971) soil moisture data from neutron probe

9/14/71 – soil moisture data from neutron probe

May 18, 1972 – soil moisture data from neutron probe

May 31 – (1972) soil moisture data from neutron probe

6/15 – (1972) soil moisture data from neutron probe

6/28/72 – soil moisture data from neutron probe

7/13/72 – soil moisture data from neutron probe

7/27 – (1972) soil moisture data from neutron probe

8/9/72 – soil moisture data from neutron probe

8/24 – (1972) soil moisture data from neutron probe

9/7 – (1972) soil moisture data from neutron probe

9/20 – (1972) soil moisture data from neutron probe

10/4/72 – soil moisture data from neutron probe

5/31/73 (only plots with sprayed/grubbed study measured) – soil moisture data from neutron probe

6/4/73 – soil moisture data from neutron probe

6/12–14/73 – soil moisture data from neutron probe

6/25/73 – soil moisture data from neutron probe

7/10/73 – soil moisture data from neutron probe

7/24 & 25/73 – soil moisture data from neutron probe

8/9/73 – soil moisture data from neutron probe

8/22/73 – soil moisture data from neutron probe

9/5 – (1973) soil moisture data from neutron probe

9/19 & 20/73 – soil moisture data from neutron probe

10/4/73 – soil moisture data from neutron probe

Winter 1973–74 – soil moisture data from neutron probe

6/2/75 – soil moisture data from neutron probe

6/18/75 – soil moisture data from neutron probe

7/1 – (1975) soil moisture data from neutron probe

7/17 – (1975) soil moisture data from neutron probe

8/5 & 8/27 Ft Collins Americium Source – soil moisture data from neutron probe

9/15/75 – soil moisture data from neutron probe

10/1/75 – soil moisture data from neutron probe

April 28, 1977 – soil moisture data from neutron probe

May 18, 1977 JW – soil moisture data from neutron probe

6/9–10/77 – soil moisture data from neutron probe

6/29/77 – soil moisture data from neutron probe

7/22 – (1977) soil moisture data from neutron probe

8-11-77 by JW – soil moisture data from neutron probe

8-31-77 KB – soil moisture data from neutron probe

9-10-77 KB – soil moisture data from neutron probe

10-6-77 JW – soil moisture data from neutron probe

1977–78 Winter Measurements 11/29, ¼, 3/2, 4/5 – soil moisture data from neutron probe

5/15 & 10/2/78 Plot Measurements – soil moisture data from neutron probe

6/4 & 10/1/79 1979 – soil moisture data from neutron probe

5/27–28/80 – soil moisture data from neutron probe

6/16–17/80 – soil moisture data from neutron probe

6/30–7/1/80 – soil moisture data from neutron probe

7/17/80 – soil moisture data from neutron probe

7/31–8/1/80 – soil moisture data from neutron probe

August 14–15, 1980 JW – soil moisture data from neutron probe

9/3/80 – soil moisture data from neutron probe

9/23/80 – soil moisture data from neutron probe

10/2 & 10/3/80 – soil moisture data from neutron probe

4/29–30/81 – soil moisture data from neutron probe

6/1–6/2/81 JW – soil moisture data from neutron probe

6/17–18/81 – soil moisture data from neutron probe

July 7– Oct 1, 1981 Soil Moisture Plots – soil moisture data from neutron probe

5/26 & 10/5/82 – soil moisture data from neutron probe

5/24 & 10/7/83 – soil moisture data from neutron probe

5/31/84 & 10/2/84 – soil moisture data from neutron probe

5/9/85 & 10/1/85 – soil moisture data from neutron probe

5/12/86–10/1/86 – soil moisture data from neutron probe

1987 – soil moisture data from neutron probe

1988 – soil moisture data from neutron probe

1989 – soil moisture data from neutron probe

1990 – soil moisture data from neutron probe

Summary and Analysis

1969-Study Life Statistical Analysis based on Recharge Requirements – a note describing use and replacement of soil neutron probes throughout study… statistics and summaries overall and by year and season

Avg. Soil Water Content 1968-Study Life – compares soil moisture in sprayed and unsprayed plots for entire study; data sheets, calculations

Water-Use Efficiencies based on Production and Depletion – seasonal water use notes for sprayed and unsprayed plots 1969–1981

1981 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1980 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1979 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1978 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1977 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

Summary 1977–78 Winter and Statistical Analysis – data sheets and calculations for soil moisture data

1975 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1973 Summary and Statistical Analysis & summary shts – data sheets and calculations for soil moisture data

1972 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1971 Summary and Statistical Analysis – data sheets and calculations for soil moisture data

1971 plots for soil moisture data summary sheets – plot moisture content data

File Drawer #4

Second row of file drawer's from left, 4th drawer down

Soil Moisture Plot Study (Continued)

Soil Moisture Data Summary and Analysis

1970 Statistical Analysis and Summary Data Sheets – summary soil moisture data

1970 Plots for Sprayed and Unsprayed treatments, Plot Data Sheets – hand calculations

1969 Statistical Analysis – data sheets and hand-calculated statistics

Summary Sheets 1969 – plot soil moisture spreadsheets and summary

Statistical Analysis Fall 1968 – plot soil moisture spreadsheets and summary

Snow Data

Transect Locations, General Snow Notes – snow transect location notes

Field Data

1969–1989 Snow Accumulation LC-5 parallel to plots – Snow depth, snow course, water content data-Loco Creek 5

Plot Snow Measurements All Years, Special Items – soil moisture plot study, various data 1969

1969–70 Revised Experimental Design – ANOVA, data sheets, snowdepth analysis

1969–70 Data Analysis Original and Revised Exp. Design – ANOVA for soil moisture plots sprayed and unsprayed

1969–1970 Winter – precipitation and snow survey data sheets

Snowmelt meter temperatures – snow temperature data, soil moisture plot studies

1970–71 Winter – snow data and statistical analyses

1970–71 Winter – snow data sheets and statistical analyses

1971–72 Winter – snow data sheets and statistical analyses

1972–73 Winter – snow data sheets and statistical analyses

1973–74 Winter – snow data sheets and statistical analyses

Snowmelt Meter – Western snowmelt meter readings for 1973 and 1974, and calibration calculations

Summary and Analysis

Vegetative Data

Production

Statistical Analysis Vegetation Production and Composition – soil moisture plot herbaceous production 1969 to 1987, ANOVA calculations, HP ANOVA calculator program

Program for Calculating Random Location Herbage Plots and 1 Acre Grid – as stated

Sample Point Locations – All random exact locations of soil moisture plot vegetation sampling 1969 to 1990

1969 Production and Statistical Analysis – herbaceous production data and statistics from soil moisture study

1970 Production and Statistical Analysis – herbaceous production data and statistics from soil moisture study

1970 Statistical Analysis – hand-calculated statistics of herbaceous production data

1971 Production – herbaceous production data and statistics from soil moisture study

1972 Production – herbaceous production data and statistics from soil moisture study

1973 Production – herbaceous production data and statistics from soil moisture study

1980 Production and Statistical Analyses – herbaceous production data and statistics from soil moisture study

1981 Production and Statistical Analyses – herbaceous production data and statistics from soil moisture study

1986 Production and Statistical Analyses – herbaceous production data and statistics from soil moisture study

1987 Production Soil Moisture Plots – herbaceous production data and no statistics but one calculator printout from soil moisture study

Sagebrush Canopy Cover

Soils Data

UW Soil Characteristics on Plots – bulk density and rock content of soils done by Indy Burke for plots in soil moisture study

Bulk Density

Bulk Density – soil bulk density information by site and plot number

Moisture Retention Curves

Soil sample locations – locations of randomly selected soil samples in plots of soil moisture withdrawal study (block design)

Moisture Retention Curves – soil volume moisture contents at 3 slope positions for individual plant study, moisture retention determination data sheets

Field Capacity, Permanent Wilting Percentage, Laboratory Determinations – soil sample data for soil moisture plot study

1979 Net Radiation – net radiometer installed May 1979 between Sane Creek and Middle Draw, descriptions, calibration instructions

Individual Plant Study Soil Moisture-Roots

Random Location Study Plants and Access Tubes – location of tubes in bottom, mid-slope, and ridge top field study of soil moisture and sagebrush

Bottom Site 8/20, 9/17/1970 – soil moisture by neutron probe data sheets, and summary of soil moisture change at the bottom of slope location

Bottom Site 1971 – soil moisture by neutron probe data sheets, and summary of soil moisture change at the bottom of slope location

Bottom, Midslope, Ridge Moisture Measurements 9/22–9/24/70 – soil moisture by neutron probe data sheets, and summary of soil moisture change at the three slope locations

Midslope – soil moisture by neutron probe data sheets, and summary of soil moisture change at the midslope location

Ridge – soil moisture by neutron probe data sheets, and summary of soil moisture change at the top of slope location

Summary Sheet Bottom, Mid and Ridge Sheets – miscellaneous data and calculations

Summary Sheet Bottom Site Change in Moisture Content – soil moisture data, soil moisture extraction by individual plant data sheets, ANOVAs, calculations

Summary Sheet Midslope Site change in Moisture Content – soil moisture data, soil moisture extraction by individual plant data sheets, ANOVAs, calculations

Ridge Summary – soil moisture data, soil moisture extractions by individual plant data sheets etc...

Laboratory processing of root field samples – root weights for plants at the 3 locations

Summary Root Information – analysis of site differences, root weights and density, depth and spread

Normalized Root Concentrations and Moisture Use – hand-calculations, spreadsheets

Sagebrush foliage data – weights of woody, herbaceous stem, and leaf material of individual plants at each slope position; crown area of plants, stem diameter, and plant weights

Snow Data on Study Sites – precipitation amount, snowdepth and water equivalent at each slope position.

Sagebrush Root Carbohydrates

Sturges data – correspondence from M.F. Trlica about data analysis, root data, statistical analysis, and interpretation of sagebrush root data write-up

AOV's Sturges DATA – statistical analysis of root study data, scads of printout paper, hand-written notes

Brewer's Sparrow Nesting Study

Brewer's sparrow field data – data sheets from bird censing, tabulations, temperatures, field notes, nest locations and treatment notes

Brewer's Sparrow Summary – 1971 data summary, statistical analysis, body length measurements, map of study location, nest temperatures, etc...

Study 315 Sprayed Grubbed Big Sagebrush

Soils data sage-root study – soil map and descriptions for individual plant study

Sprayed-Grubbed-Sagebrush Study 315 Soil Moisture data – change in soil moisture content data spreadsheets

Root data study 315 – root weights and ANOVA of root weights

Vegetation Data Study 315 – production, density, phenology, canopy cover data of sprayed, grubbed, and undisturbed sagebrush

File Drawer #5

Second row of file drawer's from left, 5th drawer down

Field Data Forms

Sagebrush W/S Study

Snow Survey- Transects – blank snow survey forms

Snow survey-random points – blank snow survey forms

Work Maps – watershed maps of Stratton

Snowfence Watershed Study

Precipitation – Pole Mt. watershed blank forms

MRI Redox – MRI data reduction forms

Temperature Summary- SF RI-RM – blank forms for climate and temperature

Snow Survey-Transects – blank snow survey forms

Snow Accum Profiles behind w.s 2 Fence – drawn profile (Not Stratton)

Work Maps – Pole Mt. Study

Sagebrush Spraying Snow Study (309)

Snow Survey Forms

(several forms folders.....)

Miscellaneous

(forms folders for Stratton studies and others)

North Draw Sagebrush-Snowfence Study

no title – sagebrush characteristics and canopy intercept data from transects at North Draw, 1983 to 1989

Sagebrush characteristics N.D. Snow Fence – sagebrush characteristics and canopy intercept data forms

Statistical Analysis Sagebrush plant data and snow data – snow depth data and statistical analysis of sagebrush transect data

ND: Sage snowfence study-snow data – transect data including snow depth, accumulations, course, profiles, etc...

Snowmold Fungus Study

Snowmold data analysis – snowmold data and analysis (correspondence with Rudy King-biometrician who helped analyze data)

Snowmold Fungus Field and Snow Data – data cartridge, snowmold transect data, snow survey data

File Drawer #6

3rd row of file drawers from left, top drawer

Precipitation

Climate Data Summaries 1968–1989 – 1 page, average daily radiation line graph

Field Note Book-Pages From – filed notebooks containing data from various gages at Stratton

Twin Groves (Grove) Daily Precipitation Summaries Oct, 1975 to present – as stated, to 1987

Sage Creek Daily Precipitation Summaries Oct 26, 1972 to July 1990 – as stated North Draw Daily Precipitation Summaries June–Sept. 1970 to present– as stated to 1988

Weather Station#2 Daily Precipitation Summaries June–Sept. 1968 to present – as stated, to 1987

Data used to determine daily precip 1968 to 1972 – Sane Creek and Sage Creek gage data comparison

Precipitation Intensity – precipitation data and selected storm intensities, 1968–1973

Summer Precipitation Thiessen Network – Thiessen-weighed watershed precipitation data at Stratton 1968 and 1976

1968 Precipitation – precipitation charts and field data from all gages on Stratton

1969 Precipitation – precipitation charts and field data from all gages on Stratton

1970 Precipitation – precipitation charts and field data from all gages on Stratton

1971 Precipitation – precipitation charts and field data from all gages on Stratton

1972 Precipitation – precipitation charts and field data from all gages on Stratton

1973 Precipitation – precipitation charts and field data from all gages on Stratton

1974 Precipitation – precipitation charts and field data from all gages on Stratton

1975 Precipitation – precipitation charts and field data from all gages on Stratton

1976 Precipitation – precipitation charts and field data from all gages on Stratton

1977 Precipitation – precipitation charts and field data from all gages on Stratton

1978 Precipitation – precipitation charts and field data from all gages on Stratton

1979 Precipitation – precipitation charts and field data from all gages on Stratton

1980 Precipitation – precipitation charts and field data from all gages on Stratton

1981 Precipitation – *precipitation charts and field data from all gages on Stratton*

1982 Precipitation – precipitation charts and field data from all gages on Stratton

1983 Precipitation – precipitation charts and field data from all gages on Stratton

1984 Precipitation – precipitation charts and field data from all gages on Stratton

1985 Precipitation – precipitation charts and field data from all gages on Stratton

1986 Precipitation – precipitation charts and field data from all gages on Stratton

1987 Precipitation – precipitation charts and field data from all gages on Stratton

1988 Precipitation – precipitation charts and field data from all gages on Stratton

1989 Precipitation – precipitation charts and field data from all gages on Stratton

1990 Precipitation – precipitation charts and field data from all gages on Stratton

Snow Survey

Snow Survey Network – 1968 to 1984, original data from snow transects at Loco Creek, Sane Creek, Middle, South, and North Draws

Snow density MSM neutron probe – Federal snow sampler vs. neutron probe (for snow density) 1984 and 1985

North Draw Snowpack Insulation – data and description of a study where they used hay, straw, and woodchip mulches to insulate snowpack, field data forms

Snow Course Profiles – profile drawings of Loco Creek, Sane Creek, South Draw, and North Draw snow courses

Snow Survey 1968 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey 1969 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey 1970 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey 1971 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey 1972 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey 1973 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Snow Survey Middle Draw 1975 – snow survey data for Middle Draw only including snow depth and snow courses; data chart and field notes

Snow Survey 1974 – snow survey data including snow depth and snow courses; data chart and field notes for Stratton watersheds

Sane Creek Snow Measurements 1974 – snow survey data for Sane Creek including snow depth and snow courses; data chart and field notes

Snow Survey 1975 – snow survey field data forms

Snow Survey 1976 – snow survey field data forms

North Draw Channel Snow Accumulation 1976 – North Draw profile drawings, field data, photo-copied notes

Snow Survey 1977 – snow survey data forms

Snow Survey 1978 – snow survey data forms

1978 Middle Draw Snow Survey 4/4/78 – snow survey data forms

Snow Survey 1979 – snow survey data forms

North Draw Snow Survey 1978–79 – channel profile drawings, transect data, snow survey forms

Middle Draw Snow Survey – snow survey data forms

Snow Survey 1980 – snow survey data forms

North Draw Snow Survey 1979–80 – summary forms of snow characteristics, data sheets

Snow Survey 1981 – snow survey data forms

Snow Survey 1982 – snow survey data forms

North Draw Snow Survey 1981–1982 – snow transect data

1983 Snow Survey – snow survey data forms

1982–83 North Draw Snow Survey – snow transect data

Snow Survey 1984 – snow survey data forms

1983–84 North Draw Snow Survey – snow transect data

Sane Creek Snow Measurements 1974 – Sane Creek snow data forms

Snow Survey 1975 – snow data forms, all watersheds

Snow Survey 1976 – snow data forms, all watersheds

1985 Snow Survey – snow data forms, all watersheds

1984–85 North Draw Snow Survey – snow transect data

1986 Snow Survey – snow data forms, all watersheds

1985–86 North Draw Snow Accumulation – various snow data forms, transect data

1986 North Draw Drift Ablation – data sheets documenting snowmelt dates

1987 Snow Accumulation – various snow data forms, transect data

1986–87 North Draw Snow Accumulation – various snow data forms, transect data

1988 Snow Survey – snow data forms, all watersheds

1987–88 North Draw Snow Accumulation – various snow data forms, transect data

1989 Snow Survey – snow data forms, all watersheds

1988–89 North Draw Snow Accumulation – various snow data forms, transect data

1990 Stratton Snow Survey – North Draw and Sane Creek snow course data only

Photographs, Slides, and Aerial Photos

In the file cabinets on the east wall of the same records storage room (Rocky Mt. Forest and Range Experiment Station, Laramie, Wyoming) there are many photographs and slides from Stratton Sagebrush Hydrology Study Area. Drawers containing these files are titled "Stratton", and contain the following: vegetation transect photo points, soil moisture studies, Sane Creek herbicide spraying, stream gages, snow conditions, livestock use, miscellaneous wildlife, slides from research, and aerial photos of Stratton. They are well labeled and will prove useful for researchers wishing to compare past conditions with current ones at exact locations.