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United States
Department of
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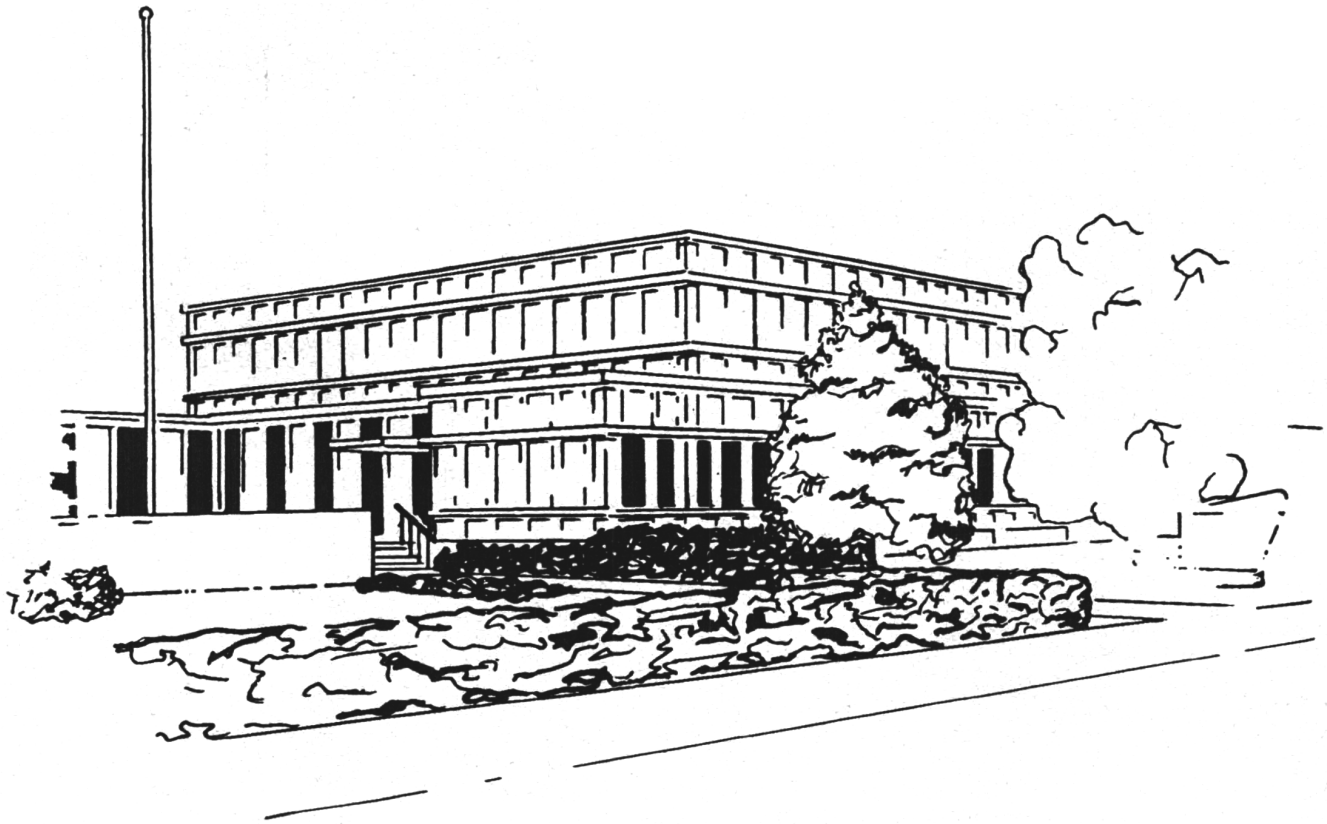
Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins
Colorado 80526

**General Technical
Report RM-208**

Publications of the Rocky Mountain Forest and Range Experiment Station 1980–1989



Winokur, Robert P., compiler. 1992. Publications of the Rocky Mountain Forest and Range Experiment Station, 1980–1989. General Technical Report RM–208. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 296 p.

Lists alphabetically, by author, publications of the Rocky Mountain Forest and Range Experiment Station for 1980 through 1989, including both subject matter and author indexes. This publication continues the information shown in USDA Forest Service General Technical Report RM–6, "Publications of the Rocky Mountain Forest and Range Experiment Station , 1953–1973," compiled by Mona F. Nickerson and Glen E. Brink, published in 1974; and "Publications of the Rocky Mountain Forest and Range Experiment Station, 1974–1979," compiled by Sharon M. Litten, and published in 1980 (which included all information previously published in USDA Forest Service General Technical Report RM–31).

USDA Forest Service
General Technical Report RM-208

January 1992

Publications of the Rocky Mountain Forest and Range Experiment Station 1980–1989

compiled by
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Rocky Mountain Forest and Range Experiment Station[1]

[1]*Headquarters is in Fort Collins, in cooperation with Colorado State University*

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Publications Distribution
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1. **Agnew, William; Uresk, Daniel W.; Hansen, Richard M. 1988. Arthropod consumption by small mammals on prairie dog colonies and adjacent ungrazed mixed grass prairie in western South Dakota.** *In:* **Uresk, Daniel W.; Schenbeck, Greg L.; Cefkin, Rose, technical coordinators. Eighth Great Plains wildlife damage control workshop proceedings; 1987 April 28-30; Rapid City, SD. General Technical Report RM-154. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 81-87. 231 p.**

   The percentage of arthropods and plants in the diets of seven small rodents captured on prairie dog colonies and adjacent mixed grasslands were estimated by microhistological techniques. Arthropod composition over the 2-year study averaged 51% and 37% on prairie dog colonies and mixed grasslands, respectively. Composition of arthropods on prairie dog colonies was greater during the summer than in late spring or late summer. Conversely, arthropods made up a considerably smaller percentage of small mammal diets in the summer on mixed grasslands. Prairie dog colonies favor insectivorous rodent species. Prairie dogs, in creating habitat for insectivorous small mammals, may indirectly reduce localized arthropod outbreaks.

2. **Agnew, William; Uresk, Daniel W.; Hansen, Richard M. 1986. Flora and fauna associated with prairie dog colonies and adjacent ungrazed mixed-grass prairie in western South Dakota. Journal of Range Management. 39(2): 135-139.**

   Vegetation, small rodents, and birds were sampled during the growing seasons of 2 years on prairie dog colonies and adjacent mixed-grass prairie in western South Dakota. Prairie dog grazing decreased mulch cover, maximum height of vegetation, plant species richness, and tended to decrease live plant canopy cover. Prairie dog towns supported greater densities of small rodents but significantly few species compared to undisturbed mixed-grass sites.

3. **Aguilar, Richard D.; Heil, R. D. 1988. Soil organic carbon, nitrogen and phosphorus quantities in northern Great Plains rangeland. Soil Science Society of America Journal. 52: 1076-1081.**

4. **Aguilar, Richard D.; Kelly, E. F.; Heil, R. D. 1988. Effects of cultivation on soils in northern Great Plains rangeland. Soil Science Society of America Journal. 52: 1081-1085.**

5. **Aitken, William M. 1982. The effects of ozone on Colorado Front Range ponderosa pine.** *In:* **Proceedings, 29th Annual Western International Forest Disease Work Conference. 1981 September 15-17; Vernon, BC and Juneau, Alaska. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region: 93-94.**

6. **Aitken, William M.; Jacobi, William R.; Staley, John M. 1984. Ozone effects on seedlings of Rocky Mountain ponderosa pine. Plant Disease. 68: 398-401.**

7. **Ajzen, Icek; Peterson, George L. 1988. Contingent value measurement: the price of everything and the value of nothing.** *In:* **Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 65-76.**

   Willingness to pay is a narrow economic measure of value that is not a sufficient criterion of social and psychological benefits. This paper examines value from the psychological point of view, constructively criticizes the contingent valuation method, and recommends ways to apply psychological valuation theories and methods.

8. **Aldon, Earl F. 1984. Broadcast seeded western wheatgrass successfully spreads on mine spoil. Reclamation and Revegetation Research. 3: 167-170.**

   Western wheatgrass will survive and spread when broadcast seeded on mine spoil receiving some additional moisture as a result of topographic shaping. In 8 years, depending on water harvest catchment area, this plant spread by rhizomes from an area 1.5 m^2 to 5.9 and 11.5 m^2.

9. **Aldon, Earl F. 1985. Hydrologic parameters of surface mine spoils in the Southwest.** *In:* **Williams, Dean; Fisher, Scott E., Jr., editors. Proceedings of the second annual meeting of the American Society for Surface Mining and Reclamation; 1985 October 8-10; Denver, CO. Princeton, WV: American Society for Surface Mining and Reclamation: 228-231. 412 p.**

   Increased surface mining of coal in the Four Corners area of the U. S. has caused concern as to whether cast over-burden (spoil) contributes significant sediment

due to runoff to the already high levels in area streams. This paper reports some of the first measured values of these parameters from a southwestern coal field.

10. **Aldon, Earl F. 1981. Long-term plant survival and density data from reclaimed southwestern coal mine spoils. Great Basin Naturalist. 41(271-273).**

    Plantings on northwestern New Mexico raw mine spoils from 1973, examined for establishment (1975) and survival (1979), showed 75 percent survival of fourwing saltbush, each plant occupying 2.32 square meters (1.52 by 1.52 m). Alkali sacation cover was 4 percent and had a density of 0.05 plant per square meter.

11. **Aldon, Earl F. 1984. Methods for establishing fourwing saltbush (*Atriplex canescens* [Pursh] Nutt.) on disturbed sites in the Southwest. *In:* Tiedemann, Arthur R. [and others] Proceedings of the symposium on the biology of Atriplex and related chenopods; 1983 May 2-6; Provo, Utah. Ogden, Utah: Intermountain Forest and Range Experiment Station: 265-268. 309 p.**

    This paper outlines the techniques for establishing fourwing saltbush on disturbed sites using transplants, methods needed for establishing this plant on surface coal mine areas by direct seeding and with supplemental irrigation, and the long-term survival of fourwing saltbush on reclaimed coal mine spoils.

12. **Aldon, Earl F. 1980. Micro-catchment water harvesting. *In:* Brittain, Richard G.; Myhrman, Matts A., editors. Proceedings, vegetative reclamation of mine wastes in the Southwest; 1980 April 23-25; Tucson, AZ. Tucson, AZ: Arizona Mining and Mineral Resources Institute: 19-1 to 19-6.**

    In the water-scarce Southwest, a small additional increment of water may dramatically affect survival of newly planted vegetation. This paper examines the yield of water and growth of shrubs in small plots treated with either paraffin or black polyethylene. The effects of paraffin and a silicone emulsion sprayed on coals mine spoil also were examined to determine if they increase water catchment for shrub growth.

13. **Aldon, Earl F. 1984. Mine reclamation in arid lands. *In:* Vegetation rehabilitation and equipment workshop, 38th annual report. 1984 February 14-15; Rapid City, SD. San Dimas, CA. U.S. Department of Agriculture, Forest Service, Equipment Development Center: 18-19.**

14. **Aldon, Earl F. 1980. Mycorrhizal enhancement of plant establishment and growth. *In:* Brittain, Richard G.; Myhrman, Matts A., editors. Proceedings, vegetative reclamation of mine wastes in the Southwest; 1980 April 23-25; Tucson, AZ. Tucson, AZ: Arizona Mining and Mineral Resources Institute: 17-1 to 17-3.**

    Mycorrhizae have been shown to be instrumental in increasing phosphate absorption by plants from sources considered to be unavailable. Mycorrhizae also appear to be important in protecting plant roots from pathogens. Most of the research on the protective function was done with ectomycorrhizae.

15. **Aldon, Earl F. 1986. An overview of natural areas protection in the Southwest. *In:* 13th annual natural areas conference; 1986 October 21-24; Potosi, MO. Rockford, IL: The Natural Areas Association.**

16. **Aldon, Earl F. 1986. The role of a government experiment station and the experimental approach in developing and testing reclamation practices. *In:* Reith, Charles C.; Potter, Loren D., editors. Principles and methods of reclamation science with case studies from the arid Southwest. Albuquerque: University of New Mexico Press: 69-84. 224 p.**

    This paper describes how the Rocky Mountain Forest and Range Experiment Station, which is part of a geographic network of research facilities supported by the USDA Forest Service, has identified and responded to needs for reclamation research in the San Juan Basin.

17. **Aldon, Earl F. 1982. Use of organic amendments for biomass production on reclaimed strip mines in the Southwest. *In:* Sopper, W. E.; Seaker, E. M.; Bastian, R. K., editors. Land reclamation and biomass production with municipal waste water on sludge. 1980 September 16-18; Pittsburgh, PA. University Park, PA: Pennsylvania State University Press: 317-320. 524 p.**

    This paper is a brief summary of some of our work with organic amendments on coal mine spoils in the Southwest. The Station began its initial work with a greenhouse study using sludge and has recently expanded this work to several field studies. Some field studies include the use of sewage sludge. in other studies we are using other organic amendments. Both types will be reported here.

18. **Aldon, Earl F. 1982. Vegetation stability on mine spoils in the Southwest. *In:* Aldon, Earl F.; Oaks, Wendell R., co-editors. Proceedings of reclamation**

of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 198-200. 218 p.

Both grass and shrub species can be successfully established on the most difficult of mined sites. Additional ecological work is needed to better understand, early in the reclamation process, whether a stand is on its way to sustain itself or needs additional effort to establish and perpetuate itself.

19. **Aldon, Earl F. 1984. Vegetation parameters for judging the quality of reclamation on coal mine spoils in the Southwest. Great Basin Naturalist. 44(3): 441-446.**

Mining reclamation specialists and government regulators need sound criteria for judging when reclamation is complete and expensive bonds can be released. Values are given for five easily measured plant parameters that can be used for judging success on native species that are growing on semiarid grasslands and sagebrush lands.

20. **Aldon, Earl F.; Barstad, Janet F. 1987. Escudilla Mountain Research Natural Area: A study of an undisturbed montane grassland in Arizona. Natural Areas Journal. 7(3): 107-117.**

Three undisturbed montane grassland meadows on Escudilla Mountain in the Apache-Sitgreaves National Forest, Arizona, were studied during the summers of 1984 and 1985. Importance values were used to delineate plant composition of each community. Toolbox Draw was dominated by Arizona fescue *(Festuca arizonica)* and a sedge *(Carex oreocharis)*. Bead Springs was strongly dominated by thurber fescus *(Festuca Thurberi)*, the only known location of this grass in Arizona. Middle Meadow was dominated by a forb *(Geum triflorum)* and Arizona fescue. The use of similarity coefficients indicated that the three communities were probably part of the same montane grassland association.

21. **Aldon, Earl F.; Francis, Richard E. 1984. A modified utilization gauge for western range grasses. Research Note RM-438. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.**

Accurate, low-cost measurements of forage utilization by livestock are essential in range management and the evaluation of grazing systems. To help land managers better determine use, range utilization calculating charts have been revised into a utilization gauge. Height-weight distributions of two additional southwestern grasses have been measured and incorporated into this gauge.

22. **Aldon, Earl F.; Gonzales Vicente, Carlos E.; Moir, William H. 1987. Strategies for classification and management of native vegetation for food production in arid zones: symposium proceedings; 1987 October 12-16; Tucson, AZ. General Technical Report RM-150. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 257 p.**

These proceedings contain 44 papers presented as part of a continuing cooperative effort in forestry and related resources between Mexico and the U.S. Sessions were held on arid land classification, sampling techniques, utilization of native plants, soil management, desertification, agrosilvicultural systems, and watershed management.

23. **Aldon, Earl F.; Green, Norman. 1980. Effects of endomycorrhizae on shrub and grass growth in the Southwest. *In:* Mineral waste stabilization liaison committee: meeting and field trip; 1980 July 16-18; Santa Fe, NM. Socorro, NM: New Mexico Bureau of Mines and Mineral Resources: 98-106. 133 p.**

Several western shrubs have been shown to benefit from endomycorrhizal fungi associations. Shrub species and endomycorrhizal fungi effects are reviewed. Laboratory studies for the southwestern native grasses as affected by these fungi are also presented.

24. **Aldon, Earl F.; Oaks, Wendell R., editors. 1983. Reclamation of mined lands in the Southwest: symposium proceedings; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter. 218 p.**

25. **Aldon, Earl F.; Pase, Charles P. 1981. Plant species adaptability on mine spoils, in the Southwest: a case study. Research Note RM-398. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.**

Five native plant species and one introduced species showed high survival rates (67 percent to 100 percent), good vigor, and some spreading 6 years after transplanting on raw mine spoil.

26. **Aldon, Earl F.; Scholl, David G.; Pase, Charles P. 1981. Establishing cool-season grasses on mine spoils. *In:* Proceedings of the 1980 watershed management symposium; 1980 July 21-23; Boise, ID. New York, NY: Irrigation and Drainage Division, American Society of Civil Engineers; 1: 91-97. 587 p.**

At a high-grade, coking coal, strip mining operation, in northwestern New Mexico, several surface reclamation treatments were tested both on experimental plots and on large demonstration areas. A combination treatment of contour furrowing, drilling, and straw mulching proved the best combination for western wheatgrass *(Agropyron smithii)* and russian wildrye *(Elymus junceus)* establishment

27. **Aldon, Earl F.; Scholl, David G.; Fresquez, Philip R.; Francis, Richard E. 1988. Natural production potential of some Rio Puerco soils in New Mexico. Research Note RM-481. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Soils from six representative plant communities on the upper Rio Puerco watershed in New Mexico were sampled and tested for inherent production capability. Tests included leaf area and dry weight of greenhouse grown barley (*Hordium vulgare* var. *arivat*), soil chemical/physical properties, dehydrogenase activity, and plant community herbaceous production. There was no difference between inherent production capability of the soils based on barley leaf area and dry weight; barley leaf area was correlated to soil chemical properties and herbaceous production was correlated with plant communities.

28. **Aldrich, Robert C. 1981. Limits of aerial photography for multiresource inventories. *In:* Lund, H. Gyde [and others], editors. Arid land resource inventories: developing cost-efficient methods. Proceedings of the worshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 221-229. 620 p.**

29. **Aldrich, Robert C. 1980. Satisfying multiresource information needs for national assessments: a challenge for remote sensing. *In:* Heller, Robert C.; Ullman, J., editors. Remote sensing for natural resources—an international view of problems, promises and accomplishments. Proceedings of the symposium; 1979 September 10-14; Moscow, ID. Moscow, ID: University of Idaho: 1-15.**

30. **Alexander, Billy G., Jr.; Fitzhugh, E. Lee; Ronco, Frank Jr; Ludwig, John A. 1987. A classification of forest habitat types of the northern portion of the Cibola National Forest, New Mexico. General Technical Report RM-143. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 34 p.**

Vegetation data were collected from 124 sample plots on the Cibola National Forest, New Mexico, to develop a forest habitat classification based on potential natural vegetation. The 21 habitat types identified represent six climax forest series: *Picea engelmannii, Abies lasiocarpa, Picea pungens, Abies concolor, Pseudotsuga menziesii,* and *Pinus ponderosa.* A habitat type key is included for field identification. Each habitat type is described by vegetational composition, topographical occurrence, and related and adjacent habitats.

31. **Alexander, Billy G., Jr.; Ronco, Frank Jr; Fitzhugh, E. Lee; Ludwig, John A. 1984. A classification of forest habitat types of the Lincoln National Forest, New Mexico. General Technical Report RM-104. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 29 p.**

Vegetational data were collected to develop a forest habitat classification based on potential natural vegetation. Each habitat type is described according to vegetational composition, topographical occurrence, soils information (when known), ecotones, adjacent habitat types, and general features.

32. **Alexander, Billy G., Jr.; Ronco, Frank Jr; White, Alan S.; Ludwig, John A. 1984. Douglas-fir habitat types of northern Arizona. General Technical Report RM-108. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p.**

Four Douglas-fir *(Pseudotsuga menziesii)* habitat types and two phases were identified from a reconnaissance survey of 46 Douglas-fir stands in northern Arizona. General descriptions of these habitat types are presented, and a key to their identification is provided.

33. **Alexander, Lynn E.; Uresk, Daniel W.; Hansen, Richard M. 1983. Summer food habits of domestic sheep in southeastern Montana. Journal of Range Management. 36(3): 307-308.**

Grasses and sedges made up 96 percent of the diets. Prairie sandreed (40 percent), needleleaf sedge (28

percent), and western wheatgrass (20 percent) were the most important foods. Forbs and shrubs made up less than 1 and 3 percent of sheep diets, respectively.

34. **Alexander, Martin E. 1980. Four fire scar records on lodgepole pine (*Pinus contorta* Dougl.) in north-central Colorado. Southwestern Naturalist. 25(3): 432-434.**

35. **Alexander, Martin E.; Hawksworth, Frank G. 1982. Forest fires and dwarf mistletoes (*Arceuthobium* spp.): bibliography supplement. Northern Forest Research Centre Report. Edmonton, Alberta, Canada: Canadian Forest Service. 10 p.**

36. **Alexander, Martin E.; Hawksworth, Frank G. 1986. Forest fires and dwarf mistletoes (*Arceuthobium* spp.): bibliography supplement. Edmonton, Alberta, Canada: Canadian Forest Service, Northern Forest Center. 15 p. (Unnumbered report).**

37. **Alexander, Robert R. 1986. Classification of the forest vegetation of Wyoming. Research Note RM-466. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 10. p.**

    Forest vegetation in Wyoming is classified into 9 series, 111 habitat and community types, and plant communities. The name, location, relative site, successional status, principal tree and understory associates, and the authority are included.

38. **Alexander, Robert R. 1987. Classification of the forest vegetation of Colorado by habitat type and community type. Research Note RM-478. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.**

    Forest vegetation classified by habitat types and community types in Colorado are tabulated; 15 series and 161 habitat and community types are identified. Included are the name, location, relative site, successional status, tree and principal undergrowth associates, and the authority.

39. **Alexander, Robert R. 1985. Diameter and basal area distributions in old-growth spruce-fir stands in Colorado. Research Note RM-451. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

    Old-growth spruce-fir stands on the Fraser Experimental Forest, Colorado, were found to be irregularly uneven-aged. Although subalpine fir trees were most numerous, most of the basal area was Engelmann spruce. Alternatives to current cutting methods are suggested for stands with similar structures.

40. **Alexander, Robert R. 1987. Early history of St. Louis Creek and the Fraser Experimental Forest: a narrative. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-11. 253 p.**

    The early history of the St. Louis Creek drainage and the Fraser Experimental Forest is described in a narrative. Included are the establishment of the national forests in 1908, logging by
    railroad and flume, and logging camps in the early 1900s, acquisition of private lands, establishment of the Fraser Experimental Forest in 1937, construction of the headquarters complex, research activities from the early days of the experimental forest to the present, and personnel that have worked on the Fraser Experimental Forest in the past 50 years.

41. **Alexander, Robert R. 1987. Ecology, silviculture, and management of the Englemann spruce-subalpine type in the central and southern Rocky Mountains. Agriculture Handbook 659. Washington, DC: U.S. Department of Agriculture. 144 p.**

    This publication presents a detailed summary of the ecology and resource, and the silvics, silviculture, and management of spruce-fir forests. Major emphasis is placed on the silviculture and management of old-growth and the establishment of new stands. This publication is intended to guide land managers and land use planners who are responsible for prescribing and supervising the application of cultural treatments in the woods.

42. **Alexander, Robert R. 1980. Engelmann spruce—subalpine fir. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 86-87.**

43. **Alexander, Robert R. 1986. Engelmann spruce seed production and dispersal, and seedling establishment in the central Rocky Mountains. General Technical Report RM-134. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.**

Engelmann spruce seed production and dispersal, and seedling establishment in the central Rocky Mountains indicate that in the *Abies lasiocarpa/vaccinium scoparium* habitat type, shaded, mechanically scarified, mineral soil seedbeds on north aspects can be adequately restocked naturally within a 5-year period in clearcut openings 300 to 450 feet wide. With shade or scarification alone, size of opening that will restock is reduced to 200 to 350 feet. The effective seeding distance is so limited on unshaded natural seedbeds on north aspects and on south aspects regardless of the seedbed conditions that the expectation of natural restocking in a reasonable period of time with clearcutting, is not a realistic option.

44. **Alexander, Robert R. 1988. Forest vegetation on national forests in the Rocky Mountain and Intermountain regions: habitat types and community types. General Technical Report RM-162. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 47 p.**

Habitat types and community types and their phases for the major forest tree species in the Rocky Mountain and Intermountain regions are tabulated. Included are the name(s), general location, elevation, relative site, successional status, principal tree and undergrowth associates, and the authority.

45. **Alexander, Robert R. 1985. Major habitat types, community types, and plant communities in the Rocky Mountains. General Technical Report RM-123. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 105 p.**

Habitat types, community types, and plant communities in the Rocky Mountains in which interior *Pinus ponderosa*, interior *Pseudotsuga menziesii*, interior *Abies concolor, Pica pungens, Populus tremuloides, Pinus contorta, Picea engelmannii*, and *Abies lasiocarpa* occur are tabulated. Included are the name, location, site, successional status, principal tree and understory associates, and the authority.

46. **Alexander, Robert R. 1984. Natural regeneration of Engelmann spruce after clearcutting in the central Rocky Mountains in relation to environmental factors. Research Paper RM-254. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 17 p.**

Successful natural regeneration of Engelmann spruce in small, clearcut openings depends on weather and aspect, and is modified by silvicultural treatments. Small clearcut openings (1-2 ha) can be successfully regenerated on north aspects with moneral soil seedbeds and shade. On south aspects, shade is absolutely essential for any survival. However, successful natural regeneration is not likely, regardless of silvicultural treatment. Drought is the most serious cause of mortality; but clipping by birds, frost heaving (north aspect), heat girdle (south aspect), and snowmold (north aspect) caused significant losses.

47. **Alexander, Robert R. 1983. Seed:seedling ratios of Engelmann spruce after clearcutting in the central Rocky Mountains. Research Note RM-426. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Seed:seedling ratios on treated seedbeds, on north aspects indicate that acceptable stocking levels can be expected on small clearcut openings (not more than 5 to 6 tree heights wide) after 5 years. Seed:seedling ratios on untreated seedbeds on north aspects and all seedbed conditions on south aspects are so high that prompt restocking of any opening under the circumstances is questionable.

48. **Alexander, Robert R. 1986. Silvicultural systems and cutting methods for old-growth spruce-fir forests in the central and southern Rocky Mountains. General Technical Report RM-126. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 33 p.**

Guidelines are provided to help the forest manager and silviculturist develop even-and/or uneven-aged cutting practices needed to convert old-growth spruce-fir forests into managed stands for a variety of resource needs. Guidelines consider stand conditions, succession, windfall risk, and insect and disease susceptibility. Cutting practices are designed to integrate timber production with increased water yield, maintained water quality, improved wildlife habitat, and enhanced opportunites for recreation and scenic viewing.

49. **Alexander, Robert R. 1986. Silvicultural systems and cutting methods for old-growth lodgepole pine forests in the central Rocky Mountains. General Technical Report RM-127. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 31 p.**

Guidelines are provided to help forest managers and silviculturists develop even- and uneven-aged cutting practices needed to convert pure and mixed old-growth lodgepole pine forests into managed stands. Guidelines consider stand conditions, succession, windfall risk, and insect and disease susceptiblity. Cutting practices -clearcutting, shelterwood, and selection-are designed to integrate timber production with increased water yield, maintained water quality, improved wildlife habitat, and enhanced opportunities for recreation and scenic beauty.

50. **Alexander, Robert R. 1986. Silvicultural systems and cutting methods for ponderosa pine forests in the Front Range of the central Rocky Mountains. General Technical Report RM-128. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 22 p.**

Guidelines are provided to help forest managers and silviculturists develop even- and/or uneven-aged cutting practices needed to convert old-growth and mixed ponderosa pine forests in the front range into managed stands for a variety of resource needs. Guidelines consider stand conditions, and insect and disease susceptibility. Cutting practices are designed to integrate maintained water quality, improved wildlife habitat, and enhanced opportunities for recreation and scenic viewing, with providing wood products.

51. **Alexander, Robert R. 1987. Silvicultural systems, cutting methods, and cultural practices for Black Hills ponderosa pine. General Technical Report RM-139. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.**

Guidelines are provided to help forest managers and silviculturists develop even- and uneven-aged cutting methods and associated silvicultural practices needed to convert ponderosa pine forests in the Black Hills into managed stands, and maintain them for a variety of resource needs. Guidelines consider stand conditions and insect susceptibility. Cutting practices are designed to maintain water quality, improve wildlife habitat, enhance opportunities for recreation and scenic viewing, and provide wood products.

52. **Alexander, Robert R.; Edminster, Carleton B. 1983. Engelmann spruce seed dispersal in the central Rocky Mountains. Research Note RM-424. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

A mathematical expression was developed to estimate Engelmann spruce seed dispersal into clearcut openings. The pattern of seed dispersal is a rapid decline from within the windward stand to the stand edge and beyond into the opening. The pattern of seedfall is strongly influenced by the direction of the prevailing winds, with little dispersal of seeds from the leeward stand.

53. **Alexander, Robert R.; Edminster, Carleton B.; Watkins, Ross K. 1986. Estimating potential Engelmann spruce seed production on the Fraser Experimental Forest, Colorado. Research Paper RM-269. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Two good, three heavy, and two bumper spruce seed crops were produced during a 15-year period. There was considerable variability in seed crops, however. Not all locations produced good to bumper seed crops when overall yearly ratings averaged good or better; conversely, some locations produced bumper seed crops in 3 or more years. Mathematical relationships, that should be useful in estimating potential sound seed production, were estimated between periodic annual 15-year sound seed production and (1) periodic annual 15-year total seed production and (2) selected stand parameters of dominant and codominant spruces.

54. **Alexander, Robert R.; Edminster, Carleton B. 1980. Lodgepole pine management in the central Rocky Mountains. Journal of Forestry. 78(4): 196-201.**

Estimates obtained by simulation are given for potential production of lodgepole pine (*Pinus contorta* Dougl. ex Loud) in the central Rocky Mountains under various combinations of stand density, site quality, ages, and thinning schedules. Such estimates are needed to project future development of stands managed for various uses.

55. **Alexander, Robert R.; Edminster, Carleton B. 1980. Management of spruce-fir in even-aged stands in the central Rocky Mountains. Research Paper RM-217. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.**

Potential production of Engelmann spruce and subalpine fir in the central Rocky Mountains is simulated for various combinations of stand density, site quality, ages, and thinning schedules. Such estimates are needed to project future development of stands managed in different ways for various uses.

56. **Alexander, Robert R.; Edminster, Carleton B. 1980. Management of ponderosa pine in even-aged stands in the southwest. Research Paper RM-225. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.**

Potential production of ponderosa pine in the Southwest is simulated for various combinations of stand density, site index, age, and thinning schedule. Such estimates are needed to project future development of stands managed in different ways.

57. **Alexander, Robert R.; Edminster, Carleton B. 1981. Management of ponderosa pine in even-aged stands in the Black Hills. Research Paper RM-228. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.**

Potential production of ponderosa pine in the Black Hills is simulated for various combinations of stand density, site index, age, and thinning schedule. Such estimates are needed to project future development of stands managed in different ways for various uses.

58. **Alexander, Robert R.; Edminster, Carleton B. 1981. Management of lodgepole pine in even-aged stands in the central Rocky Mountains. Research Paper RM-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.**

Potential production of lodgepole pine in the central Rocky Mountains is simulated for various combinations of stand density, site index, age, and thinning schedule. Such estimates are needed to project future development of stands managed in different ways for various uses.

59. **Alexander, Robert R.; Engelby, Orville. 1983. Engelmann spruce—subalpine fir. *In:* Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture: 59-62. 191 p.**

60. **Alexander, Robert R.; Hoffman, George R.; Wirsing, John M. 1986. Forest vegetation of the Medicine Bow National Forest in southeastern Wyoming: a habitat type classification. Research Paper RM-271. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 39 p.**

A vegetation classification based on concepts and methods developed by Daubenmire and refined by others was used to identify 16 forest habitat types on the Medicine Bow National Forest. These included two habitat types in in the *Pinus flexilis* series; three each in the *Pinus ponderosa, Populus tremuloides,* and *Abies lasiocarpa* series; and five in the *Pinus contorta* series. A key to identify the habitat types and the management implications associated with each are provided.

61. **Alexander, Robert R.; Lotan, James E.; Larson, Milo J.; Volland, Leonard A. 1983. *In:* Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture: 63-66. 191 p.**

62. **Alexander, Robert R.; Ronco, Frank Jr. 1987. Classification of the forest vegetation on the national forests of Arizona and New Mexico. Research Note RM-469. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.**

Forest vegetation classified by habitat types and community types in Arizona and New Mexico are tabulated. Eleven series and 123 habitat and community types are identified; however, these habitat types and community types have been grouped into a lesser number of categories having similar characteristics or synonymous names. The table includes the name, location, relative site, successional status, tree and principal undergrowth associates, and the authority.

63. **Alexander, Robert R.; Shearer, Raymond C.; Shepperd, Wayne D. 1984. Silvical characteristics of subalpine fir. General Technical Report RM-115. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 29 p.**

This report summarizes information on distribution, botanical description, habitat conditions, life history, special uses, and genetics of subalpine fir.

64. **Alexander, Robert R.; Shepperd, Wayne D. 1984. Silvical characteristics of Engelmann spruce. General Technical Report RM-114. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 p.**

This report summarizes information on distribution, botanical description, habitat conditions, life history, special uses, and genetics of Engelmann spruce.

65. **Alexander, Robert R.; Troendle, Charles A.; Kaufmann, Merrill R.; Shepperd, Wayne D.; Crouch, Glenn L.; Watkins, Ross K. 1985. The Fraser Experimental Forest, Colorado - research program and published research 1937 - 1985. General Technical Report RM-118. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 46 p.**

This report provides an overview of the research done on the Fraser Experimental Forest. It replaces GTS's RM-40 and RM-40a by Robert A. Alexander and Ross K. Watkins, published in 1977 and 1978. Included are descriptions of physical features and resources, highlights of past and current research, and the publications derived from that research.

66. **Alexander, Robert R.; Watkins, Ross K.; Edminster, Carleton B. 1982. Engelmann spruce seed production on the Fraser Experimental Forest, Colorado. Research Note RM-419. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Two good, three heavy, and one bumper spruce seed crops were produced during a 10-year period. Mathematical relationships were estimated between periodic annual 10-year sound seed production and (1) periodic annual 10-year total seed production, and (2) selected stand parameters of dominant and codominant spruces that should be useful in estimating potential sound seed production.

67. **Alig, Ralph J. 1983. Impacts from forestland conversion: an overview. Renewable Resources Journal. 1(4) and 2(1): 8-12.**

While recent studies indicate opportunities for conversion of over 30 million acres of forestland to cropland in the U.S., the economic and environmental impacts for renewable natural resources have not been widely studied. Several case studies that have examined such impacts are reviewed and future research needs are discussed.

68. **Alig, Ralph J. 1985. Modeling acreage changes in forest ownerships and cover types in the Southeast. Research Paper RM-260. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.**

A system based on economic criteria projects changes in acreages of six major land ownerships/uses by physiographic region in the Southeast, including three private forest ownership classes. Acreage changes for five major forest types on each of the three forest ownerships are projected using transition rates among forest types associated with the application of certain management practices. Changes in forest acreage, projected by decade to the year 2040, indicate a continued drop in farm forest acreage and natural pine acreage.

69. **Alig, Ralph J.; Adams, Darius M.; Haynes, Richard W. 1983. Long-range projection of forest area change: new approaches are needed. Journal of Forestry. 81(11): 723-727.**

Timberland acreage in the United States has been declining for several decades; yet, the relative contribution of various determinants has not been quantitatively estimated. Long-term land area change is thought to be determined largely by economic pocesses. Incorporating such factors into an explicit model for forest area change is needed to improve projections of natural resource supplies.

70. **Alig, Ralph J.; Brink, Glen E.; Goforth, Marcus H.; Labau, Vernon J.; Mills, Thomas J. 1982. TRAS-1980: user's manual for an expanded version of the TRAS projection system. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 63 p.**

This user's manual for TRAS-1980, an expanded version of the basic timber resource analysis system (TRAS), supersedes Agriculture Handbook 377 (Larson and Goforth 1970). The TRAS-1980 program can update or backdate timber inventories to a common date, compute timber resource changes between surveys, and project long-term timber supplies.

71. **Alig, Ralph J.; Knight, Herbert A. 1983. Forest acreage model for the U.S. Southeast.** ***In:*** **Bell, John F.; Atterbury, Toby, editors. Poceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis: Oregon State University, College of Forestry: 242-246. 737 p.**

An econometric model of acreage trends for four forest types in the southeastern United States was developed using a pooled cross-sectional/time series approach. Separate equations were estimated for forest industry, farmer, and miscellaneous private ownerships. Observations were drawn from 21 survey units in the southeast for the period 1937 to 1983.

72. **Alig, Ralph J.; Kurtz, William B.; Mills, Thomas J. 1981. Financial return estimates of alternative management strategies for 9- to 15-year-old southern pine plantations in Mississippi. Southern Journal of Applied Forestry. 5(1): 3-7.**

Estimated present net worths did not differ significantly overall between passive and immediate management. An immediate management produced considerably larger financial returns than passive management only when the plantation was in poor condition because of high hardwood basal areas.

73. **Alig, Ralph J.; Lewis, Bernard J.; Morris, Paul A. 1984. Aggregate timber supply analysis. General Technical Report RM-106. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 49 p.**

Timber supply analysis techniques for broad geographical levels are summarized by land allocation, timber growth and yield, short-term harvest flows, and long-term timber investment modeling components. Aspects of aggregation and uncertainty in timber supply analyses also are discussed.

74. **Alig, Ralph J.; Mills, Thomas J.; Shackleford, Robert L. 1980. Most soil bank plantings in the south have been retained; some need follow-up treatments. Southern Journal of Applied Forestry. 4(1): 60-64.**

Observations from 91 pine plantations in Georgia, Mississippi, and South Carolina approximate the current status of 1.7 million acres planted in the south through the conservation reserve phase of the soil bank program. Planted trees are growing on 89 percent of the original soil bank acreage, with a large majority of the acreage well stocked. Incidence of fusiform rust *(Cronartium fusiforme)* and pine overstocking indicate timber production could be enhanced through follow-up treatments.

75. **Alig, Ralph J.; Mills, Thomas J.; Shackleford, Robert L. 1980. Survey of soil bank plantations shows very high retention rate. Forest Farmer. 39(10): 8-9, 13-14.**

A recent study of plantations in Georgia, South Carolina, and Mississippi, three states where 60 percent of the southern soil bank plantings took place, shows nearly 90 percent of the original plantations are still growing pines. Plantations are generally in good condition, well stocked, and steadily accruing timber volume and value.

76. **Alig, Ralph J.; Parks, Peter J.; Farrar, Robert M., Jr.; Vasievich, J. Michael. 1984. Regional timber yield and cost information for the south: modeling techniques. General Technical Report RM-112. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 28 p.**

This report surveys analytical techniques for estimating the timber production of southern forests under various forestland management alternatives, and associated costs of those management alternatives. The integration of in formation from growth and yield modeling with timber management cost information in regional timber studies also is examined. Appendixes summarize the nature of data used to develop the timber growth and yield models, inputs required and outputs provided by the timber growth and yield models, and availability of cost information for different forestland management practices.

77. **Allen, Deborah J.; Driver, B. L.; Shikiar, Richard. 1982. Management preferences of recreationists in a scenic corridor: Oak Creek Canyon, Arizona.** ***In:*** **Forest and river recreation: research update; 1981 October 25-27; Minneapolis, MN. Agricultural Experiment Station Miscellaneous Publication 18. St. Paul, MN: University of Minnesota: 38-41. 163 p.**

Oak Creek Canyon is a scenic corridor that extends for 12 miles through the Mogollon Rim in north-centeral Arizona, near Flagstaff. Because Oak Creek is a perennial stream and the Canyon crosscuts five vegetation zones, the area is a popular spot for swimming, fishing, hiking, camping, and picnicking in the summer and for sightseeing year-round. Similar to most public recreation areas, use in the Canyon has grown, but the Canyon's narrow confines makes increasing number of visitors difficult to manage.

78. Allen, Michael F.; Hipps, L. E.; Wooldridge, Gene L. 1989. Wind dispersal and subsequent establishment of VA mycorrhizal fungi across a successional arid landscape. Landscape Ecology. 2(3): 165-171.

79. Allen, Timothy F. H.; Hoekstra, Thomas W. 1985. The instability of primitives and unpredictable complexity. *In:* Banathy, Bela H., editor. Systems inquiring: theory, philosophy, methodologies; 1985 May 17-31; Los Angeles, CA. Seaside, CA: Intersystems Publications; 1: 41-44.

80. Allen, Timothy F. H.; Hoekstra, Thomas W. 1984. Nested and non-nested hierarchies: a significant distinction for ecological systems. *In:* Smith, A. W., editor. Systems methodologies and isomorphies; 1984 May 28-June 1; New York, NY. Leaside, CA: Intersystems Publications; 1: 175-180.

81. Allen, Timothy F. H.; O'Neill, R. V.; Hoekstra, Thomas W. 1984. Interlevel relations in ecological research and management: some working principles from hierarchy theory. General Technical Report RM-110. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.

    This report clarifies the role of the observer and what he observes as an aid to ecological research and natural resource management. It describes what is involved in observing complex natural systems, the role of the observer in moving through surfaces of natural systems, and finally summarizes, from these, the important principles in linking levels of natural systems that emerge.

82. Allen, Timothy F. H.; O'Neill, R. V.; Hoekstra, Thomas W. 1987. Interlevel relations in ecological research and management: some working principles from hierarchy theory. Journal of Applied Systems Analysis. 14: 63-79.

83. Allison, Ray P. 1981. A low-cost x/y stereo carrier. Field Engineering Notes. 13(2): 1-3.

84. Alward, Gregory S. 1987. Assessing the socioeconomic implications of multiple-use forestry. *In:* XVIII IUFRO World Congress, economic value of multiple-use forestry, Project 4.08; 1986 September 7-21; Ljubljana, Yugoslavia. Corvallis, OR: Department of Resource Recreation Management, Oregon State University: 191-202.

85. Alward, Gregory S. 1986. Local and regional economic impacts of outdoor recreation development. *In:* A literature review: the President's Commission on Americans Outdoors. Washington, DC: U.S. Government Printing Office: 47-57.

86. Alward, Gregory S.; Palmer, C. J. 1983. IMPLAN: an input-output analysis system for Forest Service planning. *In:* Seppala, Risto; Rowe, Clark; Morgan, Ann, editors. Proceedings of the IIASA North American conference on forest sector models; 1981 December 2-4; Williamsburg, VA. AB Academic Publishers: 131-140.

87. Alward, Gregory S.; Sullivan, Bradley J.; Hoekstra, Thomas W. 1985. Using socioeconomic data in the management of fishing and hunting lands. Transactions of the North American Wildlife and Natural Resources Conference. 49: 91-103.

    This paper illustrates the use of the survey data with implan models to determine the impacts of wildlife management policies upon the supplying industries and income of regional economies. The data given by the survey can be extremely useful in the context of regional economic analysis. Information can be used directly from the survey to evaluate the economic implications of various resource policies that may affect hunting and fishing behavior.

88. Amundson, Robert G.; Kohut, R. J.; Schoettle, Anna W.; Raba, R. M.; Reich, Peter B. 1987. Correlative reductions in whole-plant photosynthesis and yield of winter wheat caused by ozone. Phytopathology. 77(1): 75-79.

89. Amundson, Robert G.; Raba, R. M.; Schoettle, Anna W.; Reich, Peter B. 1986. Response of soybean to low concentrations of ozone. II. Effects on growth, biomass allocation, and flowering. Journal of Environmental Quality. 15: 161-167.

90. Anas, Alex. 1988. Optimal preservation and pricing of natural public lands in general equilibrium. Journal of Environmental Economics and Management. 15: 158-172.

91. Anderson, Linda M.; Levi, Daniel J.; Daniel, Terry C.; Dieterich, John H. 1982. The esthetic effects of prescribed burning: a case study. Research Note RM-413. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Scenic values were compared for two 10-acre ponderosa pine plots, both logged, but one with a prescribed burn to remove slash. The burned plot was significantly less attractive immediately following the burn, but significantly more attractive 1 year later. Recovery on both plots reached an apparent asymptote after 3 years.

92. **Anderson, Mark T. 1981. Improved method for separating zooplankton from detritus. The Progressive Fish-Culturist. 43(1): 42-44.**

A long, glass column equipped with two side valves and filled with 0.4 m magnesium sulfate was designed for density separation of zooplankton from debris inadvertently collected with the sample. Rapid and efficient separation is obtained when the debris is mainly inorganic, a common condition in samples collected from turbid water. The concentration of the salt, settling time, and column length are standardized, which reduces the variation between samples.

93. **Anderson, Mark T.; Hawkes, Clifford L. 1984. Trace elements in northern Great Plains strip mine and livestock impoundment water. Water Resources Bulletin. 20(2): 251-254.**

All but one of the 41 ponds sampled in north dakota, South Dakota, and Wyoming contained elemental concentrations, especially cadmium and lead, that would be detrimental for livestock use or aquatic life. The potential for detrimental concentrations of trace elements in pond water should be evaluated when designing land use management plans for ponds intended to be used by livestock or aquatic life.

94. **Anderson, Mark T.; Hawkes, Clifford L. 1985. Water chemistry of northern Great Plains strip mine and livestock water impoundments. Water Resources Bulletin. 21(3): 499-505.**

The water from 34 strip mine and 9 livestock water impoundments on the northern great plains was analyzed. In all areas the water was classified as slightly brackish or saline. The most appropriate use of these strip mine ponds is for waterfowl, warmwater fisheries, and other wildlife associated with prairie wetlands. However, even these uses are jeopardized by detrimental concentrations of trace elements in the water.

95. **Anderson, Robert L.; Martin, Margaret B.; Peterson, Glenn W. 1980. How to identify and control phomopsis blight of junipers. Forestry Bulletin SA-FB/P 25. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area State and Private Forestry. 6 p.**

96. **Armstrong, Betsy R. 1981. Avalanche burials in the United States: 1967-1980. *In:* Canadian Avalanche Committee, editors. Proceedings of the avalanche workshop; 1980 November 3-5; Vancouver, BC. Ottawa, Ontario, Canada: The Secretary, Associate Committee on Geotechnical Research, National Research Council of Canada: 215-230. 248 p.**

Four additional years of data since 1976 are included to update previous findings on avalanche burials. Survival rates according to type of rescue, body position when found, burial depth, and activity category were specifically examined.

97. **Armstrong, Betsy R. 1981. A quantitative analysis of avalanche hazard on U.S. Highway 550, southwestern Colorado. *In:* Proceedings of the Western Snow Conference: forty ninth annual meeting; 1981 April 14-16; St. George, UT. 95-104. 138 p.**

Avalanche event data from 1951 to 1978 are used to calculate the probability of encounters between avalanches and vehicles and expected numbers of vehicles hit. Results of the statistical tests show that U.S. Highway 550 can be classified as a high hazard route.

98. **Armstrong, Richard. 1981. Some observations on snow cover temperature patterns. *In:* Canadian Avalanche Committee, editors. Proceedings of the avalanche workshop; 1980 November 3-5; Vancouver, BC. Ottawa, Ontario, Canada: The Secretary, Associate Committee on Geotechnical Research, National Research Council of Canada: 66-81. 248 p.**

This paper introduces the concept of a minimal vapour pressure gradient required to produce faceted temperature gradient grains rapidly enough to be important for the avalanche formation problems.

99. **Armstrong, Richard; Williams, Knox. 1981. Snowfall forecasting in the Colorado mountains. *In:* Second conference on mountain meteorology; 1981 November 9-12; Steamboat Springs, CO. Boston, Mass: American Meteorological Society: 386-390. 408 p.**

An orographic precipitation model developed by rhea has been used as an objective aid to quantitative

precipitation forecasts since 1975 in the Colorado Avalanche Warning Program. This paper presents the accuracy of snowfall forecasts for 21 sites in the Colorado mountains during the 1979-1980 winter season.

100. Asbury, C. E.; Vertucci, Frank A.; Mattson, M. D.; Likens, Gene E. 1989. Acidification of Adirondack Lakes. Environmental Science and Technology. 23: 362-365.

101. Ault, Stacey C.; Stormer, Fred A. 1983. Seasonal food selection by scaled quail in northwest Texas. Journal of Wildlife Management. 47: 222-228.

102. Ault, Stacey C.; Stormer, Fred A. 1983. A suction device for sampling seed availability. Wildlife Society Bulletin. 11: 63-65.

103. Avery, Charles C.; Baker, Malchus B., Jr. 1980. Evaluating hydrologic responses to forest activities. *In:* Symposium on watershed management. Proceedings of the American Society of Civil Engineers, Irrigation and Drainage Division: 485-493.

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104. Bailey, D. K.; Hawksworth, Frank G. 1983. *Pinaceae* of the Chihuahuan Desert region. Phytologia. 53(3): 226-234.

The abbreviated treatment of the Pinaceae, prepared for the Chihuahuan Desert region flora, recognizes 15 taxa of *Pinus* and 1 each of *Abies* and *Pseudotsuga*. The region is particularly rich in pinyons, with 8 taxa.

105. Bailey, Robert G. 1982. Classification systems for habitat and ecosystems. *In:* Research on fish and wildlife habitat. EPA 600/8-82-022. Washington, DC: U.S. Environmental Protection Agency: 16-26. 248 p.

This paper presents an overview of some of the best-known classification systems and highlights future needs.

106. Bailey, Robert G. 1983. Delineation of ecosystem regions. Environmental Management. 7(4): 365-373.

This paper explains the basis for the regions delineated on the 1976 map ecoregions of the United States. Four ecological levels are discussed—domain, division, province, and section—based on climatic and vegetational criteria. Statistical tests are needed to verify and refine map units.

107. Bailey, Robert G. 1980. Description of the ecoregions of the United States. Miscellaneous Publication 1391. Washington, DC: U.S. Department of Agriculture. 77 p.

108. Bailey, Robert G. 1981. Integrated approaches to classifying land as ecosystems. *In:* Laban, P., editor. Proceedings of the workshop on land evaluation for forestry: international workshop of the IUFRO/ISSS; 1980 November 10-14; Wageningen, The Netherlands. Wageningen, The Netherlands: International Institute for Land Reclamation and Improvement: 95-109. 355 p.

Systems for classifying and evaluating land as ecosystems have developed in different parts of the world during the past century. These systems describe and analyze relatively homogenous units of land on local or regional scales. They classify land both as holistic ecosystems and according to their components. An example of a hierarchical system for classification of natural terrestrial ecosystems based on a combination of biotic and abiotic criteria is outlined for the United States.

109. Bailey, Robert G.; Zoltai, Steven C.; Wiken, Ed B. 1985. Ecological regionalization in Canada and the United States. Geoforum. 16(3): 265-275.

Present interest in environmental problems which are international, interstate or interprovincial in scope is drawing attention to the necessity for ecological regionalizations that will serve as a basis for intraregional transfer of experience. Before any regionalization is used it should be thoroughly tested, and modified if necessary.

110. Baker, F. A.; Rabin, D. 1988. Using computer graphics to assess the visual impact of limb rust in ponderosa pine. *In:* The 35th annual western forest disease work conference; 1987 August 18-21; Nanaimo, BC. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 16-20.

111. **Baker, Malchus B., Jr. 1982. Changes in streamflow in an herbicide-treated juniper watershed in Arizona.** *In:* **Hydrology and water resources in Arizona and the Southwest; 1982 April 24; Tempe, AZ. Arizona Section—American Water Resources Association, and the Hydrology Section—Arizona-Nevada Academy of Science; 12: 19-25. p.**

112. **Baker, Malchus B., Jr. 1984. Changes in streamflow in an herbicide-treated pinyon-juniper watershed in Arizona. Water Resources Research. 20(11): 1639-1642.**

The herbicide treatment induced an increase in annual streamflow of about 157%. There is an indication that after the dead trees were removed, streamflow was reduced to near-pretreatment levels.

113. **Baker, Malchus B., Jr. 1987. The diversity of streamflow response from upland basins in Arizona.** *In:* **Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 211-215. 253 p.**

Although water yield from a basin is a function of a number of factors, soil depth is considered foremost in explaining hydrograph differences from study areas in Arizona. The most attenuated hydrograph found was in the chaparral vegetation type, which has the greatest soil depth, while the most responsive or peaked hydrographs were found in the pinyon-juniper and ponderosa pine types, which have soil depths of 3 feet or less.

114. **Baker, Malchus B., Jr. 1986. Effects of ponderosa pine treatments on water yield in Arizona. Water Resources Research. 22(1): 67-73.**

Annual water yields were determined for three levels of overstory removal and three levels of strip cut with thinning applied on ponderosa pine watersheds. Water yield increases from a completely cleared watershed were statistically significant for 7 years, losing significance after recovery and growth of Gambel oak and herbaceous vegetation. Water yield increase remained at a 15% level during the first 6 years on a strip-cut watershed with 60% of its area on northern aspects.

115. **Baker, Malchus B., Jr. 1981. Hydrologic regimes of three vegetation types across the Mogollon Rim.** *In:* **Hydrology and water resources in Arizona and the Southwest: proceedings of the 1981 meetings of the Arizona Section, American Water Resources Association, and the Hydrology Section, Arizona-Nevada Academy of Science; 1981 May 1-2; Tucson, AZ. Tucson, AZ: Arizona Section of the American Water Resources Association, University of Arizona: 5-12. 223 p.**

This paper presents an analysis of research concerning the hydrologic regimes of the natural woodland and forested areas on Beaver Creek. The information is based on 22 years of research.

116. **Baker, Malchus B., Jr. 1982. Hydrologic regimes of forested areas in the Beaver Creek Watershed. General Technical Report RM-90. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.**

Winter precipitation is shown to be most important to the streamflow regimes in this area. The data indicate that the best opportunity for increasing water yield by vegetation manipulation is in the ponderosa pine type. Mean annual peak discharges are higher in the two juniper vegetation types and are more frequent in the summer than those occurring in the pine type.

117. **Baker, Malchus B., Jr. 1982. Influence of clearing ponderosa pine on timing of snowmelt runoff.** *In:* **Proceedings, 50th annual meeting of the Western Snow Conference; 1982 April 19-23; Reno, NV. 20-26.**

118. **Baker, Malchus B., Jr. 1988. Selection of silvicultural systems for water.** *In:* **Baumgartner, David M.; Lotan, James E., editors. Ponderosa pine: the species and its management: symposium proceedings; 1987 September 29-October 1; Spokane, WA. Pullman, WA: Washington State University: 201-211.**

Water yield from the ponderosa pine averages from 3 to 5 inches per year. Opportunities to increase water yield do exist in the ponderosa pine type, but because of its situation in lower elevation and precipitation zones, the potential is not as great as it is in the higher subalpine zones.

119. **Baker, Malchus B., Jr. 1986. A supercritical flume for measuring sediment-laden streamflow. Water Resources Bulletin. 22(5): 847-851.**

After 25 years of operation on ephemeral streams in the semiarid Southwest, this supercritical flume has provided more than 350 station-years of reliable streamflow data, even under freeze-thaw conditions experienced at elevations of 1,500 to 2,100 m, in Arizona. The flume has also provided streamflow conditions, where considerable sediment and other debris was moved downstream.

120. **Baker, Malchus B., Jr. 1986. Water yield from treatment of ponderosa pine. *In:* 30th annual Arizona water symposium; 1986 September 17; Scottsdale, AZ. Scottsdale, AZ: Arizona Water Resources Committee: 27-38.**

Initial water yield increases of 15 to 41% were predicted based on actual results obtained from various levels of basal area reduction of between 30 and 100% in pine forests on shallow, basalt-derived soils. On southern aspects, water yield response was generally lost after 6 to 10 years. There are indications that water yield response on northern exposures will persist longer.

121. **Baker, Malchus B., Jr.; Rogers, James J. 1983. Evaluations of water balance models on a mixed conifer watershed. Water Resources Research. 19(2): 486-492.**

Three water balance and yield models of differing degrees of complexity were evaluated using data from a mixed conifer watershed in east-central Arizona. Evaluations of models provide information that help managers to judge which models, if any, are most suited to their own particular situations. This information also helps to determine which models merit further development or refinement.

122. **Balda, Russell P.; Gaud, William S.; Brawn, Jeffrey D. 1983. Predictive models for snag nesting birds. *In:* Davis, Jerry W.; Goodwin, Gregory A.; Ockenfels, Richard A., technical coordinators. Snag habitat management: proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. General Technical Report RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 216-220. 226 p.**

123. **Baldassare, Guy A.; Whyte, Richard J.; Quinland, Eileen E.; Bolen, Eric G. 1983. Dynamics and quality of waste corn available to postbreeding waterfowl in Texas. Wildlife Society Bulletin. 11: 25-31.**

124. **Baldassare, Guy A.; Whyte, Richard J.; Bolen, Eric G. 1980. Patagial tags for pintails wintering on the southern high plains of Texas. Inland Bird Banding. 52(2): 13-18.**

125. **Baldassare, Guy A.; Whyte, Richard J.; Bolen, Eric G. 1980. Use of ultrasonic sound to estimate body fat deposits in the mallard. Prairie Naturalist. 12: 79-86.**

126. **Baltensperger, Arden A.; Smith, Mark A. 1984. Nitrogen fixation estimates for some native and introduced legumes, forbs, and shrubs. Journal of Range Management. 36: 77-78.**

127. **Baltic, Tony J.; Hof, John G. 1988. Documentation of the National Forest System resource interactions model. General Technical Report RM-155. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest And Range Experiment Station. 30 p.**

The National Forest System resource interactions model is an upper level linear programming model developed to aid the analysis of multiresource interactions for the 1989 RPA National Assessment. This report documents the development and structure of this linear programming model, emphasizing its multilevel nature and the data requirements for such an approach. A brief description of the solution output that can be derived from the model is also presented. Finally, the solution of data deficiencies, a major problem in applying such a multilevel optimization approach, is examined.

128. **Baltic, Tony J.; Hof, John G.; Kent, Brian M. 1989. Review of critiques of the USDA Forest Service land management planning process. General Technical Report RM-170. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.**

This report reviews a sampling of the literature evaluating the USDA Forest Service land management planning process. The Forest Service planning process and what constitutes an evaluation or critique of this process are defined. Relevant critiques are then reviewed individually by interest group category. The reviews lead us to conclude that a diversity of views dominated while consensus is limited. Perhaps the only consensus identifiable at this time is that the planning process includes a strong political element that has not been adequately considered.

129. **Barrager, Stephen M.; Cohan, David; Roussopoulos, Peter J. 1982. The economic value of improved fuels and fire behavior information. Research Paper RM-239. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.**

An analysis of two routine fire management decisions on the Mount Hood National Forest provided insights into the appropriate expenditure levels for improving fuels and fire behavior information bases. In formulating the annual fire management budget request, improved information on fuel types is worth about one cent per acre per year, while the value of perfect fire intensity prediction is between one and five cents per acre per year. For complex decisions among alternative postharvest fuel treatments, reliable postharvest fuel loading estimates may be worth up to $800 for a 25-acre site.

130. **Barrett, Reginald H.; Beasom, Samuel L. 1980. Research needs for management of barbary sheep in the future.** *In:* **Simpson, C. David, editor. Proceedings of the symposium on ecology and management of barbary sheep; 1979 November 19-21; Lubbock, TX. Lubbock, TX: Department of Range and Wildlife Management, Texas Tech University: 106-107. 112 p.**

Barbary sheep research must be considered within the larger framework of research priorities for renewable resource management in general.

131. **Beasom, Samuel L.; Hood, Jeffrey C.; Cain, J. Richard. 1981. The effect of strip width on helicopter censusing of deer. Journal of Range Management. 34: 36-37.**

132. **Beasom, Samuel L.; Laplant, Larry; Howard, V. W., Jr. 1982. Fecal pH of pronghorn and sheep as related to diet. Journal of Wildlife Management. 46(4): 1102-1104.**

The objective of this study was to relate diet similarity to fecal pH of pronghorn and domestic sheep in an effort to evaluate the efficacy of the pH technique for identifying feces of these two herbivores.

133. **Beasom, Samuel L.; Laplant, Larry; Howard, V. W., Jr. 1981. Similarity of pronghorn, cattle, and sheep diets in southeastern New Mexico.** *In:* **Proceedings of the wildlife—livestock relationships symposium; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station: 565-572.**

134. **Beasom, Samuel L.; Pattee, Oliver H. 1980. The effect of selected climatic variables on wild turkey productivity.; Little Rock, AR. Proceedings of the 4th national wild turkey symposium: 127-135.**

135. **Becker, Dale M. 1986. Early Nesting records of merlins in Montana and North Dakota. Raptor Research. 19(2/3): 102.**

136. **Becker, Dale M. 1985. Food habits of Richardson's merlins in southeastern Montana. Wilson Bulletin. 97(2): 226-230.**

Grassland/prairie avifauna are shown to be a major prey component of breeding Richarson's merlins in southeastern Montana. Similar results have been recorded in studies of food habits of merlins breeding in the Canadian prairies.

137. **Becker, Dale M. 1987. Use of black-billed magpie nests by american kestrels in southeastern Montana. Prairie Naturalist. 19(1): 41-42.**

Five pairs of American kestrels in southeastern Montana used black-tailed magpie nests rather than typical cavity nests in trees and cliffs. Use of these magpie nests probably represented a local cultural tradition. The structural and security features of these nests were likely important in their selection.

138. **Becker, Dale M.; Sieg, Carolyn Hull. 1985. Breeding chronology and reproductive success of Richardson's merlins in southeastern Montana. Raptor Research. 19(2/3): 52-55.**

Breeding activity spanned 5 months from the earliest observation of adults to the latest dispersal of adults and young from nesting areas. Clutch size, brood size and fledging success at active nests were similar among the 4 yrs. Mortality tended to be highest before the hatching stage. Breeding chronology and reproductive success were similar to results of studies in Canada.

139. **Becker, Dale M.; Sieg, Carolyn Hull. 1987. Eggshell quality and organochlorine residues in eggs of merlins, *Falco columbarius*, in southeastern Montana. Canadian Field-Naturalist. 101(3): 369-372.**

Eggshell weights and thickness indices of Richardson's merlin (*Falco columbarius* Richardsonii) Eggs collected in southeastern Montana were 13% and 20% lower, respectively, than eggshells collected before 1946. These indications of declining eggshell quality and the occurrence of seven organochlorines are signs that this merlin population merits periodic monitoring.

140. Becker, Dale M.; Sieg, Carolyn Hull. 1987. Home range and habitat utilization of breeding male merlins, *Falco columbarius*, in southeastern Montana. Canadian Field-Naturalist. 101(3): 398-403.

Home ranges of three breeding Richardson's merlins (*Falco columbarius* Richardsonii) in southeastern Montana encompassed 13, 23, and 28 km^2. Sagebrush/grassland, riparian, and ponderosa pine *(Pinus ponderosa)* communities were used significantly more, and grasslands and agricultural fields used less, than expected, based on proportions in the combined home ranges.

141. Bedunah, D.; Trlica, M. J. 1981. Carbon dioxide exchange of ponderosa pine as affected by sodium chloride and polyethylene glycol. Forest Science. 27(1): 139-146.

142. Bennett, D. D.; Schmid, John M.; Mata, Steven A., Jr.; Edminster, Carleton B. 1987. Growth impact of the North Kaibab pandora moth outbreak. Research Note RM-474. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 4 p.

Tree mortality and growth were examined in defoliated, insecticide treated, and undefoliated stands in the pandora moth outbreak area on the Kaibab National Forest. Tree mortality was less than 1%. radial and basal area growth were significantly different among areas in trees > 14 inches d.b.h. and over and increased significantly in the undefoliated area, while rates in the defoliated and treated areas remained unchanged. Defoliation loss was estimated at least 11 f.b.m. per acre per year.

143. Bennett, D. D.; Wahlfeld, D. R.; Schmid, John M. 1984. Pandora moth suppression project using acephate, Jacob Lake, Arizona, 1983. Forest Pest Management Report R-3 84-10. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 18 p.

144. Benson, Carl S. 1982. Reassessment of winter precipitation on Alaska's arctic slope and measurements on the flux of wind blown snow. UAG R-288. University of Alaska Geophysical Institute, Fairbanks, AK. 26 p.

145. Bentz, B.; Lister, C. Kendall; Schmid, John M.; Mata, Steven A., Jr.; Rasmussen, L. A.; Haneman, D. 1989. Does verbenone reduce mountain pine beetle attacks in susceptible stands of ponderosa pine? Research Note RM-495. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Verbenone capsules were stapled to trees in mountain pine beetle infested stands of ponderosa pine at densities of 10, 20, 40, and 68 capsules per acre. None of these treatments was effective in reducing the number of attacked trees. The effectiveness of the treatments may have been compromised when above-average temperatures followed early placement of the capsules, which may have degraded the verbenone before peak beetle emergence.

146. Berg, William A.; Smith, Charles M.; Aldon, Earl F. [and others]. 1981. Drastically disturbed lands: conservation needs, technology, and policy alternatives. *In:* Larson, William E.; Walsh, Leo M.; Stewart, B. A.; Boelter, Don H., editors. Soil and water resources: research priorities for the nation: executive summary. Madison, WI: Soil Science Society of America, Inc.; Chapter 9: 33-35. 45 p.

Drastic land disturbances by mining, mineral-waste disposal, and earth construction greatly alter soil, water, land use, and esthetics. Adverse effects can be reduced and, in some cases, nullified, by timely, well-prepared reclamation based on experience and research.

147. Bergen, James D.; Hutchison, Boyd A.; McMillen, R. T.; Ozment, Arnold D.; Gottfried, Gerald J. 1983. Observations on the relation of the shortwave reflectivity of recently deposited snow to its physical properties. Journal of Climate and Applied Meterology. 22(2): 193-200.

Albedos calculated from samples taken from differing surface layers and variation of the prediction errors with the snow accumulation pattern were compared. Results suggest that a major source of error is the large depth interval sampled by the surface layer measurement technique as compared with the thickness of the surface layer of snow in which the bulk of absorption and scattering occur.

148. **Betters, David R.; Donnelly, Dennis M.; Worth, Harold E. 1984. Opportunities for timber management and wood utilization of the mixed conifer type in Arizona and New Mexico. Resource Bulletin RM-8. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 16 p.**

Production cost advantages favor Arizona mills; but marketing cost advantages favor New Mexico mills. Mills in both states can serve Chicago, Dallas, and Denver market areas with traditional and diverse new wood products. Forest management potential benefits from all increased utilization, resulting in better returns to the timber resource.

149. **Betters, David R.; Hof, John G.; Ryan, Phyllis P. 1984. Demand for commercially delivered domestic fuelwood in Colorado, 1980. Research Note RM-433. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

State and regional demand schedules are developed. At 1980 prices, there appeared to be little excess demand for commercially delivered fuelwood on a statewide basis. This situation may have changed as factors such as state population, incomes, and oil and gas prices fluctuated in subsequent years.

150. **Bevenger, G. S.; Troendle, Charles A. 1985. Coon Creek water yield augmentation pilot project.** ***In:*** **Collins, Michael A., editor. Water for the 21st century: will it be there?; 1984 April 3-5; Dallas, TX. Dallas, TX: Center for Urban Water Studies, Southern Methodist University: 240-251.**

Research in the Rocky Mountain subalpine zone indicates that vegetative manipulation (clearcutting) reduces evapotranspirational water losses and changes the aerodynamics and energy balance of the subalpine forest, resulting in increased streamflow. The Coon Creek water yield augmentation pilot project is currently in the pre-harvest phase, with harvesting scheduled for 1987. The project will make possible large-scale testing and field verification of hydrologic prediction tools.

151. **Bevenger, G. S.; Troendle, Charles A. 1987. The Coon Creek water yield augmentation pilot project.** ***In:*** **Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 145-149. 253 p.**

Research in the Rocky Mountain subalpine zone has demonstrated that vegetative manipulation (primarily clearcutting) causes a net reduction in evapotranspirational losses, changes the aerodynamics and energy balance of the timber stand, and results in increased streamflow. Because the results of research on small watersheds has shown that water yield can be increased, and because forest management represents one of several options for manipulating water yield, the Coon Creek water yield augmentation pilot project was initiated. The objective of the project is to apply state-of-the-art technology in water yield management on an operational timber sale. The project also will make possible large-scale testing and field verification of hydrologic prediction tools so commonly used in planning.

152. **Bevins, Collin D.; Roussopoulos, Peter J. 1980. National fuels inventory library.** ***In:*** **Proceedings: sixth conference on fire and forest meteorolgy; 1980 April 22-24; Seattle, WA. Washington, DC: Society of American Foresters: 146-150. 304 p.**

An overview is given of the library structure and contents, the function of the various database management programs, and the use of component programs for storage, manipulation, and analysis of wildland fuel inventory data.

153. **Biggs, P. H.; Wood, Geoff B.; Schreuder, Hans T.; Brink, Glen E. 1986. Comparison of point-model based sampling and point-poisson sampling for timber inventory in Jarrah Forest. Australian Forest Research. 15(4): 481-493.**

154. **Biotic communities of the Southwest. 1980. Brown, David E.; Lowe, Charles H. [Map]. General Technical Report RM-78. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 1: 1,000,000; 1 p.**

A 48- by 60-inch color map (scale 1:1,000,000) of New Mexico, Arizona, Southern California and Nevada,

and northern Mexico, shows 5 formations, 22 biotic communities, 6 communities, major political divisions, rivers, cities, roads, and mountain ranges. Supersedes USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-41.

155. **Bird, Kenneth G. 1980. Design and construction of a miniature solar power system to operate meteorological instruments. Research Note RM-390. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

The relatively inexpensive solar power system improves meteorological instrument reliability by maintaining an optimum operating voltage. System voltage and charging capabilities are easily modified to fit specific power requirements for other low-voltage applications.

156. **Bird, Kenneth G.; Jairell, Robert L. 1989. Sequential flash for photographing trajectories of saltating particles.** *In:* **57th Western Snow Conference: proceedings of the conference; 1989 April 18-20; Kalispell, MT. Fort Collins, CO: Colorado State University: 130-133.**

This paper describes a light source for photographs of sufficient quality that computer analysis can determine these heights automatically. The method uses eight small electronic flash units fired in sequence through color filters. The flashes, combined with continuous white light, are projected through a narrow slit by a single lens, producing trajectory images that are white traces with colored dots noting particle position at sequential time intervals.

157. **Birdsey, R.; Schreuder, Hans T. 1989. Forest change - an assessment of nationwide forest inventory methods.** *In:* **State-of-the-art methodology of forest inventory; 1989 August 5; Syracuse, NY. General Technical Report PNW-263. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Experiment Station: 119-125.**

158. **Bishop, Richard C. 1988. Uncertainty and resource valuation: theoretical principles for empirical research.** *In:* **Toward the measurement of total econcomic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.**

159. **Bjugstad, Ardell J. 1983. Establishment of trees and shrubs on lands disturbed by mining in the West.** *In:* **New forests for a changing world. Proceedings of the 1983 SAF national convention; 1983 October 16-20; Portland, OR. Washington, DC: Society of American Foresters: 434-438. 640 p.**

Increased research and development of silvicultural practices and species has assured success of establishment of trees and shrubs on lands disturbed by surface mining. Trickle irrigation and water harvesting techniques have increased survival of planted stock by 250 percent for some species.

160. **Bjugstad, Ardell J. 1987. Hybrid poplar cultivars for maximizing phytomass production on gold mine tailings in the Black Hills.** *In:* **1986 national symposium on mining, hydrology, and reclamation; 1986 December 8-11; Lexington, KY. Lexington, KY: University of Kentucky: 263-265.**

Twenty-six hybrid poplar clones were planted as cuttings on a gold mine tailings in the Black Hills. Four exhibited very good survival and growth. Other clones had relatively high (exceeding 50 percent) survival but slow growth (below 60 cm) over a 5-year period.

161. **Bjugstad, Ardell J. 1988. Prairie chickens on the Sheyenne National Grasslands: proceedings of the symposium; 1987 September 18; Crookston, MN. General Technical Report RM-159. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 73 p.**

These proceedings contain eight papers and two abstracts of papers presented at a special symposium arranged as part of the 17th prairie grouse technical conference. The papers document and synthesize information gained over the past several years on prairie chicken ecology, habitats and diets, and effects of cattle grazing.

162. **Bjugstad, Ardell J. 1984. Shrub and tree establishment on coal spoils in the northern high plains, USA. Minerals and the Environment. 6(3): 127-130.**

163. **Bjugstad, Ardell J.; Fortune, William A. 1989. The western prairie fringed orchid** ***(Platanthera praeclara)*****: monitoring and research.** *In:* **Bragg, Thomas B.; Stubbendieck, James, editors. Prairie pioneers: ecology, history and culture: proceedings of the 11th North American prairie conference; 1988 August 7-11; Lincoln, NE. Lincoln, NE: University of Nebraska Printing: 197-199.**

In 1987, permanently located individual plants were counted on the Sheyenne National Grasslands of southeastern North Dakota. Population trends of this orchid were compared regarding effects of mowing, grazing, and fire. The evaluation of the permanently located individual plants and data on total counts per area in 1988 showed a difference between years and a significant difference among grazed, mowed, or no use treatments. The western prairie fringed orchid appears very resilient, but more data will be needed to test this prognosis.

164. **Bjugstad, Ardell J.; Francis, Richard E.; Skinner, Paul W. 1983. Leafy spurge—a potential conflict with woody plants on the northern high plains. *In:* Proceedings of the 35th annual meeting of the Great Plains Agricultural Council, Forestry Committee; 1983 July 11-14; Billings, MT. Helena, MT: Montana Department of State Land: 124-132. 185 p.**

This study found that leafy spurge infestations were dominant on lowland/bottomland range site/topographical positions compared to other range sites/topographical positions.

165. **Bjugstad, Ardell J.; Girard, Michele M. 1984. Wooded draws in rangelands of the northern Great Plains. *In:* Henderson, F. Robert, editor. Guidelines for increasing wildlife on farms and ranches with ideas for supplemental income sources for rural families. Manhattan, KS: Cooperative Extension Service, Kansas State University: 27B-36B.**

This article briefly describes the woody-draws and suggested management for their maintenance and/or regeneration.

166. **Bjugstad, Ardell J.; Kissel, Kendall E.; Whitman, Warren C. 1983. Germination of shrubs for wildlife habitat restoration on mined lands in the northern Great Plains. *In:* Issues and technology in the management of impacted western wildlife. Proceedings of a national symposium; 1982 November 15-17; Steamboat Springs, CO. Boulder, CO: Thorne Ecological Institute: 238-245. 250 p.**

Research assessed the germination and ease of establishment and growth of selected shrubs by direct seeding in topsoil, scoria as a surface mulch on mine spoil and coal mine spoil. Growth was greatest for shrub seedlings in topsoil.

167. **Bjugstad, Ardell J.; Noble, Daniel L. 1983. Hybrid poplar cultivars grow well in the Black Hills. *In:* Proceedings of the 35th annual meeting of the Great Plains Agricultural Council, Forestry Committee; 1983 July 11-14; Billings, MT. Helena, MT: Montana Department of State Land: 116-123. 185 p.**

Four of 26 hybrid poplar clones planted as cuttings on a gold mine tailings in the black hills exhibited very good survival and growth. Other clones had relatively high (exceeding 50 percent) survival but slow growth (less than 60 cm) over a 5-year period.

168. **Bjugstad, Ardell J.; Rumble, Mark A.; Olson, Richard A.; Barker, William T. 1983. Prairie pond morphometry and aquatic plant zonation—northern High Plains. *In:* Scott, M. Douglas, editor. Proceedings of the third biennial plains aquatic research conference; 1983 August 24-25; Bozeman, MT. Bozeman, MT: Institute of Natural Resources, Department of Earth Sciences, Montana State University: 89-99. 243 p.**

Surface mine ponds varying in age from 12 to 25 years for bentonite clay and coal, respectively, had smaller surface areas, greater water depths, and steeper basin slopes than livestock ponds. Livestock ponds were richer than surface mine ponds, floristically, with 106 plant species compared to 76 on surface mine ponds.

169. **Bjugstad, Ardell J.; Sorg, Cindy F. 1987. Northern high plains woodland values and regeneration. *In:* Proceedings of national symposium: issues and technology in the management of impacted western wildlife; 1985 February 4-6; Glenwood Springs, CO. 131-138.**

Data from wildlife habitat use, wood production, and values of hunting, trapping, and firewood were extrapolated to reflect the contribution to values of the northern high plains woodlands. Values per annum, derived from expenditures and net willingness to pay, were deer hunting $26,055,968; turkey hunting $960,411; fur trapping $3,757,354; and firewood $6,822,000, for a total annual revenue of $37,595,733 from northern high plains woodlands. These deciduous tree-shrub woodlands deteriorate to open, low-density stands without regeneration. Enhancement and revitalization of these types were accomplished by partial cutting, underplanting, and protecting from cattle grazing.

170. **Bjugstad, Ardell J.; Sorg, Cindy F. 1984. The value of wooded draws on the northern high plains for hunting, furs, and woodcutting. *In:* In Wooded draws: characteristics and values for the northern Great Plains. Symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication No. 111. Rapid City, SD: South Dakota School of Mines and Technology: 5-9. 52 p.**

Data from wildlife habitat use, wood production, and values of hunting, trapping, and firewood reflect the contribution to values of wooded draws on the northern high plains. Values included expenditures and net willingness to pay. Approximate values per annum derived were: deer hunting $26 million; turkey hunting $1 million; fur trapping $4 million; and firewood $7 million for a total annual value of $38 million from wooded draws.

171. **Bjugstad, Ardell J.; Uresk, Daniel W.; Hamre, Robert H. 1989. Ninth Great Plains wildlife damage control workshop proceedings; 1989 April 17-20; Fort Collins, CO. General Technical Report RM-171. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 181 p.**

These proceedings consist of 43 presented papers on control of damage caused by many different animals. After an 'overview' session, papers were presented in session titled: carnivores, urban, big game, birds, and rodents and lagomorphs.

172. **Bjugstad, Ardell J.; Whitman, Warren C. 1989. Promising native forbs for seeding on mine spoils. *In:* Walker, D. G.; Powter, C. B.; Pole, M. W., compilers. Proceedings of the conference: Reclamation, a global perspective; 1989 August 27-31; Calgary, Alberta. Report No. RRTAC89-2. Edmonton, Alberta: Alberta Land Conservation and Reclamation Council; 1: 255-262. (2 volumes).**

Twenty-nine species of perennial forbs and two biennial forbs were directly seeded into coal mine spoil materials at Dickinson, North Dakota, to determine which species would be most successful for direct seeding into coal mine spoil. Several species showed exceptionally good emergence and vigorous growth of seedlings in a 2-year study, and some showed lesser but acceptable germination. Other species tested showed little to no germination and, hence, were difficult to establish by direct seeding into coal mine spoil.

173. **Bjugstad, Ardell J.; Yamamoto, Teruo; Uresk, Daniel W. 1981. Shrub establishment on coal and bentonite clay mine spoils. *In:* Stelter, Lavern H.; Depuit, Edward J.; Mikol, Sharon A., technical coordinators. Proceedings of the shrub establishment on disturbed arid and semi-arid lands symposium; 1980 December 2-3; Laramie, WY. Cheyenne, WY: Wyoming Game and Fish Department: 104-122. 154 p.**

Shrubs and some trees are an important component of the premining landscape in Wyoming. Therefore, managers need to decide carefully on the species and establishment operations to insure the return of the shrub and tree element in the postmining landscape.

174. **Bjugstad, Rochelle A.; Bjugstad, Ardell J. 1989. Do you know *Platanthera praeclara*? *In:* Bragg, Thomas B.; Stubbendieck, James, editors. Prairie pioneers: ecology, history and culture: proceedings of the 11th North American prairie conference; 1988 August 7-11; Lincoln, NE. Lincoln, NE: University of Nebraska Printing: 201-202.**

This is a brief synthesis on the plant, habitat, and range of the western prairie fringed orchid (*Platanthera praeclara* Sheviak and Bowles). This species was once common on the tallgrass prairie, but its numbers have been greatly reduced by improper management and loss of habitat. Comparisons are made to the eastern prairie fringed orchid [*Platanthera leucophaea* (Nutt.) Lindl].

175. **Blankenship, James O. 1984. Can you get a PSD permit if you exceed the Class I increment? San Francisco, CA: Air Pollution Control Association. 7 p.**

176. **Bock, Carl E. 1987. Distribution-abundance relationships of some Arizona landbirds: a matter of scale. Ecology. 68(1): 124-129.**

177. **Bock, Carl E.; Bock, Jane H. 1983. Responses of birds and deer mice to prescribed burning in ponderosa pine. Journal of Wildlife Management. 47: 836-840.**

178. **Bock, Carl E.; Webb, Betsy. 1985. Birds as grazing indicator species in southeastern Arizona. Journal of Wildlife Management. 48(3): 1045-1049.**

179. **Bock, Jane H.; Bock, Carl E. 1984. Effect of fires on woody vegetation in the pine-grassland ecotone of the southern Black Hills. American Midland Naturalist. 112(1): 35-42.**

180. **Bodenham, Judy; Stevens, Robert E. 1981. Insects associated with second-year ponderosa pine cones, Larimer and Boulder Counties, Colorado. Southwestern Naturalist. 26(4): 375-378.**

Conotrachelus neomexicanus fall (Coleoptera: Curculionidae), *Conophthorus ponderosa* Hopkins (Coleoptera: Scolytidae), *Dioryctria rossi* Munroe, *D. auranticella* (Grote), *D. abietivorella* (Grote), *D. cambiicola* (Dyar) (Lepidoptera: pyralidae), *Cydia piperana* (Kearfott) (Lepidoptera: tortricidae), and *Leptoglossus occidentalis* Heidmann (Hemiptera: coreidae) were reared from samples of infested cones or cone-bearing shoots. Timing of certain life history events is discussed, and a key to species responsible for damage is presented.

181. **Bolander, Donald H. 1982. Chaparral in Arizona. *In:* Conrad, C. Eugene; Oechel, Walter C., technical coordinators. Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: ISDA Forest Service, Pacific Southwest Forest and Range Experiment Station: 60-63.**

182. **Boldt, Charles E.; Larson, Milo J.; Alexander, Robert R. 1983. Interior ponderosa pine in the Black Hills. *In:* Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture: 80-83. 191 p.**

183. **Bolen, Eric G. 1982. Playa wetlands of the U.S. southern High Plains: their wildlife values and challenges for management. *In:* Gopal, Brij; Turner, R. Eugene; Wetzel, Robert G.; Whigham, Dennis F., editors. Wetlands ecology and management: proceedings of the international wetlands conference; 1980 September 10-17; New Delhi, India. New Delhi, India: National Institute of Ecology and International Scientific Publications: 9-20.**

184. **Boulding, Kenneth E.; Lundstedt, Sven B. 1988. Value concepts and justification. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 13-22.**

185. **Boyce, R. R.; Brown, Thomas C.; McClelland, G. D.; Peterson, George L.; Schulze, William D. 1989. Experimental evidence of existence value in payment and compensation contexts. *In:* Boyle, K. J.; Heekin, T., editors. Benefits and costs in natural resource planning; 1989; San Diego, CA. San Diego, CA:: 305-336.**

186. **Boyd, J. E.; Jacobi, William R. 1989. The development of a risk rating system for comandra rust in lodgepole pine. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 73-77.**

187. **Bradford, P. W.; Wood, Karl M.; Tromble, John R.; Ward, Timothy J. 1986. A hand-portable single nozzle rainfall simulator designed for use on steep slopes. Journal of Range Management. 39(4): 375-377.**

188. **Brady, Ward W.; Patton, David R.; Paxson, Jay. 1985. The development of southwestern riparian gallery forests. *In:* Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, Robert H., technical coordinators. Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium; 1985 April 16-18; Tucson, AZ. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 39-43. 523 p.**

Riparian gallery forests along two rivers in the southwestern United States are described in a developmental continuum ranging from nursery bar to mature forest. Habitats suitable for tree reproduction are recognizable by their position relative to the active water course. These sites are typically located in overflow channels and receive flow only during floods. Flooding and the subsequent aggradation appear to be the major variables for the natural sequence of development within riparian stands.

189. **Brady, Ward W.; Stromberg, M. R.; Aldon, Earl F.; Bonham, C. D.; Henry, S. H. 1989. Response of a semi-desert grassland to 16 years of rest from grazing. Journal of Range Management. 42(4): 284-288.**

190. Brajer, Victor; Cummings, Ronald G. 1988. Integrating social science research in the contingent valuation methods: an overview. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 229-234.

191. Brandel, Kimberley; Omi, Philip N. 1983. An evaluation of current prescribed fire reporting practices. *In:* Proceedings, 7th conference on fire and forest meteorology; 1983 April 25-28; Fort Collins, CO. Boston, MA: American Meteorological Society: 75-80.

192. Brewer, J. Wayne; Stevens, Robert E.; Leatherman, David A. 1983. Douglas-fir tussock moths. Service in Action Leaflet 5.542. Fort Collins, CO: Colorado State University Extension Service. 2 p.

193. Brewer, J. Wayne; Stevens, Robert E. 1983. Integrated pest management of outdoor ornamental plants. *In:* Frankie, G. W.; Koehler, G. S., editors. Urban entomology: interdisciplinary perspectives. New York, NY: Praeger Publishing Co. 441-457.

194. Brickler, Stanley K.; Tunnicliff, Brock; Utter, Jack. 1983. Use And quality of wildland water: the case of the Colorado River corridor in the Grand Canyon. Western Wildlands. 9(2): 20-25.

195. Brickler, Stanley K.; Tunnicliff, Brock. 1980. Water quality analyses of the Colorado River corridor of the Grand Canyon. College of Agriculture Paper 350. Tucson, AZ: University of Arizona. 134 p.

196. Brink, Glen E. 1982. Coping with changing technology in the ADP environment. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 461-464. 1101 p.

Natural resource managers who may not be directly involved in ADP are advised to anticipate changes by avoiding unique hardware/software features, by keeping appropriate backups and testing materials, and by becoming more personally involved in ADP.

197. Brock, John H. 1983. Interseeding and interplanting techniques for Southwest reclamation. *In:* Aldon, Earl F.; Oaks, Wendell R., editors. Proceedings symposium on reclamation of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 192-195.

198. Brock, John H. 1985. Physical characteristics and pedogenesis of riparian soil in the upper Gila River basin. *In:* Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, Robert H., technical coordinators. Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the first North American riparian conference; 1985 April 16-18; Tucson, AZ. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 49-53. 523 p.

199. Brock, John H.; Debano, Leonard F. 1982. Runoff and sedimentation potentials influenced by litter and slope on a chaparal community in central Arizona. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 372-377. 637 p.

Simulated rainfall intensities of 12.5 centimeters per hour were applied to steep, moderate, and gentle sloped plots covered with none, light, moderate, and heavy litter. Infiltration capacity was heaviest on heavy litter plots. Highest sediments were from bare soils. Litter cover significantly reduced sediment losses and decreased runoff potentials.

200. Brookshire, David S.; Eubanks, Larry S.; Sorg, Cindy F. 1986. Existence values and normative economics: implications for valuing water resources. Water Resources Research. 22(11): 1509-1518.

The definitinal issues and conceptual framework of existence value are explored. It is argued that existence value may have two components: (1) an economic component that is consistent with utility maximizing behavior and (2) an ethical component that is inconsistent with normative benefit-cost assumptions. Issues as how to appropriately include a measure of existence value within a utility maximizing framework are also explored.

201. Brookshire, David S.; Eubanks, Larry S.; Swanson, Cindy Sorg. 1988. Existence values and normative economics. *In:* Toward the measurement of total econcomic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 14-26. 44 p.

202. Brown, Barbara G.; Murphy, Allan H.; Radloff, David L. 1985. Quantification of the uncertainty in spot fire-weather forecasts: some experimental results. *In:* Donoghue, Linda R.; Martin, Robert E., editors. Weather—the drive train connecting the solar engine to forest ecosystems. Eighth conference on fire and forest meteorology; 1985 April 29-May 2; Detroit, MI. Bethesda, MD: Society of American Foresters: 252-258.

203. Brown, Barbara G.; Murphy, Allan H.; Radloff, David L. 1985. Spot fire-weather forecasting: current procedures and practices. *In:* Donoghue, Linda R.; Martin, Robert E., editors. Weather—the drive train connecting the solar engine to forest ecosystems Eighth conference on fire and forest meteorology; 1985 April 29-May 2; Detroit, MI. Bethesda, MD: Society of American Foresters: 222-226.

204. Brown, David E. 1983. Biotic communities of the American Southwest-United States and Mexico. Desert Plants. 4(1-4): 1-342. (special issue).

This publication is explanatory and descriptive, not exhaustive. The chapters on the biotic communities tend to be more uniform than diverse in matters of content and style, with greater emphasis on community ecology than physiological ecology. Both floristics and faunistics are used in characterizing the biotic communities. Thus, in addition to information on the vegetation and flora, authors have made an effort to provide information on the animal taxa relevant to the biomes for the area.

205. Brown, David E.; Lowe, Charles H.; Pase, Charles P. 1980. A digitized systematic classification for ecosystems with an illustrated summary of the natural vegetation of North America. General Technical Report RM-73. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 93 p.

The world's natural ecosystems are classified in an hierarchical framework with seven levels: vegetation, formation-type, climatic (thermal) zone, regional formation (biome), series (community of generic dominants), association (of specific dominants), and composition-structure-phase. Such a digitized system facilitates land use classification, resource planning, inventory, and assessment.

206. Brown, Perry J. 1982. Psychological benefits of outdoor recreation. *In:* Kelly, J. R., editor. Social benefits of outdoor recreation. Champaign, IL: Leisure Behavior Research Laboratory, University of Illinois: 13-17.

207. Brown, Perry J.; Driver, B. L.; Bruns, Donald H.; McConnell, Charles. 1980. The outdoor recreation opportunity spectrum in wildland recreation planning: development and application. *In:* First annual national conference on recreation planning and development; 1979 April 18-21; Snowbird Resort, Snowbird, UT.; 1: 527-538.

The Bureau of Land Management and the USDA Forest Service are developing a new outdoor recreation planning system which is based on the recreation opportunity spectrum (ROS) concept. This system and its development are described. Relationships of the system to multiple use land management planning are indicated.

208. Brown, Perry J.; Driver, B. L.; Berry, Joseph K. 1981. Use of the recreation opportunity planning system to inventory recreation opportunities of arid lands. *In:* Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods. Proceedings of the workshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 123-128. 620 p.

209. Brown, Perry J.; Dyer, A. Allen. 1988. Overview. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 49-52.

210. Brown, Perry J.; Manfredo, Michael J. 1982. Recreation opportunity spectrum planning—an arid land case. Australian Journal of Parks and Recreation. 5: 45-49.

211. **Brown, Perry J.; Ross, David M. 1982. Using desired recreation experiences to predict setting preferences. *In:* Lime, David W., technical coordinator. Forest and river recreation: research update; 1981 October 25-27; Minneapolis, MN. Miscellaneous Publication 18-1982. St. Paul, MN: University of Minnesota, Agricultural Experiment Station: 105-110.**

212. **Brown, Thomas C. 1984. The concept of value in public resource allocation. Land Economics. 60(3): 231-246.**

This paper considers the appropriateness of using neoclassical economic measures of value in allocating public resources. Market prices and other monetary measures of value are described as group assigned values. It is argued that economic value measures are important sources of assigned value information, but are often inappropriate as the sole value measures upon which to base public resource allocation decisions.

213. **Brown, Thomas C. 1982. Monetary valuation of timber, forage, and water yields from public forest lands. General Technical Report RM-95. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p.**

This paper describes methods for deriving monetary values for three market products of the forest: timber, forage, and water. Elements of the theory are reviewed and applied to actual forest conditions in central arizona using available data. The paper should aid analysts with microeconomics training in understanding economic studies of resource values and in conducting valuations during the public land management planning process.

214. **Brown, Thomas C. 1987. Production and cost of scenic beauty: examples for a ponderosa pine forest. Forest Science. 33(2): 394-410.**

Psychophysical models of scenic beauty for an all-aged ponderosa pine area were combined with estimates of management costs and physical output values to indicate more efficient input combinations for production of scenic beauty. Also, in combination with biophysical models, the scenic beauty models were used to examine tradeoffs between scenic beauty and net present worth from timber, forage, and water yields. These examples demonstrate the use, as well as important limitations, of scenic beauty models in a multiple use context.

215. **Brown, Thomas C. 1981. Tradeoff analysis in local land management planning. General Technical Report RM-82. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

A set of concepts, procedures, and displays is presented to facilitate land management planning at the local level. The emphasis is on tradeoffs (analysis) in the formulation of alternatives, the estimation of the effects of the alternatives, and the comparison of the alternatives.

216. **Brown, Thomas C. 1987. The value of incremental water flow from pinyon-juniper lands. *In:* Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 177-182.**

Benefit-cost analysis of pinyon-juniper treatments that significantly increase runoff should include the value of the incremental flows. The value depends on the use of those flows, which is affected by the stochastic nature of flows and institutional arrangements for water storage and routing. Under common institutional arrangements, much of the incremental flows from pinyon-juniper manipulation probably would not be consumptively used. This would diminish the at-the-watershed value of incremental flows.

217. **Brown, Thomas C.; Daniel, Terry C. 1987. Context effects in perceived environmental quality assessment: scene selection and landscape quality ratings. Journal of Environmental Psychology. 7: 233-250.**

Observer groups rated the scenic beauty of forest scenes represented by color slides presented in the context of different scene mixes. The proportion of scenes from recently harvested, low scenic beauty forests compared with those from unharvested high scenic beauty forests had a significant effect on judgments of scenes common to both sets. The effects of different scene contexts on scenic beauty judgments can result from changes in observers' perception of the scenes and from shifts in their criteria for assigning ratings. A psychophysical scaling analysis is suggested as a means for dealing with criterion shifts.

218. **Brown, Thomas C.; Daniel, Terry C. 1984. Modeling forest scenic beauty: concepts and application to ponderosa pine. Research Paper RM-256. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 35 p.**

Statistical models are presented which relate near-view scenic beauty of ponderosa pine stands in the Southwest to variables describing physical characteristics. The models suggest that herbage and large ponderosa pine contribute to scenic beauty, while numbers of small and intermediate-sized pine trees and downed wood, especially as slash, detract from scenic beauty. Areas of lower overstory density and less tree clumping were preferred. Moderate harvest of relatively dense stands tends to improve scenic beauty once the stand has recovered from obvious harvest effects. The recovery period can be greatly reduced by slash cleanup.

219. **Brown, Thomas C.; Daniel, Terry C. 1986. Predicting scenic beauty of timber stands. Forest Science. 32(2): 471-487.**

The psychophysical approach to developing scenic beauty models is extended to the timber stand level. Ponderosa pine timber stands are shown to be quite homogeneous in terms of variables important in the prediction of scenic beauty. Candidate timber stand scenic beauty models are presented, along with the results of cross-validation experiments. The models agree with earlier studies that focused on one-acre plots, suggesting that scenic beauty increases with increases in herbage and large pine and with decreases in downed wood, and tree grouping. Finally, judgments of the scenic beauty of individual color slides taken within timber stands provide valid estimates of overall stand scenic beauty of conventionally delineated timber stands based on standard forest inventory information.

220. **Brown, Thomas C.; Daniel, Terry C.; Richards, Merton T.; King, David A. 1989. Recreation participation and the validity of photo-based preference judgments. Journal of Leisure Research. 21(1): 40-60.**

221. **Brown, Thomas C.; Fogel, Martin M. 1987. Use of streamflow increases from vegetation management in the Verde River Basin. Water Resources Bulletin. 23(6): 1149-1160.**

Although the effects of vegetation management on streamflow have been studied in many locations, the effects of augmented streamflow on downstream water users have not been carefully analyzed. This study examines the routing of streamflow increases that could be produced in The Verde River Basin of Arizona. Reservoir management and water routing to users in the Salt River Valley around Phoenix were carefully modeled. Simulation of water routing with and without vegetation modification indicates that, under current institutional conditions, less than one-half of the streamflow remainder would accumulate in storage until a year of unusually heavy runoff, when it would add to reservoir spills. Under alternative scenarios, from 39% to 58% of the streamflow increase was delivered to consumptive users.

222. **Brown, Thomas C.; Harding, Benjamin L.; Lord, William B. 1988. Comsumptive use of streamflow increases in the Colorado River basin. Water Resources Bulletin. 24(4): 801-814.**

This study examined the disposition of streamflow increases that could be created by vegetation management on forest land along the upper reaches to the Colorado River. A network optimization model was used to simulate water flow, storage, consumptive use, and loss within the entire Colorado River basin with and without the flow increases, according to various scenarios incorporating both current and future consumptive use levels, as well as existing and potential institutional constraints.

223. **Brown, Thomas C.; Harding, Benjamin L. 1987. A preliminary economic assessment of timber and water production in subalpine forests. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 126-137. 253 p.**

Management costs and timber and water benefits of intensive management of a subalpine forest area in the upper Colorado River basin were estimated. The water benefits were estimated with the use of a water basin model that indicated disposition of streamflow increases throughout The Colorado River basin. This preliminary analysis indicates that the primary benefits of streamflow increases from intensive forest management in the basin are in nonconsumptive water uses. The economic viability of intensive forest management was found to be very sensitive to costs of road construction and to estimates of values of water yield.

224. **Brown, Thomas C.; Harding, Benjamin L.; Payton, Elizabeth A. 1989. Reply to discussion of "Consumptive use of streamflow increases in the Colorado River Basin". Water Resources Bulletin. 25(5): 1089-1091.**

225. **Brown, Thomas C.; Slovic, Paul. 1988. Effects of context on economic measures of value.** *In:* **Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 23-30.**

Any assigned value reflects the context of the valuation, as well as the evaluator's preference and endowment. Factors that characterize the valuation context include response mode, relative magnitudes, order of presentation, stimulus mixture, informational cues, constituency, valuation iterations, and social setting. The evidence on context effects has implications for economic valuation.

226. **Brown, Thomas C.; Walsh, Richard G. 1988. Methods of monetary valuation: overview.** *In:* **Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 145-149.**

This paper briefly summarizes and compares three papers that describe alternative approaches to estimating the monetary value of amenity products. These approaches include those relying on (1) market behavior for related goods, (2) hypothetical markets, and (3) experimental markets.

227. **Bryant, Fred C.; Guthery, Fred S.; Webb, William M. 1981. Grazing management in Texas and its impact on selected wildlife.** *In:* **Proceedings of the wildlife—livestock relationships symposium; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station: 94-112.**

228. **Burke, I. C.; Matson, P. A.; Reiners, W. A.; Sturges, David L. 1987. Herbicide treatment effects on properties of mountain big sagebrush soils after 14 years. Soil Science Society of America Journal. 51(5): 1337-1343.**

229. **Burke, I. C.; Matson, P. A.; Reiners, W. A.; Sturges, David L. 1987. Herbicide treatment effects on properties of mountain big sagebrush soils after fourteen years. Soil Science Society of America Journal. 51(5): 1337-1343.**

230. **Burr, Karen E. 1987. Cold hardiness, root growth capacity, and bud dormancy testing of conifer seedlings. Fort Collins, CO: Colorado State University. 146 p. Ph.D. dissertation.**

231. **Burr, Karen E.; Tinus, Richard W.; Wallner, Steven J.; King, Rudy M. 1986. Comparison of four cold hardiness tests on three western conifers.** *In:* **Proceedings: combined Western Forest Nursery Council and Intermountain Nursery Association meeting; 1986 August 12-15; Tumwater, WA. General Technical Report RM-137. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 87-95. 164 p.**

Container-grown ponderosa pine, Douglas-fir, and engelmann spruce seedlings were cold acclimated and deacclimated in growth chambers over 19 weeks. A whole-plant freeze test and three tissue tests were performed weekly. The whole-plant freeze test provided results in 7 days and indicated differences in cold hardiness between stems, buds, and needles. Results from a freeze-induced electrolyte leakage test and differential thermal analysis were available in 2 days and 1 hour, respectively. Both tests were good predictors of tissue cold hardiness when calibrated against the whole-plant freeze test. Ethylene and ethane evolution were poor predictors of the development of cold hardiness.

232. **Burr, Karen E.; Tinus, Richard W.; Wallner, Steven J.; King, Rudy M. 1987. Comparison of time and method of mist chamber measurement of root growth potential.** *In:* **Landis, Thomas D., technical coordinator. Meeting the challenge of the nineties: proceedings, Intermountain Forest Nursery Association; 1987 August 10-14; Oklahoma City, OK. General Technical Report RM-151. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 77-86. 138 p.**

Container-grown ponderosa pine, Douglas-fir, and Engelmann spruce seedlings were cold acclimated and deacclimated in growth chambers over 19 weeks. Weekly whole-plant freeze tests and 7-and 14-day root growth potential (RGP) tests indicated 7-day rgp results were misleading during cold acclimation and that the 14-day test period was preferable. During cold deacclimation, both rgp test periods were suitable. Quantification of RGP as total length and total number of new roots per seedling were nearly equally informative from budset to bud break, independent of the length of the RGP test.

233. **Burr, Karen E.; Tinus, Richard W. 1989. Effect of the timing of cold storage on cold hardiness and root growth potential of Douglas-fir.** *In:* **Landis, Thomas D., technical coordinator. Proceedings, combined meeting of the Western Forest Nursery Associations; 1988 August 8-11; Vernon, BC. General Technical Report RM-167. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 133-138. 227 p.**

Seedlings were cold acclimated during 20 weeks. At weekly intervals, samples of seedlings were placed in 1 C storage for 4 weeks. Cold hardiness and rgp were measured before and after storage. Cold hardening continued and rgp generally declined in storage, regardless of when seedlings were stored during acclimation.

234. **Burr, Karen E.; Tinus, Richard W.; Wallner, Steven J.; King, Rudy M. 1989. Relationships among cold hardiness, root growth potential and bud dormancy in three conifers. Tree Physiology. 5: 291-305.**

Container-grown ponderosa pine, Douglas-fir, and Engelmann spruce seedlings were cold acclimated and deacclimated in growth chambers over 19 weeks. Stem cold hardiness, root growth potential, and bud dormancy were measured weekly. Relationships between these physiological attributes suggest that cold hardiness testing could provide quick estimation of the other two.

235. **Buskirk, Steven W.; Forrest, Steven C.; Raphael, Martin G.; Harlow, Henry J. 1989. Winter resting site ecology of marten in the central Rocky Mountains. Journal of Wildlife Management. 53(1): 191-196.**

We investigated the resting site ecology of American marten in the central Rocky Mountains during two winters, 1985-1986 and 1986-87. We found 8 marten used 57 resting sites on 141 occasions. Marten rested primarily in subnivean sites associated with coarse woody debris, including logs and stumps. Resting sites associated with coarse woody debris occurred primarily in spruce-fir stands, whereas other resting sites occurred in other stand types. Resting sites were closer to streams and lakes than expected. The importance of resting where coarse woody debris is available to provide thermal cover may explain the apparent dependence of marten on old-growth forest in the central Rocky Mountains in winter.

236. **Buskirk, Steven W.; Harlow, Henry J.; Forrest, Steven C. 1987. Studies on the resting site ecology of marten in the Central Rocky Mountains.** *In:* **Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO . General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 150-153. 253 p.**

237. **Buskirk, Steven W.; Harlow, Henry J.; Forrest, Steven C. 1988. Temperature regulation in American marten** ***(Martes americana)*** **in winter. National Geographic Research. 4(2): 208-218.**

238. **Butkay, S. M. 1989. The economic value of instream flows for recreation: a contingent valuation approach. Missoula, MT: University of Montana. 178 p. M.S. thesis.**

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239. **Cable, Dwight R. 1982. Partial defoliation stimulates growth of Arizona cottontop. Journal of Range Management. 35(5): 591-593.**

Responses of Arizona cottontop to partial defoliation were determined by removal of the terminal growing point in the latter half of July of basal culms that were in various stages of development at the time. If soil moisture was available, cottontop responded well to grazing throughout its growing season. Removal of the growing point stimulated auxillary shoot growth regardless of the stage of development.

240. **Cable, Dwight R. 1980. Seasonal patterns of soil water recharge and extraction on semidesert ranges. Journal of Range Management. 33(1): 9-15.**

Soil water recharged in the semidesert southwest during the usual winter precipitation season, and again during the usual summer rainy season. The amount and depth of recharge varies widely depending primarily on the amount of precipitation, and secondarily on storm character, soil texture, vegetation cover, and evapotranspiration. Soil water deple-

tion patterns and amounts differed among species, between plants and bare soil, and between seasons. Compared to evaporation from bare soil, plants extracted water much faster, but at more variable rates. Essentially all available soil water was used by plants or evaporated during most depletion periods.

241. **Cain, J. Richard; Beasom, Samuel L.; Rowland, Lenton O.; Rowe, Loyd D. 1982. The effects of varying dietary phosphorus on breeding bobwhites. Journal of Wildlife Management. 46: 1061-1065.**

242. **Calvin, Clyde L.; Hawksworth, Frank G.; Knutson, Donald M. 1984. Phloem in *Arceuthobium globosum* (viscaceae). Botanical Gazette. 145(4): 461-464.**

Arceuthobium globosum, a primitive member of the genus, has highly specialized phloem tissue. The sieve elements of this large Mexican species have transverse to oblique, usually simple sieve plates and small but numerous diffuse lateral pores. The sieve elements show the normal pattern of callose deposition and subsequent removal reported for other dicothyledons. Sieve elements were not found in *A. douglasii* or *A. tsugense*, two specialized, temperate-region species.

243. **Campbell, Ralph E.; Ryan, Michael G. 1982. Precipitation and temperature characteristics of forested watersheds in north-central Arizona. General Technical Report RM-93. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

Precipitation and temperature characteristics of the Utah and alligator juniper woodlands and ponderosa pine forest types, on the Beaver Creek Experimental Watersheds, are described using 23 years of record. The climatic patterns, both precipitation and temperature, are quite representative of similar vegetation types and fit into a continuum within Arizona and New Mexico

244. **Canton, Alan R.; Workman, John P.; Uresk, Daniel W. 1984. An economic analysis of black-tailed prairie dog *(Cynomys lucovicianus)* control. Journal of Range Management. 37: 358-361.**

245. **Capen, David E. 1981. The use of multivariate statistics in studies of wildlife habitat. General Technical Report RM-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 249 p.**

This report contains edited and reviewed versions of papers presented at a workshop held at the University of Vermont in April 1980. Topics include sampling avian habitats, multivariate methods, applications, examples, and new approaches to analysis and interpretation.

246. **Carolin, V. M., Jr.; Stevens, Robert E. 1981. Key to large Lepidopterous larvae on new foliage of Douglas-fir and true firs. Research Note RM-401. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Presents a key, primarily for field use, emphasizing characteristics visible with a hand lens. The key separates larvae of associates of the western spruce budworm, *Choristoneura occidentalis* Freeman, in advanced instars.

247. **Casti, J. 1983. Forest monitoring and harvesting policies. Applied Mathematics and Comp. 12:19-48.**

248. **Catts, G. P. 1986. Use of panoramic aerial photographs to estimate forest stand variables and land cover classes in northern California and southwestern Oregon. *In:* Use of auxiliary information in natural resource inventories; 1985 October 1-2; Blacksburg, VA. SAF 86-01. Blacksburg, VA: Virginia Polytechnic University: 95-113.**

249. **Catts, G.P.; Cost, Noel D.; Czaplewski, Raymond L.; Snook, Paul W. 1988. Preliminary results from a method to update timber resource statistics in North Carolina. *In:* Proceedings of the eleventh biennial workshop on color aerial photography in the plant sciences; 1987 April 27-May 1; Weslaco, TX. U.S. Department of Agriculture, Agricultural Research Service Laboratory, and American Society for Photogrammetry and Remote Sensing: 39-52.**

This study examines the land cover and timber resource acreage classification results produced by the photointerpretation of 111, 1,000 acre plots in North Carolina imaged on 1:12,000 scale color infrared aerial photography acquired in November of 1985. The results are compared with timber resource statistics produced by the Southeastern Forest Inventory and Analysis Unit in 1983. There is a high degree of agreement between the two data sources in the majority of categories. The discrepancies, however, may prove to contain much useful and timely information.

250. Catts, G. P.; Hiserote, B. 1986. Use of high altitude photography (NHAP) color infrared transparencies in stand volume estimation for western Oregon conifer inventory. *In:* Use of auxiliary information in natural resource inventories; 1985 October 1-2; Blacksburg, VA. SAF 86-01. Blacksburg, VA: Virginia Polytechnic University: 114-123.

251. Catts, G. P.; James, Arnold; Griffith, Douglas. 1987. Estimating timber removal acreage from color infrared, aerial optical bar panoramic photography. *In:* Proceedings of the eleventh biennial workshop on color aerial photography in the plant sciences; 1987 April 27-May 1; Weslaco, TX. U.S. Department of Agriculture, Agricultural Research Service Laboratory, and American Society for Photogrammetry and Remote Sensing: 73-83.

The characteristics of optical bar panoramic photography make it an ideal source of land cover classification data. In this study it was used to estimate the timber removal acreage created on the Mendocino National Forest. Estimates were produced by simultaneous photointerpretation of optical bar imagery and compared with annual recorded figures. The high degree of similarity between photointerpreted estimates of timber removal and recorded figures strongly suggests optical bar panoramic photography has the potential to be an effective information source for detecting and updating certain types of landscape change.

252. Chalk, David E.; Miller, Stephen A.; Hoekstra, Thomas W. 1984. Multi-resource inventories: integrating information on wildlife resources. Wildlife Society Bulletin. 12(4): 357-364.

A land use/land-cover classification matrix has been developed for organizing data collected from multiresource inventories which provides the ecological context by which wildlife habitat can be described.

253. Cherem, Gabriel J.; Driver, B. L. 1983. Visitor employed photography: a technique for measuring common perceptions of natural environments. Journal of Leisure Research. 15(1): 65-83.

Sample users of each of the study areas revealed common patterns of perceptual response, even when tests for differences were made across up to 17 different user characteristics. Theoretical explanations for this commonality are offered, as are implications for recreation resource planning and management.

254. Chestnut, Lauraine G. 1988. Incorporating psychology in contingent valuation applications. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 245-252.

255. Christon, Mark; Burns, Patrick J.; Sommerfeld, Richard A. 1988. A 2-d microscopic simulation of temperature gradient metamorphism in dry snow. *In:* Heat transfer in geophysical and geothermal systems; 1987 August 9-12; Pittsburgh, PA. New York, NY: The American Society of Mechanical Engineers; 76: 1-8.

256. Cincotta, Richard P. 1989. Note on mound architecture of the black-tailed prairie dog. Great Basin Naturalist. 49(1): 621-623.

257. Cincotta, Richard P.; Uresk, Daniel W.; Hansen, Richard M. 1987. Demography of black-tailed prairie dog populations reoccupying sites treated with rodenticide. Great Basin Naturalist. 47(2): 339-343.

Zinc phosphide was applied to remove black-tailed prairie dogs *(Cynomys ludovicianus)* from 6 ha of a prairie dog colony in southwestern South Dakota. Another adjacent 6 ha was left untreated. The removal experiment was repeated two consecutive years. Contingency table analysis showed that the resultant population was not homogeneous; age classes by sex of the immigrant and resident subpopulations were different. The ratio of adult females to yearling females was greater among immigrants than among residents. Female immigrants did not produce young in the treated zone during the year of their arrival.

258. Cincotta, Richard P.; Uresk, Daniel W.; Hansen, Richard M. 1989. Plant compositional change in a colony of black-tailed prairie dogs in South Dakota. *In:* Bjugstad, Ardell J.; Uresk, Daniel W.; Hamre, Robert H., technical coordinators. Ninth Great Plains wildlife damage control workshop proceedings; 1989 April 17-20; Fort Collins, CO. General Technical Report RM-171. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 171-177. 181 p.

Peak season multi-species cover of vegetation and burrow mound density were estimated for 3 years along a transect that ran from the geometric center of a black-tailed prairie dog colony to its edge.

259. **Cincotta, Richard P.; Uresk, Daniel W.; Hansen, Richard M. 1988. A statistical model of expansion in a colony of black-tailed prairie dogs. *In:* Uresk, Daniel W.; Schenbeck, Greg L.; Cefkin, Rose, technical coordinators. Eighth Great Plains wildlife damage control workshop proceedings; 1987 April 28-30; Rapid City, SD. General Technical Report RM-154. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 30-33. 231 p.**

To predict prairie dog establishment in areas adjacent to a colony we sampled: (1) visibility through the vegetation using a target, (2) population density at the colony edge, (3) distance from the edge to the potential site of settlement, and (4) percent forb cover. Stepwise regression analysis indicated that establishment of prairie dogs in an adjacent prairie was most likely to occur when an area was near a densely populated colony edge with high visibility through the vegetation.

260. **Clancy, Karen M.; Price, Peter W. 1989. Effect of plant resistance, competition, and enemies on a leaf-galling sawfly (Hymenoptera: Tenthredinidae). Environmental Entomology. 18(2): 284-290.**

The relative importance of three sources of larval mortality (host plant resistance, intraspecific competition, and natural enemies) was evaluated for a population of leaf-galling sawflies, *Pontania* sp., near *P. pacifica* Marlatt, on arroyo willow, *Salix lasiolepis* Bentham, at a site in Flagstaff, Arizona, from 1981 to 1984. The ratio of the percentage of sawfly larvae killed by natural enemies to the percentage lost to host platn fefences (i.e.; abortion, defined as an aborted formation of a gall resulting from death of the egg or small larva) was 1.53:1.

261. **Clancy, Karen M.; Price, Peter W.; Craig, Timothy P. 1986. Life history and natural enemies of an underscribed sawfly near *Pontania pacifica* (Hymenoptera: Tenthredinidae) that forms galls on arroyo willow, *Salix lasiolepsis*. Annals of the Entomological Society of America. 79(6): 884-892.**

262. **Clancy, Karen M.; Price, Peter W. 1987. Rapid herbivore growth enhances enemy attack; sublethal plant defenses remain a paradox. Ecology. 68(3): 733-737.**

263. **Clancy, Karen M.; Price, Peter W. 1986. Temporal variation in three-trophic-level interactions among willows, sawflies and parasites. Ecology. 67(6): 1601-1607.**

264. **Clancy, Karen M.; Wagner, Michael R.; Tinus, Richard W. 1988. Variation in host foliage nutrient concentrations in relation to western spruce budworm herbivory. Canadian Journal of Forest Research. 18: 530-539.**

Foliar Concentrations And Balances Of N And Eight Mineral Elements (P, K, Ca, Mg, Mn, Cu, Fe, Zn, P/N, Cu/Zn, Mn/Fe, and Ca/Mg) in current-year needles were dependent on both seasonal phenology and tree species. differences were apparent among three host species and sample times in spite of the interaction.

265. **Clancy, Karen M.; Wagner, Michael R.; Tinus, Richard W. 1988. Variations of nutrient levels as a defense: identifying key nutritional traits of host plants of the western spruce budworm. *In:* Mattson, William J.; Levieux, Jean; Bernard-Dagan, C., compilers and editors. Mechanisms of woody plant defenses against insects: search for pattern. New York, NY: Springer-Verlag: 203-213.**

Seasonal and ontogenetic trends in foliar concentrations on nitrogen, phosphorus, potassium, calcium, zinc, and iron suggest that these elements may be potential key plant nutrient traits affecting western spruce budworm performance. The significance of this variation cannot be appreciated until we understand the budworm's dietary requirements for nitrogen and materials.

266. **Clapsaddle, C.; Lamb, D. 1989. The sorption behavior of SO_2 on ice at temperatures between -30° .degrees and -5° C. Geophysical Letters. 16(10): 1173-1176.**

267. **Clark, William R.; Medcraft, J. Richard. 1986. Wildlife use of shrubs on reclaimed surface-mined land in northeastern Wyoming. Journal of Wildlife Management. 50(4): 714-718.**

268. **Clary, Warren P.; Jameson, Donald A. 1981. Herbage production following tree and shrub removal in the pinyon-juniper type of Arizona. Journal of Range Management. 34(2): 109-113.**

Grasses increased in the composition from 46 to 73 percent on the average, while forbs decreased from 21 to 19 percent, and half-shrubs and shrubs decreased from 33 to 8 percent.

269. **Cline, Leo D.; Short, Robert A.; Ward, James V.; Carlson, Clarence A., Jr.; Gary, Howard L. 1983. Effects of highway construction on water quality and biota in an adjacent Colorado mountain stream. Research Note RM-429. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.**

Highway construction increased suspended solids and channel sedimentation, while nine other water quality variables were unaffected in an adjacent, high elevation stream. Epilithon standing crop and macroinvertebrate density decreased and compositional changes were noted. Effects were more pronounced in depositional areas. No change in fish condition was detected.

270. **Coe, Carole A.; Klopatek, Jeffrey M. 1983. Mycorrhizae in reclaimed soils.** *In:* **Symposium on surface mining, hydrology, sedimentation and reclamation; 1983 November 27-December 2; Lexington, KY. Lexington, KY: University of Kentucky: 399-405.**

271. **Cohan, David; Haas, Stephen M.; Roussopoulos, Peter J. 1983. Decision analysis of silvicultural prescriptions and fuel management practices on an intensively managed commercial forest. Forest Science. 29(4): 858-870.**

A decision analytic model is described for jointly evaluating alternative silvicultural and fuel management practices in areas primarily managed for timber production. The model is demonstrated in a case study on the Stanislaus National Forest, where the most intensive of six prescriptions produced the highest net present value.

272. **Cohan, David; Haas, Stephen M.; Radloff, David L.; Yancik, Richard F. 1984. Using fire in forest management: decision making under uncertainty. Interfaces. 14(5): 8-19.**

273. **Cohen, W. B.; Omi, Philip N.; Kaufmann, Merrill R. 1987. Water uptake of subalpine conifer branches during heating.** *In:* **Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 207-210. 253 p.**

Transpiring pine, spruce, and fir branches were connected to potometers and some were treated with transverse cuts to induce a wide range of transport resistances. The branches then were heated in an oven at 225° C. During heating, branches without transverse cuts transported water at significantly greater rates compared to their preheating transpiration rates, and branches that were treated with transverse cuts transported water at lesser rates than branches without transverse cuts.

274. **Cole, Dennis M.; Edminster, Carleton B. 1985. Growth and yield of lodgepole pine.** *In:* **Baumgartner, David M.; Krebill, Richard G.; Arnott, James T.; Weetman, Gordon F., compilers and editors. Lodgepole pine, the species and its management: symposium proceedings; 1984 May 8-10, May 14-16; Spokane, WA; Vancouver, BC. Pullman, WA: Washington State University, Cooperative Extension Service: 261-290.**

275. **Collins, Alan R.; Workman, John P.; Uresk, Daniel W. 1984. An economic analysis of black-tailed prairie dog** ***(Cynomys ludovicianus)*** **control. Journal of Range Management. 37(4): 358-361.**

Black-tailed prairie dog control by poisoning with zinc phosphide was not economically feasible in the Contata Basin of South Dakota. Control benefit was forage gained on treated areas. With an increase of approximately 51 kg/ha of cattle forage, over 7 ha of initial prairie dog control were required to gain 1 AUM per year for the life of the treatment.

276. **Comer, C. W.; Adams, Robert P.; Van Haverbeke, David F. 1982. Intra- and interspecific variation of** ***Juniperus virginiana*** **and** ***J. scopulorum*** **seedlings based on volatile oil composition. Biochemical Systematics and Ecology. 10(4): 297-306.**

Comparisons of volatile oil constituents were made among samples of juvenile foliage collected from 78 *Juniperus virginiana* and 28 *J. scopulorum* seedling sources growing in a "common garden" environment. A canonical variate analysis, a principal coordinates analysis and hybrid distance diagrams of 30 chemical characters indicate both taxa are good species and that they exhibit patterns in the Great Plains. In addition, a possible evolutionary link between present-day *J. virginiana* populations in southern Texas and ancient *J. scopulorum* populations is indicated.

277. **Connell, Bernadette H. 1988. Evaluation of a 3-D diagnostic wind model: NUATMOS. Fort Collins, CO: Colorado State University. 135 p. M.S. thesis.**

278. Connell, Bernadette H.; Fox, Douglas G.; Wooldridge, Gene L. 1989. Evaluation of a 3-D wind model (NUATMOS) with implications. *In:* 10th conference on forest and fire meteorology; Ottawa, Canada. 58-64.

279. Connell, Bernadette H.; Fox, Douglas G.; Wooldridge, Gene L. 1987. The San Antonio Mountain experiment (SAMEX) data base. *In:* Ninth conference, fire and forest meteorology; 1987 April 21-24; San Diego, CA. Boston, MA: American Meteorological Society: 158-164.

The interpretation of weather conditions that influence day- to-day activities is aided by the analysis of historical weather data. In 1980, the San Antonio Mountain Experiment Station (samex) was initiated to specifically study the effects of elevation and aspect on the meteorological variables, to compare the surface measurements of temperature, humidity, and wind components with those of the boundary layer air nearby and to validate temperature, humidity, and wind models in complex terrain. An idealized topographic feature, a conically shaped mountain, was chosen for this purpose.

280. Coppola, John. 1989. Wind dispersal of *Arceuthobium americanum* pollen. Southwestern Naturalist. 34(2): 291-293.

Wind dispersal of lodgepole pine dwarf mistletoe pollen was studied on the Roosevelt National Forest, Colorado. The amount of pollen caught decreased markedly as the distance from source plants increased. Most pollen was caught within 8 meters, but some pollen was dispersed up to 512 meters.

281. Cortner, Hanna J.; Schweitzer, Dennis L. 1981. Forest resource planning and reality: institutional problems and limitations. *In:* Proceedings, IUFRO symposium on forest management and planning. Publication FWS-1-81. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Research: 11-26.

282. Cortner, Hanna J.; Schweitzer, Dennis L. 1981. Institutional limits to national public planning for forest resources: the Resources Planning Act. Natural Resources Journal. 21: 203-222.

283. Cortner, Hanna J.; Schweitzer, Dennis L. 1981. The political nature of quantitative models in local public forest planning. *In:* Proceedings, XVII IUFRO world congress; 1981 September 6-12; Kyoto, Japan. Ikarashi, Niigata, Japan: Niigata University: 305-314.

284. Covington, W. Wallace; Sackett, Stephen S. 1986. Effect of periodic burning on soil nitrogen concentrations in ponderosa pine. Soil Science Society of America Journal. 50: 452-457.

285. Covington, W. Wallace; Sackett, Stephen S. 1984. The effects of a prescribed burn in southwest ponderosa pine on organic matter and nutrients in woody debris and forest floor. Forest Science. 30(1): 183-191.

286. Cox, Jerry R. [and others]. 1984. Vegetation restoration in the Chihuahuan and Sonoran Deserts of North America. Rangelands. 6: 112-115.

287. Craig, Timothy P.; Price, Peter W.; Clancy, Karen M.; Waring, Gwendolyn L.; Sacchi, Christopher F. 1988. Forces preventing coevolution in the three-trophic-level system: willow, a gall-forming herbivore, and parasitoid. Chapter 3. *In:* Spencer, Kevin C., editor. Chemical mediation of coevolution. San Diego, CA: Academic Press, Inc. 57-80.

Forces facilitating and preventing coevolution in the system consisting of the arroyo willow *Salix lasiolepis* Bentham (Salicaceae), the shoot-galling sawfly *Euura lasiolepis* Smith (Tenthredinidae), and the parasitoid *Pteromalus* spp. were examined. No evidence of coevolution in this system was found. The definition used by janzen for coevolution was used: 'an evolutionary change in a trait of the individuals of one population in response to a trait of the individuals of a second population, followed by an evolutionary response by the second population to the change in the first.

288. Craig, Timothy P.; Waring, Gwendolyn L.; Price, Peter W.; Clancy, Karen M. 1988. Forces preventing coevolution in the three trophic level system: willow, a gall-forming herbivore and parasitoid. New York, NY: Permagon Press.

289. **Crawford, John A.; Stormer, Fred A. 1980. A bibliography of the lesser prairie chicken, 1873-1980. General Technical Report RM-80. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.**

This bibliography contains 207 references on research and management of the lesser prairie chicken *(Tympanuchus pallidicinctus)* published during 1873-1980. A subject index is referenced numerically to an alphabetical list of authors.

290. **Cress, William A. 1984. Changes in free amino acids and guanosine nucleotides in *Atriplex canescens* (Pursh)[Nutt.] during water stress. *In:* Tiedemann, Arthur R. [and others], compilers. Proceedings of the symposium on the biology of atriplex and related chenopods; 1983 May 2-6; Provo, UT. Ogden, UT: U.S. Department of Agriculture, Intermountain Forest and Range Experiment Station: 116-119. 309 p.**

The decrease in glutamate and in guanosine nucleotide contents along with an increase in asparagine content during water stress suggest a cause-effect relationship between the decrease in glutamate and the decrease in polysomes during water stress.

291. **Cress, William A. 1982. The effect of varied watering regimes on proline production in *Atriplex canescens, Hilaria jamesii,* and *Agropyron smithii. In:* Aldon, Earl F.; Oaks, Wendell R., co-editors. Proceedings of reclamation of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 165-169. 281 p.**

Three native plant species—Fourwing saltbush, galleta, and western wheatgrass—responded to varied watering regimens by producing greater amounts of proline as moisture stress increased. A comparison of the three species showed a trend toward a greater survivability at lower soil moisture levels as the proline content increases.

292. **Cress, William A.; Johnson, Gordon V. 1987. The effect of three osmotic agents on free proline and amino acid pools in *Atriplex canescens* and *Hilaria jamesii.* Canadian Journal of Botany. 65: 799-801.**

Three commonly used osmotic agents, mannitol, sucrose, and polyethylene glycol 4000, were used to simulate water stress in two arid region plant species, *Hilaria jamesii* and *Atriplex canescens.* Large amounts of mannitol and sucrose were absorbed by both plant species, while insignificant amounts of polyethylene glycol 4000 were absorbed. During osmotic stress, *H. jamesii* accumulated large quantities of proline, while *A. canescens* accumulated only a small amount. Shoot proline content of both species varied significantly with the osmotic agents used to simulate water stress indicating that use of absorbable osmotic agents to simulate water stress may have important metabolic effects on the concentration of free proline and other metabolites.

293. **Cress, William A.; Johnson, Gordon V.; Baron, L. L. 1986. The role endomycorrhizal fungi in iron uptake by *Hilaria jamesii.* Journal of Plant Nutrition. 9(3-7): 547-556.**

294. **Crouch, Glenn L. 1983. Aspen regeneration after commercial clearcutting in southwestern Colorado. Journal of Forestry. 83(5): 316-319.**

Adequate numbers and distribution of sprouts for restocking were evident 1 and 7 years after clearcutting in a pure stand of mature aspen. However, the poor condition of most sprouts resulting from cattle trampling and snow breakage strongly threatens the successful replacement of sawlog quality growing stock.

295. **Crouch, Glenn L. 1986. Aspen regeneration in 6- to 10-year-old clearcuts in southwestern Colorado. Research Note RM-467. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Aspen regeneration in 6- to 10-year-old clearcut blocks was substantially less than these values from the same blocks at ages 1 to 5 years. Damage from disease and other environmental factors has reduced the numbers and distribution of sprouts to levels that preclude successful restocking of several of the blocks studied.

296. **Crouch, Glenn L. 1987. A bibliography of publications from Forest Service research in the Pacific Northwest, 1961-1986. *In:* Baumgartner, David M.; Mahoney, Ronald L.; Evans, James; Caslick, James; Breuer, David W., compilers. Animal damage management in Pacific Northwest forests: proceedings of the symposium; 1987 March 25-27; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension: 9-14.**

297. **Crouch, Glenn L. 1987. Big game habitat research in subalpine forests in the central Rocky Mountains. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 106-112. 253 p.**

Research findings indicate that subalpine forests similar to those on the Fraser Experimental Forest provide growing season habitat for deer and elk, but are unsuitable as winter range because of deep snow. Even in the growing season, their value as forage producers may be limited by closed canopies. Segments of these forests apparently can also provide year-round habitat for moose.

298. **Crouch, Glenn L. 1981. Coniferous Forest habitats, part 1. Food habits and nutrition. *In:* Wallmo, Olof C., editor and compiler. Mule and black-tailed deer of North America. Lincoln, NE: University of Nebraska Press: 423-433. 605 p.**

Black-tailed deer eat most forest understory plants including seedlings and accessible foliage of the conifer overstory. Seasonal preferences vary greatly with latitude and elevation, but green, succulent forage is preferred whenever it is available. Forage supplies are usually enhanced by clearcutting, which also appears to benefit forage quality.

299. **Crouch, Glenn L. 1981. Coniferous forest habitats, part 3. Effects of deer on forest vegetation. Wallmo, Olof C., editor and compiler. Mule and black-tailed deer of North America. Lincoln, NE: University of Nebraska Press: 449-457. 605 p.**

Forest vegetation provides forage for both mule and black-tailed deer. Most feeding is on understory plants, but conifers are also important suppliers of food. Excessive browsing on tree seedlings can delay or prevent regeneration on certain areas, but its adverse economic effects on reforestation westernwide has not yet been determined.

300. **Crouch, Glenn L. 1983. Effects of commercial clearcutting of aspen on understory vegetation and wildlife habitat values in southwestern Colorado. Research Paper RM-246. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.**

Commercial clearcutting of aspen in southwestern Colorado produced aspen sprouts, but caused relatively few lasting changes in other understory plant characteristics 5 years after logging. The most negative impact of logging on wildlife habitat was removal of the overstory, which adversely affected cavity-nesters and other species requiring mature forest.

301. **Crouch, Glenn L. 1985. Effects of clearcutting a subalpine forest in central Colorado on wildlife habitat. Research Paper RM-258. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

Clearcutting 3-acre circular blocks on average and moist sites increased understory plant production and cover, but caused few changes in species composition. Plant moisture and crude protein content, and digestibility also increased after logging but, incidence of herbivore activity varied among species.

302. **Crouch, Glenn L. 1986. Effects of thinning pole-sized lodgepole pine on understory vegetation and large herbivore activity in central Colorado. Research Paper RM-268. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.**

Thinning treatments to control growing stock levels (GSL) in a stand of 65-year-old lodgepole pine enhanced understory plant production, cover, and forage quality 5 years after treatment. Plant use and large herbivore activity also increased in the more heavily thinned blocks.

303. **Crouch, Glenn L. 1982. Pocket gophers and reforestation on western forests. Journal of Forestry. 80(10): 662-664.**

Pocket gophers (Geomydiae) damage conifer regeneration after logging or wildfires on western forests. Poisoning is the usual control method, but nonlethal techniques are currently being tested. Silvicultural practices that minimize habitat conditions favorable to gophers may be the most practical solution for avoiding damage.

304. **Crouch, Glenn L. 1986. Pocket gopher damage to conifers in western forests: a historical and current perspective on the problem and its control. *In:* Salmon, T. P., editor. Proceedings of the 12th vertebrate pest conference; 1986 March 4-6; San Diego, CA. Davis, CA: University of California: 196-198. 395 p.**

Pocket gophers damage or destroy regeneration on hundreds of thousands of acres of forestland in the western United States each year. Despite years of research, poisoning the offending animals—a technique developed around the turn of the century on agricultural land—is still the most prevalent practice for controlling damage on western forests.

305. **Crouch, Glenn L. 1981. Regeneration on aspen clearcuts in northwestern Colorado. Research Note RM-407. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Clearcutting mature aspen, on 5-acre blocks, resulted in 18,000 sprouts per acre, and nearly full stocking of half-milacre plots after one growing season. Two years later, sprouts averaged about 8,000 per acre, and mean height of the tallest stem was 4.4 feet. Further normal declines in numbers of sprouts are expected, but losses may be accelerated by trampling and browsing.

306. **Crouch, Glenn L. 1987. Survival and growth of ponderosa pine 18 years after planting and atrazine treatment in south-central Oregon.** *In:* **Baumgartner, David M.; Boyd, Raymond J.; Breuer, David W.; Miller, Daniel L., editors. Weed control for forest productivity in the interior West. Proceedings of a symposium; 1985 February 5-7; Spokane, WA. Pullman, WA: Conferences and Institutes, Washington State University: 125-128.**

Survival of ponderosa pines planted in April 1966 in small blocks and treated with atrazine changed little between 1975 and 1983, averaging about 57 and 53 percent in the respective years. Heights of these trees increased about 10 feet over the period. Pocket gophers were the principal cause of tree mortality on untreated and treated blocks during the initial 10 years.

307. **Crouch, Glenn L. 1982. Wildlife on ungrazed and grazed bottomlands on the South Platte River, northeastern Colorado.** *In:* **Peek, James M.; Dalke, P. D., editors. Proceedings of the wildlife-livestock relationships symposium; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest Wildlife and Range Experiment Station: 186-197. 614 p.**

Fifteen wildlife inventories were conducted during a 2-year period, on ungrazed and grazed bottomlands, in northeastern Colorado. Numbers of all game species observed were significantly greater on the ungrazed area. Total numbers of terrestrial nongame birds also were significantly greater on the ungrazed tract, but more aquatic birds were counted on the grazed area.

308. **Crouch, Glenn L. 1984. Wildlife habitat on the lower South Platte River in Colorado: past, present, and future.** *In:* **Wooded draws: characteristics and values for the northern Great Plains. Symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication No. 111. Rapid City SD: South Dakota School of Mines and Technology: 1-4. 52 p.**

Wooded riparian habitats present today along the South Platte River appear to be of recent origin. Early explorers found few trees and a river that flooded in the spring and was dry in late summer each year. The bottomlands could be drastically changed if management practices are not modified to favor the present environments.

309. **Cunningham, James B.; Balda, Russell P.; Gaud, William S. 1980. Selection and use of snags by secondary cavity-nesting birds of the ponderosa pine forest. Research Paper RM-222. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.**

One factor limiting the population size of secondary cavity-nesting birds in ponderosa pine is the number of suitable nesting cavities. Snags in the pine forest provide a large number of species with nesting and roosting sites. To maintain secondary cavity-nesters at their natural population level, a density of 5.2 snags per ha is recommended for mature ponderosa pine.

310. **Cunningham, Richard A.; Dix, Mary Ellen. 1983. Variation among Siberian elm in their susceptibility to defoliation by the spring cankerworm.** *In:* **Proceedings of the third north central tree improvement conference; 1983 August 17-19; Wooster, OH. Columbus, OH: Department of Forestry, Ohio State University: 190-200. 256 p.**

Siberian elm, a fast growing tree capable of surviving the harsh environmental conditions of the northern Great Plains, is widely planted in field windbreaks. These windbreaks are often severely defoliated by larvae of spring cankerworms. Leaf characteristics were measured weekly from the time of bud break until the cankerworm larvae pupated. Cluster analysis of these data separated the preferred trees from the non-preferred trees. Growth initiation by the non-preferred trees averaged 2 weeks later than the preferred trees.

311. **Czaplewski, Raymond L. 1989. Graphical analysis of stem taper in model building. Canadian Journal of Forest Research. 19: 522-524.**

When a stem-profile model is being built, a scatterplot of the empirical rate of change with respect to height provides useful information. It can indicate changes in stem taper, which provide tentative estimates for join points in segmented profile models. It can also help identify the desired form for profile models.

312. **Czaplewski, Raymond L. 1983. Use of geographic information systems to respond to changing planning requirements. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 66-69. 737 p.**

A geographic information system (GIS) was used to incorporate changes in renewable resources into both an extensive, plot based inventory and mapped inventories. The GIS also proved valuable in responding to rapidly developing management needs and planning criteria.

313. **Czaplewski, Raymond L.; Alig, Ralph J.; Cost, Noel D. 1988. Monitoring land/forest cover using the Kalman filter: a proposal. *In:* Ek, Alan R.; Shifley, Stephen R.; Burk, Thomas E., editors. Forest growth modelling and prediction: volume 2: proceedings of the IUFRO conference; 1987 August 23-27; Minneapolis, MN. General Technical Report NC-120. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 1089-1096.**

The Kalman filter, which is a flexible statistical estimator, might increase statistical efficiency and produce annual estimates of cover by combining such direct monitoring with past knowledge (i.e., model for annual change in land cover). This paper describes a potentially useful application of this topical estimator and presents specific proposals for practical methods.

314. **Czaplewski, Raymond L.; Brown, Amy S.; Guenther, Dale G. 1989. Estimating merchantable tree volume in Oregon and Washington using stem profile models. Research Paper RM-286. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.**

The profile model of Max and Burkhart was fit to eight tree species in the Pacific Northwest Region (Oregon and Washington) of the Forest Service. Most estimates of merchantable volume had an average error less than 10% when applied to independent test data for three national forests.

315. **Czaplewski, Raymond L.; Brown, Amy S.; Walker, Raymond C. 1989. Profile models for estimating log end diameters in the Rocky Mountain Region. Research Paper RM-284. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

The segmented polynomial stem profile model of Max and Burkhart was applied to seven tree species in the Rocky Mountain Region of the Forest Service. Errors were reduced over the entire data set by use of second-stage models that adjust for transformation bias and explain weak patterns in the residual diameter predictions.

316. **Czaplewski, Raymond L.; Catts, G. P.; Snook, Paul W. 1987. National land cover monitoring using large, permanent photo plots. *In:* Land and resource evaluation for national planning in the tropics, international conference; 1987 January 25-31; Chetumal, Mexico.**

A study in the State of North Carolina, USA, demonstrated that large, permanent photo plots (400 ha) can be used to monitor large regions of land by using remote sensing techniques. Estimates of area in a variety of land cover categories were made by photointerpretation of medium-scale aerial photography from a single month using 111 photo plots. Many of these area estimates compared favorably with the most recent data from the traditional forest inventory, although sampling errors of the new system are at least eight times larger due to the small sample size. The new system detected what appears to be significant conversion of harvested forestland to planted pine plantations between 1983 and 1985. An inexpensive monitoring system based on remote sensing and large photo plots, which uses a variety of aerial photography and low-cost, analog satellite imagery, might be useful for detecting rapid changes in land cover and management practices. To detect slower changes in land cover and to monitor variables impossible to measure reliably using remote sensing (e.g., wood volume and quality, tree growth, and mortality), the more precise and expensive traditional techniques must still be used.

317. **Czaplewski, Raymond L.; Cost, Noel D.; Bernu, Gregory J.; Moore, Richard A. 1986. Interpreting physiography, slope, aspect, operability, and accessibility of forest plots using large, medium, and small scale aerial photography in South Carolina. *In:* 1986 ASPRS-ACSM Fall convention; 1986 September 28-October 3; Anchorage, AK. Falls Church, VA: American Society for Photogrammetry and Remote Sensing: 309-321. 415 p.**

Large-scale (1:2,000 and 1:6,000), medium-scale (1:12,000) and small-scale (1:35,000 and 1:130,000) aerial photography were evaluated. The best results for all variables were obtained with the 1:12,000 9x9 inch color prints taken in the fall. However, similar accuracies were achieved with 1:35,000 color infrared transparencies, also taken in the fall.

318. **Czaplewski, Raymond L.; Cost, Noel D. 1987. Land use cover classification using large, medium, and smallscale photographs in South Carolina. *In:* Proceedings of the tenth biennial workshop on color aerial photography in the plant sciences; 1985 May 21-24; Ann Arbor, MI. Ann Arbor, MI: School of Natural Resources, University of Michigan: 35-44.**

Land use/land cover classes for 1-acre (0,4-ha) plots were photointerpreted using small (1:35,000, and 1:65,000, and 1:130,000), medium (1:20,000), and large (1:6,000 and 1:12,000) scale color infrared (cir), color, and black and white (b&w) panchromatic aerial photographs of a coastal plain and Piedmont area of South Carolina. Photointerpretation accuracy was generally in the 95,8-100 percent range for forest and nonforest. There were no significant differences among the various scales, film types, and acquisition dates.

319. **Czaplewski, Raymond L.; Cost, Noel D. 1986. Photointerpretation of wildlife, recreation, and livestock- grazing variables on one-acre forest plots in South Carolina. *In:* Proceedings, use of auxiliary information in natural resource inventories; 1985 October 1-2; Blacksburg, VA. Publication No. SAF 86-01. Society of American Foresters: 24-37.**

Photointerpretation of specific multiresource variables was studied for 62 plots. Interpreted variables were: type and intensity of recreational use; type of trails; intensity of grazing use; existence of fencing; stand size, shape, and diversity; amount of stand edge; percent forest; snag density; distance to permanent water; and type of water on the plot. Types of aerial photography were: 1:2,000 and 1:6,000 70-mm color transparencies; 1:12,000 9- x 9-inch color prints, 1:35, 000 and 1:130,000 9- x 9-inch color infrared transparencies. Many variables were interpreted with significant accuracy even at small-scales.

320. **Czaplewski, Raymond L.; Cost, Noel D.; Moore, Richard A.; Benue, G. J. 1989. Photointerpreting forest type and stand characteristics in South Carolina. *In:* 11th biennial workshop in the plant sciences. 51-60.**

321. **Czaplewski, Raymond L.; Crowe, D.; McDonald, L. 1983. Sample sizes and confidence intervals for wildlife population ratios. Wildlife Society Bulletin. 1(2): 121-128.**

322. **Czaplewski, Raymond L.; Kastner, W. 1986. Developing a dichotomous photointerpretation key using ancillary photo-data and a numerical distribution-free classifier. *In:* Proceedings, use of auxiliary information in natural resource inventories; 1985 October 1-2; Blacksburg, VA. Publication No. SAF 86-01. Society of American Foresters: 124-134.**

This paper demonstrates a technique using directly interpreted stand features (e.g., physiographic class, slope, aspect, average tree height, predominant tree size class, crown closure, stand shape, and stand area) and landscape features (e.g., distance to access roads, distance to lands with different types of uses, proportion of forest in the adjacent area, and local stand diversity) from aerial photographs. These photointerpreded data are used as independent variables in a numerical classification algorithm to predict a dependent variable (e.g., forest type or planted vs. natural stand origin.

323. **Czaplewski, Raymond L.; McClure, Joe P. 1988. Conditioning a segmented stem profile model for two diameter measurements. Forest Science. 34(2): 512-522.**

The stem profile model of max and burkhart is conditioned for d.b.h. and a second upper stem measurement. This model was applied to a loblolly pine data set using diameter outside bark at 5.3 m (i.e., height of 17.3-foot girard form class) as a second upper stem measurement, and then compared to the original, unconditioned model. Benchmark prediction problems, which reflect common multiproduct utilization criteria for southern pines, were used to judge the practical importance of the reductions.

324. Czaplewski, Raymond L.; Snook, Paul W. 1985. Evaluating use of an ultrasound device to measure distances to foliar and woody targets. Research Note RM-461. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

An ultrasound device was tested to evaluate its effectiveness in measuring the distances to vegetative objects under field conditions. The measuring device emits a high frequency sound wave that is aimed at a target. The elapsed time from signal emittance to return is converted to a distance estimate. Although this device can successfully measure distances to foliar targets under ideal conditions, field testing demonstrated that it is not well suited for use on forest plots. It appears that the target surface and inclination, wind, and ambient noise degrade sensor accuracy under field conditions.

325. Dams, Robert V.; Francis, Richard E. 1985. Aerial photography for post-mining vegetation inventory. *In:* PECORA 10 - remote sensing in forest and range resource management; 1985 August 20-22; Fort Collins, CO. Falls Church, VA: American Society of Photogrammetry and Remote Sensing: 419-420.

326. Dana, Robert W. 1982. Background reflectance effects in LANDSAT data. Applied Optics. 21(22): 4106-4111.

A regression analysis was performed on LANDSAT MSS data to investigate the dependence of object radiance on the radiance of adjacent areas. The object radiance is increased by a path radiance component attributed to forward scattering in the atmosphere after reflection of solar radiation from the object background. Multiple regression analysis indicates that radiance of an object is significantly affected by reflectance of background objects up to 500 m away.

327. Dana, Robert W. 1982. Dynamic tests of an infrared exposure meter. Journal of Applied Photographic Engineering. 8(3): 121-124.

The limited latitude of color infrared film requires careful exposure adjustment for photography of natural resources, an area of potential application of a spotmeter sensitive to the wavelength band of infrared films. Testing such an instrument requires careful consideration in three areas of photographic photometry: instrument pointing, film sensitiometry, and camera calibration. The results of regression analysis indicate that the infrared meter is an improvement over a conventional spotmeter in predicting the response of infrared film.

328. Dana, Robert W. 1981. An infrared exposure meter. *In:* Proceedings of the eighth biennial workshop on color aerial photography in the plant sciences; 1981 April 21-23; Luray, VA. Falls Church, VA: American Society of Photogrammetry: 145-156. 167 p.

The infrared meter is an improvement over a conventional spot meter in predicting the infrared response of film. The appropriate film speed to use in the exposure meter calculator for a typical emulsion was found to be 37.5.

329. Dancak, Ken; Pence, Danny B.; Stormer, Fred A.; Beasom, Samuel L. 1982. Helminths of the scaled quail, *Callipepla squamata*, from northwest Texas. Proceedings of the Helminthological Society of Washington. 49: 144-146.

330. Daniel, Terry C.; Brown, Thomas C.; King, David A.; Richards, Merton T. 1989. Perceived scenic beauty and contingent valuation of forest campgrounds. Forest Science. 35(1): 76-90.

331. Daniel, Terry C.; Sorg, Cindy F. Methodological issues in economic valuation: overview. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 181-186.

332. Darragh, Alexander J.; Peterson, George L.; Dwyer, John F. 1983. Travel cost models at the urban scale. Journal of Leisure Research. 15(2): 89-94.

Travel cost models are estimated for three urban forest recreation sites in Chicago. The resulting models are discussed, and suggestions are made for further applications of the model at the urban scale.

333. Davis, Edwin A. 1987. Chaparral conversion and streamflow: nitrate increase is balanced by a decrease in bicarbonate. Water Resources Research. 23(1): 215-224.

Converting Arizona chaparral watersheds to grass by controlling the brush with herbicides increases water yield as subsurface runoff to streams. The increased

stream discharge is accompanied by several hundredfold increases in the nitrate concentration of the stream water. Nitrate concentrations remained 46-69 fold above normal for 11 years or more. Nitrate ion concentration increases were balanced mainly by bicarbonate ion concentration decreases, with little change in the concentration of other anions or cations. One mechanism suggested to explain the decrease in bicarbonate that balances the increase in nitrate is the reaction of $H+NO_3$ - with HCO_3 - to give carbon dioxide and water.

334. **Davis, Edwin A. 1987. Chaparral conversion to increase streamflow in Arizona: sequential treatments extend duration of nitrate loss to stream water. Forest Science. 33(1): 80-103.**

Converting an Arizona Chaparral watershed to grass cover in two stages using herbicide treatments increased streamflow and the concentration of nitrate ions in the stream water. Nitrate rose to high concentrations (83 ppm) and was exported from the watershed in large amounts (up to 143 kg/ha/yr) in comparison with a control watershed (1.0 kg/ha/yr). Abnormal concentrations of nitrate in streamflow persisted for more years from the two-stage treated watershed than from a companion watershed converted in one stage. In planning for chaparral conversions to enhance water yield, forage production, and wildlife habitat, consideration should be given to the nitrate-release phenomenon associated with conversion to reduce possible adverse environmental impacts.

335. **Davis, Edwin A. 1984. Conversion of Arizona chaparral to grass increases water yield and nitrate loss. Water Resources Research. 20(11): 1643-1649.**

Converting an Arizona chaparral watershed to grass cover by using a soil application of karbutilate granules increased streamflow and the nitrate content of the water. Maximum concentrations of 60 and 69 ppm occurred during the third and fourth posttreatment years, when annual mean concentrations were 66-and 100-fold above normal. The mean nitrate concentration of the streamflow from the treated watershed for the entire 11-year period was 29-fold greater than that for the control watershed.

336. **Davis, Edwin A. 1989. Prescribed fire in Arizona chaparral: effects on stream water quality. Forest Ecology and Management. 26: 189-206.**

A paired-watershed study demonstrated that prescribed fire had a negligible effect on the ionic composition of streamflow from a chaparral watershed that had been converted by means of a herbicide to grasses, forbs, and scattered shrubs. Concentrations of sulfate, bicarbonate, and chloride anions and of calcium, magnesium, sodium, and potassium cations were not affected by the fire. Electrical conductivity and ph also were not influenced. Seasonal fluctuations in ionic concentrations coincide with seasonal variations in rainfall and streamflow. Nitrate concentrations increased during periods of high streamflow, but other anions and all cations decreased during periods of high flow. Electrical conductivity and ph remained relatively constant during the study.

337. **Davis, Edwin A. 1982. Stream water nutrient changes associated with the conversion of Arizona chaparral. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 333-338. 637 p.**

Increased streamflow obtained by converting chaparral watersheds to grass is associated with increased nitrate concentrations in the stream water. Nitrate concentrations of 45-80 ppm occurred in stream water from treated watersheds; nitrate concentrations remained above normal for 10 years or longer.

338. **Davis, Edwin A. 1981. Tebuthiuron residues in stream water from a spot-treated chaparral watershed in Arizona. *In:* Western Society of Weed Science: 1981 research progress report; 1981 March 17-19; San Diego, CA. 52-53. 348 p.**

Factors favorable to the movement of tebuthiuron into the stream water were the gravelly sandy loam soil with a weathered granite, deeply fractured regolith, rapid soil permeability, low soil organic matter (about 1.7 percent) confined to the top 2 inches of soil, steep slopes (20 to 100 percent), and tebuthiuron's water solubility of 2,300 p/m. Factors that minimized the loss of tebuthiuron in stream water were the low overall application rate on the treated slopes (0.78 lb ai/a), the treatment of only northeast-facing slopes (40 percent of the watershed), hand application of tebuthiuron pellets as a spot treatment to individual clumps of shrubs, and the application of tebuthiuron only away from channels.

339. **Davis, Edwin A.; Debano, Leonard F. 1986. Nitrate increases in soil water following conversion of chaparral to grass. Biogeochemistry. 2: 53-65.**

An Arizona watershed converted from chaparral to grass, released high concentrations of nitrate to stream water. The nitrate originated from the rooting zone of the decomposing shrubs. High nitrate concentrations (44-373 ppm) were found in soil solutions from 1.5-, 3.0-, and 4.6-m depths on the converted watershed as compared with low nitrate concentrations (0.2-6.2 ppm) found in an adjacent undisturbed area. Soil solution nitrate concentrations at the 0.3-m depth were generally low, especially in the untreated area. High nitrate concentrations were balanced mainly by relative decreases in bicarbonate anions in the soil solutions and in the stream water. Multiple stepwise regression analyses showed improvement in the regression of bicarbonate on nitrate when chloride and sulfate anions were entered as variables.

340. **Davis, Edwin A.; Gottfried, Gerald J. 1983. Picloram pellets control New Mexico locust sprouts on a cleared forest site in Arizona. Down to Earth. 39(1): 18-21.**

Several herbicides—funuron, karbutilate, bromacil, and s-triazine, and picloram—were tested on locust sprouts in New Mexico. Picloram was the only herbicide tested that was effective. Picloram pellets at 5.3 pounds per acre were very effective on locust, but were ineffective on Gambel oak; 86 percent of the locust plants were killed, compared to only 2 percent of the Gambel oak trees. Grasses and forbs were temporarily eliminated from treated areas, but grasses generally reestablished well after two growing seasons.

341. **Davis, Edwin A.; Gottfried, Gerald J. 1981. Response of new mexico locust and gambel oak to picloram pellets. *In:* Western Society of Weed Science: 1981 research progress report; 1981 March 17-19; San Diego, CA. 54-55. 348 p.**

The large-scale study clearly demonstrated the total ineffectiveness of a 6-pound-per-acre picloram application on Gambel oak. Because Gambel oak is sensitive to tebuthiuron pellets, a possible herbicide prescription for sites on which New Mexico locust and Gambel oak are problem species would be a duo-herbicide spot treatment in which picloram pellets are applied on locust, and tebuthiuron pellets are applied on Gambel oak.

342. **Davis, Edwin A.; Kuester, James L.; Bagby, Marvin O. 1984. Biomass conversion to liquid fuels: potential of some Arizona chaparral brush and tree species. Nature. 307(5953): 726-728.**

Arizona chaparral brush and tree species can be converted into high-grade liquid hydrocarbon fuels by indirect liquefaction, in which pyrolysis is followed by catalytic liquefaction. Because most of the chaparral species tested produced pyrolysis gas of comparable olefin content, harvesting of chaparral without regard to species composition is indicated.

343. **Davis, Jerry W.; Goodwin, Gregory A.; Ockenfels, Richard A. 1983. Snag habitat management: proceedings of the symposium. General Technical Report RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 226 p.**

These proceedings include 41 papers focusing attention on the need to integrate management of snags—dead or deteriorating trees critical to needs of cavity-dependent wildlife—with other resource uses and demands.

344. **Davis, Lawrence S. 1989. Definition of the integrated federal-state planning problem. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 6-16. 278 p.**

345. **Davis, P. R.; Foster, S. O.; Emerick, D. M.; O'Thorne, S. Rush; Finch, Deborah M.; Monarch, J. W. 1989. Issues and technology in the management of impacted wildlife. Boulder, CO: Thorne Ecological Institute. 213 p.**

346. de Vries, P. G.; Schreuder, Hans T. 1989. Estimation of stand means and other ratios in point sampling. Canadian Journal of Forest Research. 19: 1067-1070. There exist best linear unbiased estimators based on point sampling data, if certain linearity conditions hold, for any ratio in tree population (e.g., mean basal area or lorey's mean stand height). Variance expressions for these estimators are given, and approximate variance expressions for the estimated ratios are proposed.

347. DeBano, Leonard F. 1982. Assessing the effects of management actions on soils and mineral cycling in Mediterranean ecosystems. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 345-350. 637 p.

Mediterranean ecosystems can be harvested, undergo type conversion, or be burned. Both wildfires and prescribed burning are important features of these ecosystems. Guides are needed by land managers for making assessments of their decisions.

348. DeBano, Leonard F. 1989. Effects of fire on chaparral soils in Arizona and California and postfire management implications. *In:* Berg, Neil H., technical coordinator. Fire and watershed management; 1988 October 26-28; Sacramento, CA. General Technical Report PSW-109. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 55-62.

349. DeBano, Leonard F.; Brejda, J. J.; Brock, John H. 1984. Enhancement of riparian vegetation following shrub control in Arizona chaparral. Journal of Soil and Water Conservation. 39(5): 317-320.

After 20 years of increased streamflow and longer duration streamflow, a riparian zone below the watershed treated for shrub control had 7 riparian plants per 100 m^2 compared with a nearby, untreated watershed that had 2.3 plants per 100 m^2. This increase in riparian vegetation has implications for water quality, wildlife, and water use.

350. DeBano, Leonard F.; Dunn, Paul H. 1982. Soil-nutrient cycling in Mediterranean-type ecosystems: a summary and synthesis. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 358-364. 637 p.

The weathering of parent rock may be an important source of some nutrients. The rates of weathering of the different parent rock materials vary and affect the inherent fertility and productivity of a site. Research on granitic soils in idaho indicates that substantial amounts of some nutrients can be added by weathering.

351. DeBano, Leonard F.; Hansen, William R. 1989. Rehabilitating depleted riparian areas using channel structures. *In:* Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffrey L., technical editors. Practical approaches to riparian resource management; 1989 May 8-11; Billings, MT. Billings, MT: U.S. Bureau of Land Management: 141-148.

352. DeBano, Leonard F.; Heede, Burchard H. 1987. Enhancement of riparian ecosystems with channel structures. Water Resources Bulletin. 23(3): 463-470.

Naturally occurring and man-made structures can be used for enhancing the development pof riparian zones. Naturally occurring structures are cienagas, beaver dams, and log steps. manmade structures include large and small channel structures and bank protection devices. All these structures affect streamflow hydraulics and sedimentation and can create a more favorable environment for riparian zone establishment. However, when they are used improperly, they can be destructive to existing riparian zones. Therefore, investigations must be of a wide scope. interactions between riparian site, channel, and streamflow may be so complex that an interdisciplinary approach is required.

353. DeBano, Leonard F.; Klopatek, Jeffrey M. 1987. Effect of management on nutrient dynamics in southwestern pinyon juniper woodlands. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 157-160. 253 p.

Pinyon and juniper trees cycle nutrients producing a mosaic nutrient distribution that is vulnerable to range improvement, grazing, and fuelwood harvesting activities. Prescribed fire releases small amounts of available nutrients, but also volatilizes large quantities. These impacts on nutrient cycling may affect long-term productivity of pinyon juniper woodlands.

354. DeBano, Leonard F.; Klopatek, Jeffrey M. 1988. Phosphorus dynamics of pinyon-juniper soils following simulated burning. Soil Science Society of America Journal. 52: 271-277.

The objective of this study was to determine the effect of a simulated prescribed fire on p compounds in a lithic ustochrept soil supporting a pinyon-juniper

woodland in Arizona. Soil, litter, and duff collected from beneath pinyon pine and utah juniper and adjacent interspaces were used to reconstruct laboratory microcosms in clay pipes that were burned when soils were wet or dry. Soil temperatures were monitored continuously throughout the microcosms during burning.

355. **DeBano, Leonard F.; Perry, Hazel M.; Overby, Steven T. 1987. Effects of fuelwood harvesting and slash burning on biomass and nutrient relationships in a pinyon-juniper stand.** *In:* **Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 382-386.**

Fuelwood made up about 38% of the tree biomass in a stand of Utah juniper, but contained less than 25% of individual nutrients. Fire acted as a rapid mineralizing agent. Slash burning and tree removal also affected soil mineralization and nitrification.

356. **DeBano, Leonard F.; Schmidt, Larry J. 1989. Improving southwestern riparian areas through watershed management. General Technical Report RM-182. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 33 p.**

This paper reviews opportunities and watershed restoration techniques available for rehabilitating and enhancing riparian ecosystems in Southwest environments. As such, it is intended to serve as a state-of-the-art report on riparian hydrology and improvement in both naturally occurring and man-made riparian areas throughout the Southwest.

357. **DeBano, Leonard F.; Schmidt, Larry J. 1989. Interrelationships between watershed condition and riparian health in southwestern United States.** *In:* **Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffrey L., technical editors. Practical approaches to riparian resource management; 1989 May 8-11; Billings, MT. Billings, MT: U.S. Bureau of Land Management: 45-52.**

358. **DeByle, Norbert V.; Winokur, Robert P. 1985. Aspen: ecology and management in the Western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 283 p.**

Information about the biology, ecology, and management of quaking aspen on the mountains and plateaus of the interior western United States, and to a lesser extent, Canada, is summarized and discussed. The biology of aspen as a tree species, community relationships in the aspen ecosystem, environments, and factors affecting aspen forests are reviewed. The resources available within and from the aspen forest type, and their past and potential uses are examined. Silvicultural methods and other approaches to managing aspen for various resources and uses are presented.

359. **DeByle, Norbert V.; Winokur, Robert P. 1986. Introduction.** *In:* **DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, General Technical Report RM-119, 283 P. Rocky Mountain Forest and Range Experiment Station: 1. 283 p.**

360. **Decker, Daniel J.; Brown, Tommy J.; Driver, B. L.; Brown, Perry J. 1987. Theoretical developments in assessing social values of wildlife: toward a comprehensive understanding of wildlife recreation involvement.** *In:* **Valuing wildlife economic and social perspectives. Boulder, CO: Westview Press: 76-95.**

361. **Deisch, Michele S.; Uresk, Daniel W.; Linder, Raymond L. 1989. Effects of two prairie dog rodenticides on ground-dwelling invertebrates in western South Dakota.** *In:* **Bjugstad, Ardell J.; Uresk, Daniel W.; Hamre, Robert H., technical coordinators. Ninth Great Plains wildlife damage control workshop proceedings; 1989 April 17-20; Fort Collins, CO. General Technical Report RM-171. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 166-170. 181 p.**

Immediate and long-term effects of three rodenticide treatments on nontarget invertebrates were evaluated on prairie dog colonies. Immediate impacts indicated zinc phosphide reduced ants, strychnine alone reduced wolf spiders, and prebaited strychnine had no impact. Long-term changes showed increases in wolf spiders and ground beetles, and densities were contributed to biotic and abiotic habitat alterations due to lack of prairie activities. Among comparisons for efficacy, zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment; long-term impacts for insects in general were minimal.

362. **Denison, Steve A.; Messner, Harold E. 1983. Control of line expansion in drip irrigation systems. Research Note RM-427. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.**

Water can be used more efficiently by modifying a trickle drip irrigation system. Modification include the use of a spring to control line movement caused by expansion and contraction.

363. **Dennis, G. L.; Fresquez, Philip R.; Johnson, Gordon V. 1987. Iron uptake by native grasses in an organically amended semi-arid grassland.** *In:* **Iron nutrition and interactions in plants: 4th international symposium; 1987 July 6-9; Albuquerque, NM. Albuqeurque, NM: University of New Mexico. (Abstract).**

364. **Dennis, G. L.; Fresquez, Philip R.; Johnson, Gordon V. 1988. Iron uptake by native grasses in a sewage sludge amended semiarid grassland. Journal of Plant Nutrition. 11(6-11): 1417-1427.**

In June 1985, a degraded semiarid grassland site was amended with surface applications of dried, anerobically digested sludge at rates of 22.5, 45, and 90 mg/ha. While DTPQ extractable soil Fe increased, tissue concentrations of Fe in the three predominant native grasses tested declined significantly ($p < 0.05$) with increasing sludge applications. However, plants in amended plots did not become Fe deficient, but rather flourished relative to controls. The greater production of aboveground biomass on amended plots compared to unamended plots suggested the possibility of a dilution effect.

365. **Dennis, G. L.; Fresquez, Philip R. 1989. The soil microbial community in a sewage-sludge-amended semi-arid grassland. Biology and Fertility of Soils. 7: 310-317.**

The value of sewage sludge for improving the fertility and productivity of a degraded semi-arid grassland soil was tested by quantifying and describing the effects of surface application of sewage sludge on soil chemical properties and the soil microbial community.

366. **Dent, J. D.; Lang, Theodore E. 1983. A biviscous modified bingham model of snow avalanche motion.** *In:* **Proceedings of the second symposium on applied glaciology; 1982 August 23-27; Hanover, NH. Annals of Glaciology. Cambridge, England: International Glaciological Society; 4: 42-46.**

367. **Dent, J. D.; Lang, Theodore E. 1980. Modeling of snow flow. Journal of Glaciology. 26(94): 131-140.**

368. **Develice, Robert L.; Ludwig, John A.; Moir, William H.; Ronco, Frank Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. General Technical Report RM-131. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 59 p.**

Forest habitat types in the mountains of northern New Mexico and southern Colorado were identified and described to develop an ecosystem classification. The final vegetation classification is based on 618 sample plots. A total of 8 climax series, 44 habitat types, and 12 phases of habitat types are defined. Keys and descriptions for each habitat type are provided. Soils and vegetation relationships, successional trends, management implications, tree productivity from the index, and relationships to other habitat type investigations in the Rocky Mountains are discussed.

369. **Dickinson, Tony G.; Garner, G. W.; Wampler, G.; Simpson, C. David. 1980. Mortality of desert mule deer fawns.** *In:* **Proceedings of the 60th annual conference of western association of fish and wildlife agencies; 1980 July 13-17; Kalispell, MT. 581-592.**

370. **Dickinson, Tony G.; Simpson, C. David. 1980. Dispersal and establishment of barbary sheep in southeast New Mexico.** *In:* **Simpson, C. David, editor. Proceedings of the symposium on ecology and management of barbary sheep; 1979 November 19-21; Texas Tech University, Lubbock, TX. Lubbock, TX: Department of Range and Wildlife Management, Texas Tech University: 33-45. 112 p.**

Periodic escapes of barbary sheep (*Ammotragus leruia*), from a ranch in the Hondo Valley of southeastern New Mexico, over the past 36 years, have resulted in a wild breeding population extending 198 km southward, into the Guadalupe Mountains National Park, Texas. Intensive surveys in southwestern New Mexico, from June 1978 through August 1979, document dispersal and establishment of these sheep.

371. **Dickinson, Tony G.; Simpson, C. David. 1980. Home range movements and topographic selection of barbary sheep in the Guadalupe Mountains, New Mexico. *In:* Simpson, C. David, editor. Proceedings of the symposium on ecology and management of barbary sheep; 1979 November 19-21; Texas Tech University, Lubbock, TX. Lubbock, TX: Department of Range and Wildlife Management, Texas Tech University: 78-86. 112 p.**

Home ranges of radio instrumented, barbary sheep, in the Three-Forks area of the Guadalupe Mountains, New Mexico, varied in size seasonally, but the center of activity remained the same throughout the study. Annual home range of marked rams (average 1,547.4 ha) was twice that of a marked ewe (764 ha).

372. **Dieterich, John H. 1980. Chimney Spring forest fire history. Research Paper RM-220. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.**

Analysis of data from seven specimens revealed a composite fire interval, in ponderosa pine, of 2.4 years, from 1745 to 1876 (122 years), a shorter interval than previously reported. In all cases, composite fire intervals were shorter than individual specimen intervals.

373. **Dieterich, John H. 1980. The composite fire interval—a tool for more accurate interpretation of fire history. *In:* Proceedings of the fire history workshop; 1980 October 20-24; Tucson, AZ. General Technical Report RM-81. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 8-14. 142 p.**

Use of the composite fire interval (CFI) as a means of expressing historical fire frequency for a particular area is discussed. Four examples are presented that summarize historical fire intervals on areas ranging in size from 100 to several thousand acres.

374. **Dieterich, John H. 1983. Fire history in southwestern mixed conifer: a case study. Forest Ecology and Management. 6: 13-31.**

Before 1900, fires burned through a mixed conifer stand in the south fork of Thomas Creek, in the White Mountains of Arizona, at an interval of 22 years. Small fires burned on the area at more frequent intervals. In the absence of these periodic fires, species diversity remains high, but stand composition and structure appears to be changing.

375. **Dieterich, John H.; Swetnam, Thomas W. 1984. Dendrochronology of a fire-scarred ponderosa pine. Forest Science. 30(1): 238-247.**

Historical fire frequency in a stand of southwestern ponderosa pine has been documented in a master fire chronology developed for a prescribed burning study area in Arizona. One of the 12 specimens used to assemble this chronology was a small, suppressed tree that contained 42 fire scars. Mean fire interval for the study area was about 2 years, mean fire interval for the individual specimen was 4 years for the 178-year period, 1722-1900.

376. **Dietrich, David L.; Marlatt, William E.; Fox, Douglas G. 1980. Particle production from surface mining: part 2 - surface particulate and meteorological measurements. *In:* Proceedings of the fourth symposium on fugitive emissions: measurement and control; 1980 May; New Orleans, LA. EPA-600 9-80-041. Washington, DC: U.S. Environmental Protection Agency: 64-80.**

377. **Dietz, Donald R.; Uresk, Daniel W.; Messner, Harold E.; McEwen, Lowell C. 1980. Establishment, survival, and growth of selected browse species in a ponderosa pine forest. Research Paper RM-219. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.**

Information is presented on establishment, survival, and growth of seven selected browse species, in a ponderosa pine forest, over a 10-year period. Methods of establishment included hand seeding and planting bare-root and containerized stock. Succcess of different methods differed with shrub species.

378. **Dix, Mary Ellen. 1989. Can attractants be used to manage insect pests of windbreak trees? *In:* 1988 Society of American Foresters convention; 1988 October 16-19; Rochester, NY. SAF 88-01. Bethesda, MD: Society of American Foresters. 424 p.**

379. **Dix, Mary Ellen. 1985. Effectivenss of carbaryl and acephate in reducing damage by *Petrova metallica* (Busck) (Lepodoptera: Tortricidae) in ponderosa pine windbreaks. Research Note RM-458. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.**

One late spring application of carbaryl, applied immediately after the end of moth flight, reduced the proportion of branches of ponderosa pine infested by

Petrova metallica (Busck) in two of the four test years. One application of acephate did not reduce infestation levels.

380. **Dix, Mary Ellen. 1987. Insect research in Great Plains windbreaks. *In:* Kossuth, Susan V.; Pywell, Nancy A., compilers. Current topics in forest research: emphasis on contributions by women scientists: proceedings of a national symposium; 1986 November 4-6; Gainesville, FL. General Technical Report SE-46. Asheville, NC: Southeastern Forest Experiment Station: 155-162.**

Windbreaks are planted in the Great Plains to protect soil from wind and water erosion, to protect crops and livestock, to beautify and conserve energy on rural farmsteads, and to improve wildlife habitat. Although over 200 species of insects can damage trees in windbreaks, only a few species damage trees severely and adversely affect windbreak function. This review of forest entomology research in the Great Plains includes recent research accomplishments of the USDA Forest Service for several of the more destructive insect species.

381. **Dix, Mary Ellen. 1986. Lilac seed, an alternate host for the ash seed weevil, *Lignyodes bischoffi* (Blatchley) (Coleoptera: Curculionidae). Journal of the Kansas Entomological Society. 59(2): 389-390.**

Lignyodes bischoffi (Blatchley), a weevil that severely damages ash seed in the northern Great Plains, was found in seed capsules of lilac collected in a seed production area in North Dakota. Adults emerged during July and early August and laid their eggs in the seed during August. Larvae fed on the endosperm within the seeds for 21 • 1.1 days, left the seeds during September, and overwintered in the soil. Pupation occurred in the soil the following spring.

382. **Dix, Mary Ellen; Cunningham, Richard A. 1984. Development of insect resistance through tree improvement work. *In:* Tree improvement in the Great Plains. Proceedings of the 36th annual meeting of the forestry committee; 1984 June 26-28; Watertown, SD. Great Plains Agricultural Council Publication 112. Lincoln, NE: University of Nebraska: 121-127. 230 p.**

The development of insect-resistant cultivars requires considerable time and research effort. Because most research projects involving insect resistance in the Great Plains are still in their early stages, it will be several years before insect resistant planting stock is available on a large scale.

383. **Dix, Mary Ellen; Doolittle, Robert E. 1985. *Acossus centerensis* (Lintner) (Lepidoptera: Cossidae): response to attractant dispenser and trap height, and determination of seasonal flight. Journal of Economic Entomology. 78(4): 802-805.**

Conrel hollow polymeric fibers with emission rates of 9 ug and 36 ug of (e,e)-3,5-tetradecadienyl acetate per day attracted significantly more male *A. centerensis* (Lintner) than did rubber septum or cotton wick dispensers baited with 500 ug of ee-tdda. Although the number of males attracted increased with the emission rate, Conrel dispensers emitting 54 ug ee-tdaa/day were not significantly more effective than those with an emission rate of 9 ug/day. Catch increased linearly with trap height. The flight of *A. centerensis*, which lasted 60 to 80 days, peaked twice.

384. **Dix, Mary Ellen; Doolittle, Robert E. 1984. Evaluation of attractant traps used for capturing male cossids. Journal of Georgia Entomological Society. 19(4): 440-445.**

The number of male carpenterworm moths caught in cylinder-platform, cylinder, cone, diamond-carton, and pherocon R1C type traps did not differ significantly. The diamond-carton trap design is less expensive, easier to construct, store, and transport, and has more surface area available for trapping males than the cylinder and cylinder-platform traps. The pherocon R1C and cylinder traps caught more moths than the carton designs and caught significantly more *A. centerensis* per cm^2 of trapping surface.

385. **Dix, Mary Ellen; Franklin, Robert T. 1983. Behavior of four braconid parasites and one pteromalid parasite of the southern pine beetle. Journal of Georgia Entomology Society. 18(1): 126-138.**

Studies were conducted in pure stands of shortleaf pine and in mixed stands of shortleaf and loblolly pine in Clarke County, Georgia. The number of *Heydenia unova* C. D., *Spathius pallidus* Ashm., *Dendrosoter sulcatus* Mues., *Meteorus hypophlaei* Cush., and *Coeloides pissodis* Ashm., arriving at southern pine beetle-infested trees fluctuated with period and year. Female activity of all the parasites was both diurnal and nocturnal.

386. **Dix, Mary Ellen; Franklin, Robert T. 1981. Observations on the behavior of the southern pine beetle parasite *Roptrocerus eccoptogastri* Ratz. (Hymenoptera: Torymidae). Journal of the Georgia Entomological Society. 16(2): 239-248.**

The number of *Roptrocerus eccoptogastri* arriving on infested shortleaf pine fluctuated with the period and

year. Parasite females peak 19 days after the initial attack by the southern pine beetle. Male and female activity was diurnal.

387. **Dix, Mary Ellen; Jacobson, Martin. 1987. Trap preferences of *Retinia metallica* and seasonal flight behavior of *Retinia* spp. *Rhyacionia* spp. (Tortricidae), and *Chionodes* spp. (Gelechiidae) in the Dakotas. Journal of Lepidopterists' Society. 40(4): 298-303.**

At high population levels, white and green traps baited with (Z)-7-dodecenyl acetate caught more retinia metallica than blue traps. Diamond-shaped traps were more effective than cup traps, but did not differ significantly in effectiveness from triangular-shaped traps. *Rhyacionia fumosana* and *R. neomexicana* responded throughout may to synthetically-baited traps. *Rhyacionia budhnrlli* and *Retinia metallica* flew in late May or early June.

388. **Dix, Mary Ellen; Jennings, Daniel T. 1982. *Rhyacionia bushnelli* (Lepidoptera:Tortricidae) damaged tips within ponderosa pine: distribution and sampling universe. Canadian Entomologist. 114: 403-409.**

Within-tree distribution of western pine tip moth infested tips generally decreased with increasing tree height and varied with whorl number and seed source in an 8-year-old Nebraska planting of ponderosa pine. Eastern Plains sources were taller and had fewer infestations than sources from other geographic regions.

389. **Dix, Mary Ellen; Leatherman, David A. 1988. Insect management in windbreaks. Agriculture, Ecosystems and Environment. 22/23: 513-537.**

This chapter discusses types of insect damage to trees and shrubs in windbreaks, their importance, and common methods used to detect, evaluate, and reduce infestation and damage levels. Impact of windbreaks on distribution and abundance of insects associated with agricultural crops surrounding a windbreak is discussed.

390. **Dix, Mary Ellen; Lessard, Gene. 1987. Egg mass survey for jack pine budworm *Choristoneura pinus* Freeman, in the Nebraska National Forest. Biological evaluation R2-87-02. Denver, CO: U.S. Department of Agriculture, Forest Service, Forest Pest Management. 12 p.**

391. **Dix, Mary Ellen; Pasek, Judith E.; Harrell, Mark O.; Baxendale, Frederick P. 1986. Common insect pests of trees in the Great Plains. Great Plains Agricultural Council Publication No. 119. Lincoln, NE: University of Nebraska, Nebraska Cooperative Extension Service EC 86-1548. 44 p.**

Insect pests of hardwoods and conifers are arranged according to damage category. Hardwood trees annually shed their leaves in the fall; conifer trees annually shed only oldest needles and retain the current year's needles. Defoliators feed on the leaves and needles. Borers mine buds, sapwood, and inner bark (between sapwood and the bark). Sapfeeding insects extract sap from leaves, needles, branches and trunks. Feeding by gall insects causes leaves, buds, and branches to grow abnormally.

392. **Dix, Mary Ellen; Richmond, Charles E.; Van Deusen, James L. 1981. Acephate residues in second-year cones of *Pinus sylvestris* L. sprayed to prevent damage by *Dioryctria disclusa* Heinrich. Research Note RM-403. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Residue analysis of homogenized cones and wash indicated that acephate (orthene 75S) and methamidophos were present in or on the cones for 10-15 days after spraying with acephate. Spray rates were 2 pounds per 100 gallons (2.36 g/l) and 4 pounds per 100 gallons (4.73 g/l) of water.

393. **Dix, Mary Ellen; Solomon, J. D.; Doolittle, Robert E. 1987. Attraction of male *Prionoxystus robinaiae* (Lepidoptera:Cossidae) to (Z,E)-3,5-tetradecadienyl acetate with different dispensers and trap designs. Journal of Economic Entomology. 80: 708-711.**

Traps with wick dispensers treated with (Z,E)-3,5-tetradecadienyl acetate initially caught significantly more adult male carpenterworms, *Prionoxystus robiniae* than traps with septum dispensers. However, septum dispensers attracted males for at least 1.5-fold longer than did wick dispensers, or for the duration of the carpenterworm flight. Catches of male *P. robiniae* in paper-cylinder, metal-cylinder, or diamond-carton traps were similar. Paper-cylinder traps have the advantage of being inexpensive, easy to construct, convenient to store, and less sticky to handle.

394. **Dix, Mary Ellen; Solomon, J. D.; Doolittle, Robert E. 1984. Effectiveness of hollow fiber as dispensers of synthetic sex attractant for male carpenterworms (Lepidoptera: Cossidae). Environmental Entomology. 13(3): 737-740.**

Traps baited with conrel hollow-fiber dispensers charged with (Z,E)-3,5-tetradecadienyl acetate caught male prionoxystus robiniae (Lepidoptera: Cossidae). Traps baited with 20-mil fiber dispensers, although they caught equivalent numbers of males as traps baited with cotton wick dispensers, were more effective for longer periods of time. Traps baited with conrel fibers charged separately with the ZE-and EE-isomers of 3,5-tetradecadienyl acetate, and released in concert, caught significantly more males than traps baited with fiber dispensers emitting the Z,E-isomer alone. The addition of the antioxidants bha/bht to the attractant did not significantly increase trap catches.

395. **Dix, Mary Ellen; Tagestad, Arden D.; Stein, John D.; Jacobson, Martin. 1984. Detecting tip mining Olethreutinae (Tortricidae) moths in the northern and central Great Plains with synthetic attractants. Research Note RM-445. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Fifteen sites in eight north-central states were surveyed for male olethreutinae with traps containing synthetic attractants. Six *Rhyacionia* spp., 2 *Petrova* spp., 13 other Torticidae, 4 Noctuidae, 1 Pyralidae, and 1 Gelechiidae were captured. No species was caught at every site within its range. The flight periods of the moths are described.

396. **Dix, Mary Ellen; Underhill, E. W. 1988. Sex pheromone of *Retinia metallica* (Busck) (Lepidoptera: Tortricidae): identification and field studies. Canadian Entomologist. 120: 721-726.**

A major sex pheromone component from female retinia metallica as isolated following gas chromatographic (GC) separation and identified as Z7,E9-dodecadienyl acetate (Z7,E9-12:AC) by a combination of electroantennographic, GC, and mass spectrometric analyses. In field tests, conspecific males were strongly attracted to lures baited with Z7,E9-12:AC.

397. **Dix, Mary Ellen; Van Deusen, James L. 1983. Carbofuran applications fail to reduce damage to seeds and cones of Scotch pine in North Dakota and Nebraska. Research Note RM-430. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Treating infested Scotch pine trees with 113 g, 227 g, 340 g of 10 percent carbofuran granules per 2.54 cm d.b.h. did not reduce the number of Scotch pine cones damaged by *Diorcyctria* spp. in North Dakota or Nebraska. The number of seeds damaged by *Leptoglossus occidentalis* in Nebraska appeared to decrease with increasing carbofuran concentration.

398. **Dixon, Gary E. 1982. Multiresource inventories: meeting challenging new information needs. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 383-388. 1101 p.**

Multiresource inventory questions discussed include map versus sample based inventories, separate inventories for each resource, level of aggregation, sample design, choice of sample units, sample unit design, sample size, assessment of resource interrelationships, and improvements to single resource procedures.

399. **Doerr, Ted B.; Guthery, Fred S. 1980. Effects of shinnery oak control on lesser prairie chicken habitat. *In:* Vohs, P. A.; Knoff, F. L., editors. Proceedings of the prairie grouse symposium; 1980 September 17-18; Stillwater, OK. Stillwater, OK: Oklahoma State University: 59-63.**

400. **Donnelly, Dennis M. 1980. Research: what's new, how to find it, how to use it. *In:* Meeting the challenge of the 80's. Proceedings: Rocky Mountain forest industries conference; 1980 May 7-10; Jackson, WY. 121-170. 170 p.**

Outlines research approaches which nonscientists can use to solve problems in forest products. recent findings in various aspects of forest products research are summarized.

401. **Donnelly, Dennis M. 1986. Stand harvest scheduling using optimal control methods. Fort Collins, CO: Colorado State University. 190 p. Ph.D. dissertation.**

402. **Donnelly, Dennis M.; Betters, David R. 1987. Optimal control for even-aged stand harvest scheduling. *In:* Dress, Peter E.; Field, Richard C., editors. The 1985 symposium on systems analysis in forest resources; 1985 December 9-11; Athens, GA. Athens, GA: Georgia Center for Continuing Education: 273-290.**

Applications of optimal control theory to forestry problems over the last 15 years have largely been theoretical, with few applications showing numerical solutions. Our study explores the feasibility of using

two different techniques to develop numerical solutions and then compares these to the dynamic programming approach. Specifically, the research shows the relationship between techniques and solutions of the linear variational control model and the optimal control model as they apply to timber harvest scheduling.

403. **Donnelly, Dennis M.; Loomis, John B.; Sorg, Cindy F.; Nelson, Louis J. 1985. Net economic value of recreational steelhead fishing in Idaho. Resource Bulletin RM-9. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.**

Average willingness to pay in addition to actual expenditure for steelhead fishing in Idaho was estimated at $27.87 per trip with the travel cost method and at $31.45 per trip with the contingent value method. Willingness to pay was greater for increased catch or fish size. average actual expenditure was $72 per trip.

404. **Donnelly, Dennis M.; Nelson, Louis J. 1986. Net economic value of deer hunting in Idaho. Resource Bulletin RM-13. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 27 p.**

Average net willingness to pay in addition to actual expenditure for deer hunting in Idaho was estimated with the travel cost method at $50.23 per trip and with the revised 1983 contingent value method at $40.09.

405. **Donnelly, Dennis M.; Rosenthal, Donald H. 1987. RMTCM: an interactive computer program for estimating travel cost models. *In:* Wiant, Harry V., Jr.; Yandle, David A.; Kidd, William E., editors. Forestry microcomputer software symposium: proceedings; 1986 June 29-July 2; Morgantown, WV. Morgantown, WV: West Virginia University: 331-347.**

rmtcm is an interactive menu-driven program for performing travel cost analysis. Four main modules—data input, data modification, regression analysis, and report writing—make up the program. Reports display estimated consumer surplus, a graph of demand curve, and information about marginal economic changes. RMTCM is written in FORTRAN-V and runs on an IBM PC or compatible. RMTCM also runs on the large mainframe univac computer at the USDA Fort Collins Computer Center.

406. **Donnelly, Dennis M.; Sorg, Cindy F.; Peterson, George L. 1988. Valuation of wildlife products: an overview with emphasis on wildlife. *In:* Raedeke, Kenneth J., editor. Streamside management: riparian wildlife and forestry interactions. Seattle, WA: University of Washington: 245-257.**

To estimate values associated with wildland products, especially wildlife, questions about value and methods must be applied in the correct context. This paper discusses the concept of value, the necessity to know the nature of the product, good, or service, and describes several methods for valuation.

407. **Donnelly, Dennis M.; Swanson, Cindy Sorg; Peterson, George L. 1988. Wilderness recreation demand and value: State-of-the-art in valuing wildlife species for studies of riparian forest management. *In:* Streamside management symposium; 1988 February; Washington, DC.**

408. **Donnelly, Dennis M.; Worth, Harold E. 1981. Potential for producing ponderosa pine plywood in the Black Hills. Resource Bulletin RM-4. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 43 p.**

This study describes possible plywood production opportunities for Black Hills ponderosa pine in terms of kinds of plywood and advantageous market areas. The resource analysis examines current and future uses of the area's timber. Economic evaluation includes analyses of discounted cash flow and operating costs and revenues.

409. **Donnelly, Dennis M.; Worth, Harold E.; Hasty, Ronald; Aitken, William M.; Morgan, Michelle. 1983. Wood product flows and market structure in the Rocky Mountain states. Resource Bulletin RM-6. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.**

Central and southern Rocky Mountain states have enough harvestable timber to supply their own needs for many lumber classes, and potentially, for products such as plywood and particleboard. However, wood products continue to be imported in large amounts. Market channels, perceived quality differences, and relatively less product variety available locally contribute to this situation.

410. **Doyle, Jack D.; Tunnicliff, Brock; Brickler, Stanley K.; Kramer, Ricky E.; Sinclair, N. A. 1984. Anaerobic incubation of membrane filter cultures for improved detection of fecal coliforms from recreational waters. Applied and Environmental Microbiology. 48(2): 324-326.**

411. **Driscoll, Richard S. 1981. The quest for a uniform classification system for land-use allocation.** *In:* **Land-use allocations: processes, people, politics, professionals. Proceedings of the 1980 convention, Society of American Foresters; 1980 October 7; Spokane, WA. Washington, DC: Society of American Foresters: 179-185.**

412. **Driscoll, Richard S. 1981. Remote sensing: its role in meeting information needs.** *In:* **Proceedings, seventh international symposium on machine processing of remotely sensed data with special emphasis on range, forestry, and wetlands assessment. West Lafayette, IN: Purdue University, Laboratory for Applications of Remote Sensing: 2-6.**

413. **Driscoll, Richard S.; Frayer, Warren E.; Werth, Lee F. 1983. Complexities of remote sensing with sampling for change detection.** *In:* **Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 613-617. 737 p.**

The LANDSAT series provides basic digital data in the form of reflected energy from four discrete wavelength bands: green, red, and two reflected infrared. Sampling designs incorporating remote sensing data have been developed for estimating, for example, land area, land cover change, and timber volume change. A universal kind of remote sensor system and sampling design for change detection and estimation cannot be recommended because of the variety of data and information requirements.

414. **Driscoll, Richard S.; Merkel, Daniel L.; Hagihara, James S.; Radloff, David L. 1983. A component land classification for the United States: status report. Technical Note 360. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 30 p.**

The framework of an ecological land classification system for the United States is described. The system is designed for coordinated land classification within and among land management agencies.

415. **Driscoll, Richard S.; Merkel, Daniel L.; Radloff, David L.; Snyder, Dale E.; Hagihara, James S. 1984. An ecological land classification framework for the United States. Miscellaneous publication 1439. Washington, DC: U.S. Department of Agriculture, Forest Service. 56 p.**

The ecological land classification framework described consists of hierarchical characteristics of vegetation and soil; a method of linking a wetlands and deep water habitat classification system to upland vegetation and soil hierarchies; landform definitions used to describe the setting for the soil, vegetation, and wetlands elements; and procedures for integrating the elements into ecological units.

416. **Driver, B. L. 1989. Applications of leisure survey research.** *In:* **Seminar on information in planning and management of recreation and tourist services; 1989; Australia. Australia: Hunter Valley Research Foundation: 44-45.**

417. **Driver, B. L. 1989. Applied leisure research: Benefits to scientists and practitioners and their respective roles.** *In:* **Jackson, Edgar L.; Burton, Thomas L., compilers, editors. Understanding leisure and recreation: mapping the past, charting the future. College Station, PA: Venture Publishing, Inc. 597-609.**

418. **Driver, B. L. 1984. Benefit and value estimation.** *In:* **Wenger, Karl F., editor. Handbook of forestry. Section 95. Outdoor recreation management. 2nd edition. New York, NY: John Wiley and Sons: 814-815.**

419. **Driver, B. L. 1986. Benefits of river and trail recreation: the limited state of knowledge and why it is limited.** *In:* **Proceedings, 1st international congress on trail and river recreation; Vancouver, British Columbia, Canada. Vancouver, British Columbia, Canada: Recreation Council of British Columbia: 44-58.**

This paper explains why a discussion of the benefits of the recreational use of trails and rivers is essentially a discussion of the benefits of outdoor recreation. Explanations are given why relatively little research has been done on recreation benefits defined as improved conditions of individuals or groups of such. The state of knowledge about the personal, social, economic, and environmental benefits is described, and additional research is proposed.

420. **Driver, B. L. 1980. Outdoor recreation, a developing profession. *In:* Proceedings: trails and rivers symposium; 1979 November 7-8; Laramie, WY. 30-33.**

Outdoor recreation resource management has become much more sophisticated over the past 10-15 years. Emergence of the recreation profession is discussed from eight related perspectives.

421. **Driver, B. L. 1984. Public responses to user fees at public recreation areas. *In:* Proceedings, 1984 conference on fees for outdoor recreation on lands open to the public; 1984 January 12-13; Durham, NH. Gorham, NH: Appalachian Mountain Club: 45-48.**

422. **Driver, B. L. 1984. Recreation on public lands: should the user pay? American Forests. 90(3): 11, 51-53.**

Recreation user fees have been considered from different perspectives over two decades. During that time demands for, and costs of providing, outdoor recreation (or) opportunities have grown rapidly, as have demands for alternative uses of public resources. Several surveys show that most people agree increases in fees are needed to help offset the costs of providing recreation opportunities.

423. **Driver, B. L. 1989. The ROS as a planning and management system. *In:* Management Workshop, Great Barrier Reef Marine Parks Authority; 1989; Townsville, Australia/Queensland.**

424. **Driver, B. L. 1985. Specifying what is produced by management of wildlife by public agencies. Journal of Leisure Sciences. 7(3): 281-295.**

The need for better specification of the goods and services (immediate outputs) produced by public wildlife management is explained. An approach for such product differentiation is proposed, and examples of its use are highlighted.

425. **Driver, B. L. 1989. What are they, how big are they, and what are they worth: Some ideas on recreation benefits. *In:* 1988 Southeastern recreation research conference; 1988; Athens, GA. Fort Collins, CO: Institute for Behavioral Research; 10: 7-20.**

426. **Driver, B. L. 1988. You can go home again. *In:* Dustin, Daniel L., compiler, editor. Wilderness in America: personal perspectives. San Diego, CA: Institute for Leisure Behavior San Diego University; 55-63.**

427. **Driver, B. L.; Bossi, James E.; Cordell, H. Ken. 1985. Trends in user fees at federal outdoor recreation areas. *In:* Proceedings, 1985 outdoor recreation trends symposium 2; 1985 February 25-27; Myrtle Beach, SC. Atlanta, GA: Southeastern Forest Experiment Station, Forestry Sciences Laboratory; and Department of Interior, National Park Service, Southeast Regional Office: 222-242.**

428. **Driver, B. L.; Brown, Thomas C.; Burch, William R., Jr. 1987. A call for more comprehensive and integrated evaluations of public amenity goods and services. *In:* 18th IUFRO world congress, project 4.08; 1986 September 7-21; Ljubljana, Yugoslavia. Corvallis, OR: Department of Resource Recreation Management, Oregon State University: 204-216.**

This paper reviews several aspects of the evaluations being used to guide allocations of public amenity resources and offers a rationale for a more comprehensive approach—one that recognizes the need for measures of the personal and social consequences of alternative resource allocations to complement and supplement results of economic efficiency analyses. Needed research is described.

429. **Driver, B. L.; Brown, Perry J. 1983. Contributions of behavioral scientists to recreation resource management. *In:* Altman, Irwin; Wohlwill, Joachim F., editors. Behavior and the natural environment. New York, NY: Plenum Press; 6: 307-339. 346 p.**

This chapter focuses on policy and management problems related to outdoor recreation that are faced by federal agencies; but the problems faced by other public, or even private, outdoor recreation agencies are similar. Outdoor recreation policy decisions, therefore, are made at all levels of a recreation agency, while management decisions are made only at those levels that actually 'manipulate' the environment to provide recreation opportunities.

430. **Driver, B. L.; Brown, Perry J. 1986. Probable personal benefits of outdoor recreation. *In:* Driver, B. L.; Peterson, George L., compilers, editors. A literature review, the President's Commission on Americans Outdoors. Washington, DC: U.S. Government Printing Office: 63-70.**

This paper describes the state of the art for measuring the benefits individuals realize from using outdoor recreation opportunities. It points out that extremely few studies have attempted to quantify desirable changes in human behavior as measures of the benefits of recreation participation. Instead, most studies have relied on introspective appraisals by

recreationists of the types of benefits they perceive they derive or of the type of experiences those users desire and expect to realize from use of particular types of recreation opportunities.

431. **Driver, B. L.; Brown, Perry J.; Stankey, George H.; Gregoire, Timothy G. 1987. The ROS planning system: evolution, basic concepts, and research needed. Leisure Sciences. 9(3): 201-212.**

This paper describes the evolution of the concept of the recreation opportunity spectrum (ROS)—a largely resource-based approach to providing recreational diversity. It explains the needs of the U.S. Department of Agriculture, Forest Service and USDI Bureau of Land Management for a recreation resource planning system and relates those needs to the development of the ROS system to guide recreation planning of large areas. The basic concepts and tenets of the ROS system are explained and needed research is outlined.

432. **Driver, B. L.; Burch, William R., Jr. 1988. A framework for more comprehensive valuations of public amenity goods and services. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 31-45.**

This paper reviews the need for multiple approaches/methods valuing publicly provided amenity goods and services, of which the benefit-cost paradigm is only one. Variables that need to be considered in the valuations are defined and their relevance to valuation described. A comprehensive valuation paradigm is presented. Emphasis is placed on the need to define, and measure the magnitude of, the gains and losses associated with an amenity resource allocation. It is shown how those measures could improve the economic measures used in benefit-cost analysis. Needed research is reviewed.

433. **Driver, B. L.; Cooksey, R. W. 1980. Preferred psychological outcomes of recreational fishing. *In:* Catch-and-release fishing as a management tool: a national sport fishing symposium; September 1977 7-8; Arcata, CA. Arcata, CA: Humboldt State University: 27-10.**

Studies in Pennsylvania and Michigan found considerable homogeneity in the preferences of three samples of fishermen; even across the two study locations, subgroups of fishermen having different psychologically defined preferences were identified using marker segmentation, 0-typing techniques. Implications for fisheries management are discussed.

434. **Driver, B. L.; Harris, Charles C. 1981. Improving measurement of the benefits of public outdoor recreation programs. *In:* Division 4. 17th IUFRO world congress; 1981 September 6-12; Kyoto, Japan. Schonbrunn-Tirolergarten, A-1131, Vienna, Austria: IUFRO Secretariat: 525-537. 578 p.**

Includes discussion of problems in identifying and quantifying benefits of public outdoor recreation programs. Suggestions are made for improving economic evaluations of recreation benefits and for greater interdisciplinary work by behavioral economists and other researchers.

435. **Driver, B. L.; Johnson, Lynn A. 1983. A pilot study of the perceived long-term benefits of the youth conservation corps. The Journal of Environmental Education. 15(2): 3-11.**

In this study, 600 enrollees and 600 parents of enrollees in the 1972-1975 program were surveyed to define possible long-term benefits of the program to enrollees.

436. **Driver, B. L.; Knopf, Richard C. 1981. Some thoughts on the quality of outdoor recreation research and other constraints on its application. *In:* Proceedings of the conference on social research in national parks and wildland areas; 1980 March 21-22; Great Smoky Mountains National Park, Gatlingburg, TN. Atlanta, GA: U.S. Department of the Interior, National Park Service: 85-98. 133 p.**

This paper offers a commentary on why outdoor recreation managers do not use more of the available research results and why researchers are not working harder to get additional research applied. Considerable attention will be devoted to evaluating the quality of past outdoor recreation research, especially that having a social-behavioral orientation.

437. **Driver, B. L.; Koch, Niels. 1981. Conditions which nurture the application of forest recreation research results. *In:* Division. 6. 17th International Union of Forest Research Organizations, world congress; 1981 September 6-12; Kyoto, Japan. Vienna, Austria: IUFRO Secretariat: 97-105. 504 p.**

Describes conditions which can help assure, but are not always necessary for, the early and effective transfer of forest recreation research results into managerial application.

438. **Driver, B. L.; Koch, Niels. 1986. Cross-cultural trends in user fees charged at national outdoor recreation areas.** *In:* **18th IUFRO World Congress, Division 6; 1986 September 7-21; Ljubljana, Yugoslavia. Corvallis, OR: Department of Resource Recreation Management, Oregon State University: 370-385.**

Paper describes nine rationales that have been used in 11 different countries to support user fees for publicly provided outdoor recreation opportunities and 11 rationales opposing fees. Trends in legislative authorities for national agencies to levy fees, changes in rationales used to promote and oppose fees, and actual changes in outdoor recreation fees charged by national agencies are discussed. Speculation is made about likely future cross-cultural trends in fees.

439. **Driver, B. L.; Krumpe, Edwin E.; Paradice, W. E. J. 1988. Predicting leisure choice behavior.** *In:* **Bicentennial conference; 1988; Dickson A.C.T., Australia. 59-1 to 59-6.**

440. **Driver, B. L.; Nash, Roderick; Haas, Glenn E. 1987. Wilderness benefits: a state-of-knowledge review.** *In:* **National wilderness research conference. General Technical Report INT-220. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 294-319. 369 p.**

Describes need for more objective information on wilderness benefits, especially as a base for formulating a sounder wilderness philosophy. Drawing on knowledge from the scientific and nonscientific literature on wilderness benefits, a taxonomy is presented that classifies benefits as personal, social, and intrinsic.

441. **Driver, B. L.; Peterson, George L. 1986. The values and benefits of outdoor recreation: an integrating overview.** *In:* **Driver, B. L.; Peterson, George L., compilers, editors. A literature review: the President's Commission on Americans Outdoors. Washington, DC: U.S. Government Printing Office: 1-9.**

The paper describes the context within which the 10 literature synthesis papers on outdoor recreation benefits were written. Differences between economic and noneconomic measures of benefits are described, as are the users of the results of these two types of measures. The general content of each of the 10 papers is summarized, and some general conclusions are drawn.

442. **Driver, B. L.; Peterson, George L. 1986. Values of benefits.** *In:* **Driver, B. L.; Peterson, George L., compilers, editors. A literature review: the President's Commission on Americans Outdoors. Washington, DC: U.S. Government Printing Office: 1-113.**

443. **Driver, B. L.; Phillips, Clynn; Bergersen, Eric P.; Harris, Charles C. 1984. Using angler preference data in defining types of sport fisheries to manage. Transactions of the North American Wildlife and Natural Resources Conference. 49: 82-90.**

This paper describes how results of two studies of angler preferences helped improve classifications of sport fisheries in Wyoming and Colorado. The research was done at the request of managers in these states, who needed better angler demand data for fishery management planning. Both studies were conducted in close cooperation with those managers.

444. **Driver, B. L.; Rosenthal, Donald H. 1982. Measuring and improving the effectiveness of public outdoor recreation programs. Report of the workshop on recreation output measures; 1979 December 11-14; Harpers Ferry, WV. Washington, DC: Department of Human Kinetics and Leisure Studies, George Washington University. 40 p.**

The general conclusion of the workshop is that, even though more research is needed, evaluations of federal outdoor recreation programs—and actual program effectiveness—can be improved immediately if the recommendations outlined in this report are implemented, which they can be at relatively low costs.

445. **Driver, B. L.; Rosenthal, Donald H.; Peterson, George L. 1980. Social benefits of urban forests and green spaces in cities.** *In:* **Proceedings of the national urban forestry conference; November 13-16, 1978; Washington, DC. ESF Publication 80-003. Syracuse, NY: State University of New York: 98-113. 874 p.**

Results of selected empirical studies of the social benefits of urban forests are interpreted. Economic, physiological, and perceived benefits are discussed with respect to their diversity and magnitude. Values of urban forests as a means of coping temporarily with undesirable urban conditions are emphasized. Suggestions are offered for managers of urban forests and for additional research.

446. Duckstein, Lucien; Pekka, Jorhonen; Tecle, Aregai. 1989. Multiobjective forest management: a visual, interactive and fuzzy approach. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 68-74. 278 p.

447. Dwyer, John F.; Peterson, George L.; Darragh, Alexander J. 1983. Estimating the value of urban forests using the travel cost method. Journal of Arboriculture. 9(7): 182-185.

Municipal urban forestry programs are guided by the values that urbanites place on urban trees and forests. This information can provide guidance for urban forest resource management programs that are short of funds.

448. Dyer, A. Allen; Hof, John G.; Kelly, John W.; Alward, Gregory S.; Crin, S. A. 1983. Implications of goal programming in forest resource allocation: a reply. Forest Science. 29(4): 837-840.

E

449. Eakle, Wade L.; Grubb, Teryl G. 1986. Prey remains from golden eagle nests in central Arizona. Western Birds. 17: 87-89.

This note documents the first recorded collection of prey remains from golden eagle *(Aquila chrysaetos)* nests in central Arizona.

450. Eakle, Wade L.; Mannan, R. William; Grubb, Teryl G. 1989. Identification of individual breeding bald eagles by voice analysis. Journal of Wildlife Management. 53(2): 450-455.

451. Eav, Bov B.; Johnson, R. Roy; Shaw, Charles G., III; Stage, Albert R. 1989. Integrating pest impact information in the next planning cycle: implementation plan. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Pest Management, Methods Application Group. 21 p.

452. Eav, Bov B.; Marsden, Michael A. 1988. Pest models for the inland mountain West. *In:* Schmitt, Wyman C., editor. Future forests of the mountain west: a stand culture symposium; 1986 September 29-October 3; Missoula, MT. General Technical Report INT-143. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 143 p.

453. Eav, Bov B.; Shaw, Charles G., III. 1987. The western root disease model: A status report. *In:* The 35th annual western forest disease work conference; 1987 August 18-21; Nanaimo, BC. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 84-92.

454. Ecoregion, land-surface form, and hydrologic unit maps of the United States. 1982. Bailey, Robert G.; Cushwa, Charles T. [Maps]. Leetown, WV: U.S. Department of the Interior, Fish and Wildlife Service, Eastern Energy and Land Use Team. 1: 5,000,000; 3 sheets.

455. Ecoregions of North America. 1981. Bailey, Robert G.; Cushwa, Charles T. [Map]. Leetown, WV: U.S. Department of the Interior, Fish and Wildlife Service, Eastern Energy and Land Use Team. 1: 12,000,000.

456. Edminster, Carleton B. 1987. Growth and yield of subalpine conifer stands in the central Rocky Mountains. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 33-40. 253 p.

Potential production of managed, even-aged stands of Engelmann spruce-subalpine fir and lodgepole pine is estimated for combinations of stand density, site quality, and rotations using whole stand growth models. Volume production is maximized at relatively high stand densities. Average maximum density curves are developed as a reference level for stocking standards.

457. Edminster, Carleton B. 1988. Stand density and stocking in even-aged ponderosa pine stands. *In:* Baumgartner, David M.; Lotan, James E., editors. Ponderosa pine: the species and its management: symposium proceedings; 1987 September 29-October 1; Spokane, WA. Pullman, WA: Washington State University: 253-260.

This paper is divided into three fairly distinct sections. The first section presents a brief discussion of various relative density measures in the literature and focuses on the standardization of stocking concepts within the Forest Service. The second section describes results from ongoing levels of growing stock studies being conducted. The third section presents a brief comparison of two relative density measures to an absolute measure in predicting average tree and stand growth responses observed from the levels of growing stock studies.

458. Edminster, Carleton B.; Beeson, Robert T.; Metcalf, Gary E. 1980. Volume tables and point-sampling factors for ponderosa pine in the Front Range of Colorado. Research Paper RM-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

Volume tables are presented for total cubic feet, merchantable cubic feet to a 4-inch top, board feet Scribner rule to a 6-inch top, and board feet international 1/4-inch rule to a 6-inch top. Point-sampling factor tables are given for merchantable volumes per square foot of basal area. Tree heights are expressed as total height in feet and merchantable height in numbers of logs.

459. Edminster, Carleton B.; Hawksworth, Frank G. 1985. Modeling growth and yield of southwestern mixed conifer stands including effects of dwarf mistletoe. *In:* Hunt, R. S., compiler. Proceedings, 32nd western international forest disease work conference; 1984 September 25-28; Taos, NM. Victoria, BC: British Columbia Forest Service, Pacific Forest Research Center: 5-11. 37 p.

460. Edminster, Carleton B.; Mowrer, H. Todd. 1985. RMYLD update: new growth and yield relationships. *In:* Van Hooser, Dwane D.; Van Peit, Nicholas, compilers. Growth and yield and other mensurational tricks: a regional technical conference; 1984 November 6-7; Logan, UT. General Technical Report INT-193. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 98 p.

461. Edminster, Carleton B.; Mowrer, H. Todd; Shepperd, Wayne D. 1985. Site index curves for aspen in the central Rocky Mountains. Research Note RM-453. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Site index curves for aspen stands in the central Rocky Mountains were developed from one-time measurements of height and age of dominant trees. These curves are compatible with site tree age data collected in forest inventories. Nonlinear equations, a figure, and two tables for estimating site index or height are presented.

462. Edminster, Carleton B.; Mowrer, H. Todd; Hinds, Thomas E. 1982. Volume tables and point-sampling factors for aspen in Colorado. Research Paper RM-232. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 16 p.

Volume tables present total cubic feet, merchantable cubic feet to a 4-inch top, metric equivalents of cubic volume, and board feet Scribner and international 1/4-inch rules to a 6-inch top. Point sampling factor tables give merchantable volumes per square foot of basal area. Tree heights are expressed as total height and merchantable number of logs.

463. Egan, B. A. [and others]. 1981. Air quality modeling and the clean air act: recommendations to EPA on dispersion modeling for regulatory applications. Boston, MA: American Meteorological Society. 288 p.

464. Eissenstat, David M.; Mitchell, John E. 1983. Effects of seeding grass and clover on growth and water potential of Douglas-fir seedlings. Forest Science. 29: 166-179.

465. Eissenstat, David M.; Mitchell, John E.; Pope, W. W. 1982. Trampling damage by cattle on northern Idaho forest plantations. Journal of Range Management. 35: 715-716.

466. Elkins, Ned Z.; Parker, Lawrence W.; Aldon, Earl F.; Whitford, Walter G. 1984. Responses of soil biota to organic amendments in strip mine spoils in northwestern New Mexico. Journal of Environmental Quality. 13(2): 215-219.

Addition of selectes organic amendments (bark) to mine spoils may be as effective in developing a soil as the more expensive topsoil/mulch procedures currently used in reclamation.

467. **Ellis, David H. 1982. The peregrine falcon in Arizona: habitat utilization and management recommendations. Research Report 1. Oracle, AZ: Institute for Raptor Studies. 24 p.**

468. **Ellis, David H.; DeWeese, R.; Grubb, Teryl G.; Kiff, Lloyd F.; Smith, D. G.; Jarman, W. M. 1989. Pesticide residues in Arizona peregrine falcon eggs and prey. Bulletin of Environmental Contamination and Toxicology. 42: 57-64.**

469. **Erickson, David C.; Gary, Howard L.; Morrison, S. M.; Sanford, Glen. 1982. Pollution indicator bacteria in stream and potable water supply of the Manitou Experimental Forest, Colorado. Research Note RM-415. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Shallow groundwater flow diverted for domestic use indicated low fecal coliform numbers, and no consistent source of warmblooded animal fecal material in stream water. Total coliforms and fecal streptococci were observed frequently and increased temporarily in both stream and domestic water supply after summer rains.

470. **Evison, Boyd; Roussopoulos, Peter J. 1985. What information is needed for wilderness fire management? *In:* Proceedings—symposium and workshop on wilderness fire; 1983 November 15-18; Missoula, MT. General Technical Report INT-182. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 299-301.**

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471. **Fechner, Gilbert H. 1985. Silvical characteristics of blue spruce. General Technical Report RM-117. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 p.**

This report summarizes information on distribution, botanical description, habitat conditions, life history, special uses, and genetics of blue spruce.

472. **Fedkiw, John. 1989. The evolving use and management of the nation's forests, grasslands, croplands, and related resources: a technical document supporting the 1989 U.S. Department of Agriculture, Forest Service RPA assessment. General Technical Report RM-175. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 68 p.**

473. **Fenner, Pattie; Brady, Ward W.; Patton, David R. 1985. Effects of regulated water flows on regeneration of Fremont cottonwood. Journal of Range Management. 38(2): 135-138.**

The effect of dams on downstream river flow and the consequent modification of the riparian habitat was studied along the lower Salt River in central Arizona. Dams were found to change the magnitude of river flows and change the seasonal timing of flows in such a way that the habitat appeared less adapted for regeneration of *Populus fremontii*. Modification of river flow patterns, therefore appears likely to have been a significant factor causing change in vegetation along the Salt River.

474. **Fenner, Pattie; Brady, Ward W.; Patton, David R. 1984. Observations on seeds and seedlings of fremont cottonwood. Desert Plants. 6(1): 55-58.**

The seeds of Fremont cottonwood lose viability within 1 to 5 weeks after dispersal. Moisture stress induced by osmotic solutions stronger than six atmospheres both delayed and reduced total germination. Root growth rates of young seedlings average 6 mm per day. Because of the limited time of seed viability, a suitable substrate for germination must occur at or soon after seed dispersal. Also, moist conditions must persist until seedling roots grow to depths where moisture is more constantly available than near the surface.

475. **Ffolliott, Peter F. 1983. Implications of snag policies on management of southwestern ponderosa pine forests. *In:* Davis, Jerry W.; Goodwin, Gregory A.; Ockenfels, Richard A., technical coordinators. Snag habitat management: proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. General Technical Report RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 28-32. 226 p.**

476. **Ffolliott, Peter F.; Gottfried, Gerald J. 1989. Production and utilization of herbaceous plants in small clearcuts in an Arizona mixed conifer forest. Research Note RM-494. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Small patch clearcutting has been recommended for managing a variety of resources from southwestern mixed conifer forests. In this study, herbage production and utilization were higher in small clearcuts (0.3-1.6 acres) than in adjacent, partially harvested forest stands. Production in the openings ranged from 208 to 355 pounds per acre, while production in the harvested forest ranged from 39 to 92 pounds per acre. Utilization of herbaceous plants was significantly higher in the clearcuts for two of the three measurement dates. Small patch clearcuts should, thus, benefit livestock, deer, and elk.

477. **Ffolliott, Peter F.; Gottfried, Gerald J.; Baker, Malchus B., Jr. 1989. Water yield from forest snowpack management: research findings in Arizona and New Mexico. Water Resources Research. 25(9): 1999-2007.**

Snow falling in high-elevation forests is an important source of water for much of the arid Southwest. A review of snow management research in Arizona and New Mexico over the past 25 years describes some of the possibilities of increasing snowmelt water yields through forest management activities. Studies have been concerned with basic snow hydrology, forest management-snowpack relationships, and techniques for predicting the effects of management on snowpack water yields.

478. **Ffolliott, Peter F.; Halffter, Gonzalo. 1981. Social and environmental consequences of natural resources policies: with special emphasis on biosphere reserves. Proceedings of the international seminar; 1980 April 8-13; Durango, Mexico. General Technical Report RM-88. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 57 p.**

The objective of this seminar was to promote international cooperation among natural resources policy makers, scientists, and educators, within the framework of the international mab program. Papers on a variety of topics relating to natural resources policies formed a basis for formal and informal discussions among the participants. Through these discussions, a dynamic process of communication was begun which, hopefully, will be continued in future meetings.

479. **Ffolliott, Peter F.; Rasmussen, William O.; Gottfried, Gerald J. 1983. Stem characteristic changes affect long-term planning for timber resources utilization. Forest Products Journal. 33(2): 57-60.**

Predicted changes in timber volume suitable for various products, along with growth and yield information, can be used in optimization programs to make long-term timber resource decisions.

480. **Finch, Deborah M. 1984. Aspects of nestling growth in Abert's towhee. The Wilson Bulletin. 96(4): 705-708.**

Mobility in the face of predators and, hence, maturity of locomotory function, may ultimately set the limit to length of the nestling period. Success of Abert's towhee in a difficult environment may be partially explained by its rapid development and short nest period.

481. **Finch, Deborah M. 1987. Bird habitat relationships in riparian communities of southeastern Wyoming. Laramie, WY: University of Wyoming. 162 p. Ph.D. dissertation.**

482. **Finch, Deborah M. 1987. Bird-habitat relationships in subalpine riparian shrublands of the central Rocky Mountains. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 167-172. 253 p.**

Breeding birds were counted in 1982, 1983, and 1984 using the spot-map method on seven 8.1-ha plots in the Medicine Bow National Forest, Wyoming. At elevations of 2,280 to 3,000 m, riparian habitats were structurally simple, dominated by one or more bush willow species. Subalpine riparian avifaunas were depauperate with only four abundant species—song sparrow, white-crowned sparrow, Lincoln's sparrow, and Wilson's warbler. Habitat requirements overlapped among these species but differed significantly from randomly-sampled habitat in the same areas. Results indicated that species preferred densely-foliated ground and shrub layers, and higher effective vegetation height. Factors complicating efforts to characterize bird-habitat relationships are discussed.

483. Finch, Deborah M. 1983. Brood parasitism of the Abert's towhee: timing, frequency, and effects. The Condor. 85(3): 355-359.

The lack of a significant difference between daily mortality rates of nonparsitized nests before and after cowbirds started breeding indicated that the reduced success of late towhee nests was primarily a result of cowbird parasitism. The success of cowbird eggs in towhee nests was also low, suggesting that towhees may not be favorable hosts.

484. Finch, Deborah M. 1987. Guild distributional patterns of breeding riparian birds in the central Rocky Mountains. Abstracts, 57th annual meeting, Cooper Ornithological Society; 1987 June 21-26; Snowbird, UT.

485. Finch, Deborah M. 1988. Habitat use and habitat overlap of riparian birds in three elevational zones. *In:* American Ornithologist's Union; 106th annual meeting; 1988 August 15-18; Fayettevile, AR.

486. Finch, Deborah M. 1989. Habitat use and habitat overlap of riparian birds in three elevational zones. Ecology. 70(4): 866-880.

Patterns of variance in habitat use and habitat overlap were examined in 20 breeding bird species found along a riparian vegational gradient in southeastern Wyoming to test whether habitat use in species differed (1) from availability of random habitat resources, (2) among elevational zones, and (3) between species that inhabited only one zone and species that occupied multiple zones. Principal components analysis was performed on both randomly sampled and territory-centered habitat data to examine the habitat use of each bird species in relation to the random centroid in n-dimensional habitat space.

487. Finch, Deborah M. 1988. Influence of surrounding habitation next-box and reproductive outcome in house wrens and tree swallows. *In:* Wilson Ornithological Society; centennial anniversary meeting; 1988 June 8-12; Philadelphia, PA.

488. Finch, Deborah M. 1982. Interspecific nest use by aridland birds. The Wilson Bulletin. 94(4): 582-584.

The long-lasting nests of many desert birds are suitable for use by unrelated species. Several instances of interspecific confiscation of deserted nests are reported here. Confiscation of nests may be related to time and energy considerations, nest site availability, and/or brood protection.

489. Finch, Deborah M. 1985. Multivariate analysis of early and late nest sites of Abert's towhees. The Southwestern Naturalist. 30(3): 427-432.

Seasonal variation in nest site selection by the Abert's towhee was studied in honey mesquite habitat along the lower Colorado River from March to July, 1981. Although mesquite was a preferred nest shrub species after it leafed out in April, flexibility in nest site choice allowed towhees to initiate reproduction in early March. By breeding earlier than migratory songbirds, multi-brooded Abert's towhees lengthen their breeding season and, thus, increase their chances of nesting successfully.

490. Finch, Deborah M. 1981. Nest predation of Abert towhees by coachwhips and roadrunners. The Condor. 83: 389.

Coachwhips selected larger nestlings first and did not always consume nest contents at once. Predation by snakes may account for some partial nest losses.

491. Finch, Deborah M. 1984. Parental expenditure of time and energy in the Abert's towhee *(Pipilo aberti)*. The Auk. 101: 473-486.

Time-energy budgets of Abert's towhees *(Pipiloaberti)* were determined for different nesting phases. Mean daily energy expenditure (DEE TOT) was at a seasonal minimum of 103.8 kj in incubating females. DEE TOT estimates ranged from 1.6 to 2.32 x basal metabolic rate. Towhees conserved energy by minimizing time spent in costly activities.

492. Finch, Deborah M. 1982. Rejection of cowbird eggs by crissal thrashers. The Auk. 99: 719-724.

Although the 'dwarf' race of the brown-headed cowbird is sympatric with the crissal thrasher in the lower Colorado River Valley, I observed no parasitism in 15 thrasher nests. To determine whether or not the absence of cowbird eggs was caused by egg rejection, I experimentally parasitized nine thrasher nests. Cowbird eggs were ejected by thrashers at all experimental nests. Rejection behavior by the crissal thrasher may either be a preadaptation or an evolved response to repeated cowbird parasitism.

493. Finch, Deborah M. 1989. Relationships of surrounding riparian habitat to nest-box use and reproductive outcome in house wrens. The Condor. 91: 848-859.

Relationships among habitat structure, nest-site selection, and reproductive outcome of house wrens were assessed by establishing three nest-box grids in

riparian woodlands in southeastern Wyoming. Over a 3-year period, 37% of the boxes contained house wren nests, 20% contained unused nests built by male house wrens, and 42% were never used by wrens. Direct discriminant analyses separated three box-use groups and three nesting outcome possibilities along gradients of habitat cover and foliage density.

494. **Finch, Deborah M. 1983. Seasonal variation in nest placement of Abert's towhees. The Condor. 85(1): 111-113.**

Abert's towhees *(Pipilo aberti)* in Arizona orientated early season nests in a nonrandom southeastern direction with respect to the nest tree. Later nests were orientated randomly. Nonrandom orientation of early nests blocked winds and allowed rapid heat gain. Random orientation of late nests may be related to higher air temperature.

495. **Finch, Deborah M. 1986. Similarities in riparian bird communities among elevational zones in southeastern Wyoming. *In:* Proceedings Wyoming 1986 and streamside zone conference; 1986 April 28-30; Casper, WY. Laramie, WY: Wyoming Water Research Center, University of Wyoming: 105-110. 181 p.**

Bird species diversity in Wyoming riparian habitats ranged from 3 bird species and 23 pairs in subalpine habitat to 21 species and 101 pairs in lowland cottonwood habitat. Few subalpine species contained unique avifaunas. similarity in species composition was greatest within elevational zones.

496. **Finch, Deborah M. 1984. Some factors affecting productivity in Abert's towhee. The Wilson Bulletin. 96(4): 701-705.**

This study shows that nesting success is not the only factor influencing productivity in Abert's towhees. Towhees can adjust length of breeding season and rapidity of nest replacement in order to maximize the number of nesting attempts per season. By maximizing the time available for renesting, towhees to some extent can regulate their annual productivity despite low nesting success.

497. **Finch, Deborah M. 1989. Species abundances, guild dominance patterns, and community structure of breeding riparian birds. *In:* Sharitz, R. R.; Gibbons, J. W., editors. Freshwater wetlands and wildlife: perspectives on natural, managed, and degraded ecosystems. CONF-8603101, DOE Symposium Series No. 61. Oakridge, TN: U.S. Department of Energy, Office of Scientific and Technical Information: 629-645.**

Trends in bird species populations, guild structure, and bird communities along a riparian altitudinal cline in the Medicine Bow National Forest of southeastern Wyoming were investigated. Streamside habitats were divided into three elevational zones. Trends in avian numbers were explained by relating guild occupancy patterns to the presence or absence of habitat layers in each elevational zone. Greater habitat stratification in low-elevation cottonwood communities resulted in greater capability to support avian species.

498. **Finch, Deborah M. 1985. A weighted-means ordination of riparian birds in southeastern Wyoming. *In:* Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 495-497. 523 p.**

Variation among habitat associations of 31 riparian bird species in southeastern Wyoming was analyzed using a weighted-means ordination. Three principal components explained 86.7% of the variation among habitat associations of bird species. The components showed high positive loadings for variables associated with canopy, shrub size, and vegetation height.

499. **Finch, Deborah M.; Anderson, Stanley H.; Hubert, Wayne A. 1987. Habitat suitability index models: lark bunting. Biological Report 87(10.137). Fort Collins, CO: USDI Fish And Wildlife Service, National Ecology Center. 16 p. (May 1987).**

This document is part of the Habitat Suitability Index (HSI) Model series which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The habitat use information section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. This information provides the foundation for the HSI Model and may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

500. Finch, Deborah M.; Reynolds, Richard T. 1988. Bird response to understory variation and conifer succession in aspen forests. *In:* Issues and technology in the management of impacted wildlife: proceedings of national symposium; 1987 November 2-4; Colorado Springs, CO. Boulder, CO: Thorne Ecological Institute: 87-96.

This paper describes objectives and study design for the preharvest study phase (1987-1989) and reports 1987 bird-count results for 15 study plots near the Wyoming and Colorado border. Objectives were to detect effects of spatial habitat variation and conifer encroachment on bird communities in uncut, mature aspen stands.

501. Fischhoff, Baruch. 1988. Specifying value measurements. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 107-116.

502. Fiscus, Edwin L.; Klute, Arnold; Kaufmann, Merrill R. 1983. An interpretation of some whole plant water transport phenomena. Plant Physiology. 71: 810-817.

503. Fisher, Ann; McClelland, Gary H.; Schulze, William D. 1988. Measures of willingness to pay versus willingness to accept: evidence, explanations, and potential reconciliation. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 127-134.

504. Fisher, Carla J.; Ziebell, Charles D. 1980. Effects of watershed use on water quality and fisheries in an Arizona mountain lake. Eisenhower Consortium Bulletin 7. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Historical information and analyses of lake bottom sediment suggest watershed use prior to impoundment had a greater influence on water quality in Cooley Lake, Arizona, than does present land use activity. Water quality in the lake is too poor between mid-July and september to support a rainbow trout fishery.

505. Fisher, James T.; Fancher, Gregory A.; Neumann, Robert W. 1987. Germination and field establishment of juniper in the Southwest. *In:* Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 293-299.

506. Fisher, James T.; Fancher, Gregory A.; Neumann, Robert W. 1986. Survival and growth of containerized native juniper *(Juniperus monosperma)* on surface-mined lands in New Mexico. Forest Ecology and Management. 16(291-299).

507. Fisher, James T.; McRae, John B.; Aldon, Earl F. 1983. Methods for establishing containerized native juniper on surface disturbed sites in the Southwest. *In:* Pope, P. E. Proceedings of the third annual better reclamation with trees conference; 1983 June 2-3; Terre Haute, IN. West Lafayette, IN: Department of Forestry and Natural Resources, Purdue University: 76-88.

508. Fisser, Herbert G.; Joyce, Linda A. 1984. *Atriplex*/grass and forb relationships under no grazing and shifting precipitation patterns in north-central Wyoming. *In:* Tiedemann, Arthur R.; McArthur, E. Durant; Stutz, Howard C.; Stevens, Richard; Johnson, Kendall L., editors. Proceedings: symposium on the biology of *Atriplex* and related chenopods; 1983 May 2-6; Provo, UT. General Technical Report INT-172. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 87-96.

509. Fitzhugh, E. Lee; Moir, William H.; Ludwig, John A.; Ronco, Frank Jr. 1987. Forest habitat types in the Apache, Gila, and part of the Cibola National Forests. General Technical Report RM-145. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 116 p.

A habitat type classification is described for forests in the mountains of the Apache, Gila, and Cibola (Magdalena District only) National Forests in Arizona and New Mexico. Using methods modified from those originally developed by Rexford Daubenmire, 7 series, including 40 habitat types and one community type, were identified. Descriptions of the habitat types, management implications, association tables, and a key to the types are presented.

510. **Flather, Curtis H.; Hoekstra, Thomas W. 1989. An analysis of the wildlife and fish situation in the United States: 1989-2040: a technical document supporting the 1989 U.S. Department of Agriculture, Forest Service RPA Assessment. General Technical Report RM-178. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 146 p.**

511. **Flather, Curtis H.; Hoekstra, Thomas W. 1985. Evaluating population-habitat models using ecological theory. Wildlife Society Bulletin. 13: 121-130.**

This paper presents a synthesis of pertinent ecological concepts concerned with understanding distribution and abundance of animals. The described theory is used to evaluate the 'theoretical validity' of the pattern recognition method, which is a technique of potential value in accomplishing assessment objectives. This evaluation is followed by conclusions and recommendations for future research involving the pattern recognition method and wildlife habitat prediction models in general.

512. **Flather, Curtis H.; Hoekstra, Thomas W.; Chalk, David E.; Cost, Noel D.; Rudis, Victor A. 1989. Recent historical and projected regional trends of white-tailed deer and wild turkey in the southern United States. General Technical Report RM-172. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 22 p.**

An analysis of the historical and future status of white-tailed deer and wild turkey populations in the southern United States is presented. Habitat-based models that statistically relate deer and turkey densities to land use and forest cover at the county level are used to evaluate regional impacts from alternative timber management and land use projections.

513. **Flather, Curtis H.; Joyce, Linda A.; King, Rudy M. 1989. Linking multiple resource analyses to land use and timber management: application and error considerations. *In:* State-of-the-art methodology of forest inventory: a symposium proceedings. General Technical Report PNW-263. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station: 478-485.**

514. **Flebbe, Patricia A.; Hoekstra, Thomas W.; Cost, Noel D. 1988. Recent historical and projected regional trends of trout in the southeastern United States. General Technical Report RM-160. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 p.**

The recent history of trout in the southeastern United States is described. A statistical relationship established between current trout density and land use and forest cover in watersheds is the core of a projected tool that evaluates impacts of expected future and alternative timber management on trout for regional and national assessments.

515. **Fletcher, A. M.; Bergman, F.; Tinus, Richard W.; Donaubauer, E.; Schmidt-Vogt, H.; Kaiser, H. Fred. 1988. Evaluation of research in forest regeneration in Finland. Helsinki, Finland: Suomen Akatemian Julkaisuja. 98 p.**

516. **Forbis, Larry A.; Grubb, Teryl G.; Zeedyk, William D. 1985. 'Eagle beagles': a volunteer bald eagle nest watcher program on Arizona National Forests. *In:* Gerrard, Jon M.; Ingram, Terrence N., editors. Proceedings of Bald Eagle Days, 1983: the bald eagle in Canada; 1983 August 18-20; Winnepeg, Manitoba, Canada. P.O. Box 155, Appleriver, IL: Eagle Foundation: 246-254. 272 p.**

The conception, development, and administration of a program using volunteers to study nesting bald eagles in the Southwest is discussed with special emphasis on management and research implications. The nest watch program has greatly facilitated protection and management of the small, unique nesting population of bald eagles in the southwestern United States.

517. **Forero, L.; Rittenhouse, L. R.; Mitchell, John E. 1989. A cow-calf vs. yearling substitution ratio for shortgrass steppe. Journal of Range Management. 42(4): 343-345.**

A preliminary study suggested that steers could be substituted for cow-calf pairs on shortgrass steppe on a weight:weight basis. This ratio was tested on two pairs of pastures, one dominated by native shortgrass steppe and the other by a seeded stand of sideoats grama. The pasture sizes were set so the cow-calf pastures were 1.8 times larger than the steer pastures to allow equal herd sizes for the two classes of animals. Adequacy of stocking was determined by equalizing utilization. No significant differences were detected after the grazing season ended.

518. **Fowler, Gary W.; Lynch, Ann M. 1988. Bibliography of sequential sampling plans in insect pest management based on Wald's sequential probability ratio test. The Great Lakes Entomologist. 20: 165-171.**

519. **Fowler, Gary W.; Lynch, Ann M. 1987. Sampling plans in insect pest management based on Wald's sequential probability ratio test. Environmental Entomology. 16(2): 345-354.**

520. **Fox, Douglas G, 1984. Acid deposition from new air pollution sources in the western United States: examples of modeled air quality and its impacts on the Bridger and Fitzpatrick Wildernesses. SME-AIME fall meeting; 1984 October 24-26; Denver, CO. Littleton, CO: Society of Mining Engineers of AIME; Preprint number 84-332. 11 p.**

Outputs from industrial activies planned in the Riley Ridge Natural Gas Project are modeled to determine the potential locations of air pollution impacts on the Bridger and Fitzpatrick Wildernesses in Wyoming. Focus is placed on the meteorological transport and atmospheric deposition parameterization contained in the hypothesis.

521. **Fox, Douglas G. 1986. Establishing a baseline/protocols for measuring air quality effects in wilderness.** *In:* Lucas, Robert G., editor. National wilderness research conference: current research; 1985 July 23-26; Fort Collins, CO. General Technical Report INT-212. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 85-91.

522. **Fox, Douglas G. 1985. Forestry. Chapter 21.** *In:* **Handbook of applied meteorology. New York, NY: John Wiley and Sons, Inc. 605-666.**

523. **Fox, Douglas G. 1984. Identifying the elements of problems associated with transport and deposition modeling.** *In:* Acid rain in the Rocky Mountain West: transcript of proceedings; 1983 June 2-3; Golden, CO. Golden, CO: Colorado School of Mines: 112-117.

524. **Fox, Douglas G. 1981. Judging air quality model performance: review of the Woods Hole workshop.** *In:* **Fifth symposium on turbulence, diffusion, and air pollution; 1981 March 9-13; Atlanta, GA. Boston, MA: American Meteorological Society: 14-16.**

The problem of evaluating the performance of models is among the most important problem facing the modeling community. To this end, the American Meteorological Society convened a small, expert working group to discuss current practices in model evaluation, recommend model performance evaluation measures and methods, and, if possible, set standards for model performance.

525. **Fox, Douglas G. 1981. Judging air quality model performance. Bulletin of the American Meteorological Society. 62(5): 599-609.**

This paper develops a comprehensive set of statistical procedures to evaluate the performance of models, especially air quality models. The procedure is based on examining the degree of difference and of association between point observations and model predictions.

526. **Fox, Douglas G. 1987. Modeling transport and diffusion in nonhomogeneous and nonstationary boundary layers.** *In:* **Modeling the urban boundary layer. Boston, MA: American Meteorological Society: 497-508.**

527. **Fox, Douglas G. 1983. Part A. U.S. experience with air quality modeling.** *In:* **Ross, D. G., editor. Workshop proceedings: air quality modeling science and regulation; 1983 August 17-18; Victoria, Australia. Caulfield East, Victoria, Australia: Chisolm Institute of Technology: 4-156. 268 p.**

The scientific community on air quality modeling has become increasingly concerned about the performance of air quality models and about their utility as regulatory tools. This workshop was planned to address this very general issue in a variety of ways.

528. **Fox, Douglas G. 1984. Uncertainty in air quality modeling: a summary of the AMS workshop on quantifying and communicating model uncertainty. Woods Hole, MA September 1982. Bulletin of the American Meteorological Society. 65(1): 27-36.**

The Air Quality Model results should be viewed as containing both reducible error and inherent uncertainty. Reducible error results from improper or inadequate meteorological and air quality data inputs and from inadequacies in the models. Inherent uncertainty results from the basic stochastic nature of the turbulent atmospheric motions that are responsible for transport and diffusion of released materials. Modelers should acknowledge that all their predictions to date contain some associated uncertainty and should strive to quantify uncertainty.

529. **Fox, Douglas G.; Bartuska, Ann M.; Byrne, James G.; Cowling, Ellis; Fisher, Richard W.; Likens, Gene E.; Lindberg, Steve E.; Linthurst, Rick A.; Messer, Jay; Nichols, Dale S. 1989. A screening procedure to evaluate air pollution effects on class 1 wilderness areas. General Technical Report RM-168. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 p.**

This screening procedure is intended to help wilderness managers conduct "adverse impact determinations" as part of prevention of significant deterioration (PSD) applications for sources that emit air pollutants that might impact class I wildernesses. This procedure provides an initial estimate of susceptibility to critical loadings for sulfur, nitrogen, and ozone. It also provides a basis for requesting necessary additional information where potential adverse impacts are identified.

530. **Fox, Douglas G.; Bernabo, J. Christopher; Hood, Betsy. 1987. Guidelines for measuring the physical, chemical, and biological condition of wilderness ecosystems. General Technical Report RM-146. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 48 p.**

Guidelines include a large number of specific measures to characterize the existing condition of wilderness resources. Measures involve the atmospheric environment, water chemistry and biology, geology and soils, and flora. Where possible, measures are coordinated with existing long-term monitoring programs. Application of the measures will allow more effective evaluation of proposed new air pollution sources.

531. **Fox, Douglas G.; Blankenship, James O.; Dietrich, David L. 1985. Meteorological tools for wilderness fire management. *In:* Proceedings—symposium and workshop on wilderness fire; 1983 November 15-18; Missoula, MT. General Technical Report INT-182. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 333-341.**

532. **Fox, Douglas G.; Dietrich, David L.; Mussard, Donald E.; Riebau, Al R.; Marlatt, William E. 1986. The topographic air pollution analysis system. *In:* Zanetti, P., editor. Envirosoft 86. Proceedings of the international conference on development and application of computer techniques to environmental studies; 1986 November; Los Angeles, CA. Trowbridge, Wiltshire, England: Redwood Burn Limited: 123-144. 809 p.**

The Topographic Air Pollution Analysis System (TAPAS) has been developed over a number of years to provide federal land managers with effective computer-based air resource management tools. TAPAS includes a digital terrain data base, two- and three-dimensional wind field simulation models, air pollution transport, dispersion, screening and deposition models, map compatible graphics routines, and data management routines. This paper presents an overview of TAPAS and illustrates its use with examples of planning and assessment activities.

533. **Fox, Douglas G.; Fairobent, James E. 1981. NCAQ panel examines use and limitations of air quality models. Bulletin of the American Meteorological Society. 62(2): 218-221.**

The results of a 22-member expert panel on dispersion modeling, which was convened by the National Commission on Air Quality In 1979, are reviewed. The panel affirmed the validity of using models in support of air quality regulations. It also recognized the need to convey some of the uncertainty in modeling and recommended technical details for the commission to consider.

534. **Fox, Douglas G.; Moir, William H. Greenhouse fish. *In:* Richardson, Frank; Hamre, Robert H., technical editors. Wild Trout IV: proceedings of the symposium; 1989 September 18-19; Yellowstone National Park, WY. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station. 34-40**

535. **Fox, Douglas G.; Murphy, Dennis J.; Haddow, Dennis. 1982. Air quality, oil shale, and wilderness—a workshop to help identify and protect air quality related values of the flat tops. General Technical Report RM-91. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.**

A workshop was conducted to discuss the potential impacts of oil shale developments on the air quality of western Colorado. The workshop illustrates a general approach to the problem of identifying air quality

related values. It is anticipated that this approach will prove useful to all federal land managers involved with class I area protection.

536. **Fox, Douglas G.; Musselman, Robert C.; Byrne, James G. 1989. Effects of air pollution on natural ecosystems. *In:* 82nd AWMA annual meeting; 1989 June 25-30; Anaheim, CA. 9 p.**

537. **Fox, Douglas G.; Randerson, D.; Smith, M. E.; White, F. D.; Wyngaard, J. C. 1983. Synthesis of the Rural Model reviews. EPA-600/53-83-108. Research Triangle Park, NC: Environmental Protection Agency. 3 p.**

538. **Fox, Douglas G.; Ross, D. G.; Dietrich, David L.; Marlatt, William E. 1983. On modeling dispersion in complex terrain—application of TAPAS/CITPUFF/WINDS. *In:* Proceedings, 6th world congress on air quality; 1983 May 16-20; Paris, France. Paris, France: International Union of Air Pollution Prevention Associations: 231-238.**

539. **Fox, Douglas G.; Rosenthal, Donald H. 1981. On the use of decision analysis in determining significant visibility impairment. Atmospheric Environment. 15(12): 2503-2510.**

A decision analysis approach to visibility protection responsibilities of federal land managers is presented. Site-specific data on the social problem of determining the significance of impaired visibility are as important as data on the physical problem of visibility impairment. Decision analysis is recommended as a useful procedure to aid and track decisions.

540. **Fox, Douglas G.; Ross, D. G.; Dietrich, David L.; Mussard, Donald E.; Riebau, Al R. 1987. An update on TAPAS and its model components. *In:* Proceedings from the ninth conference on fire and forest meteorology; 1987 April 20-24; San Diego, CA. Boston, MA: American Meteorological Society: 1-7.**

541. **Fox, Douglas G.; Schoettle, Anna W.; Vertucci, Frank A. 1987. Glacier Lakes Ecosystem Experiments Site: an 'experimental' wilderness. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 161-166. 253 p.**

This site, selected to be representative of high-mountain wilderness ecosystems, is being used to study the effects of air pollution and atmospheric deposition in alpine and subalpine, terrestrial and aquatic biotic communities. The research program includes (a) short-term experiments designed to quantify the response of system components hypothesized to be most sensitive to changes in ozone, S, and N air pollution and deposition; (b) development of operationally oriented models capable of predicting system, species, and biogeochemical responses; and (c) long-term biogeochemically oriented monitoring to help establish the validity of (a) and (b) as management tools.

542. **Fox, Douglas G.; White, F. D. 1986. Mountain air resource management. *In:* Proceedings of international symposium on the Quinghai-Xizang Plateau and mountain meteorology; 1984 March 20-24; Beijing, China. Science Press. 108-141**

543. **Francis, Richard E. [and others]. 1982. Inventory and analysis of leafy spurge sites. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 1094. 1101 p.**

544. **Francis, Richard E. 1986. Phyto-edaphic classification of the upper Rio Puerco Watershed. Fort Collins, CO: Colorado State University. 283 p. Ph.D. dissertation.**

545. **Francis, Richard E. 1986. Phyto-edaphic communities of the upper Rio Puerco Watershed, New Mexico. Research Paper RM-272. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 73 p.**

The upper Rio Puerco Watershed in northern New Mexico was classified into 45 ecological phtyo-edaphic

communities using cluster analysis based on species importance values. The community descriptions consist of vegetation and soil surface characteristics; landform; soil series, association, or complex; ecological stage; and potential natural vegetation. The communities represented 11 vegetation series consisting of 2 treeland, 5 shrubland, and 4 grassland formations. three soil orders, 27 soil series, 9 associations, and 3 soil complexes were identified. The combination of landform, vegetation, and soil were considered phyto-edaphic communities. A dichotomous key was developed for field identification.

546. **Francis, Richard E. 1983. Sagebrush-steppe habitat types in northern Colorado—a first approximation summary.** *In:* **Moir, William H.; Hendzel, Leonard, technical coordinators. Proceedings of the workshop on southwestern habitat types; 1983 April 6-8; Albuquerque, NM. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region: 67-71. 110 p.**

Seventeen habitat types in a northern Colorado park basin have been quantified and classified in relation to plant species dominance, canopy cover, frequency, species, richness, constancy, and topoedaphic characteristics. The ecological information presented forms an ecological database useful for management planning and monitoring successional stages of the plant communities described.

547. **Francis, Richard E. 1982. Vegetation measurements for multiresource inventories—an ecological concept.** *In:* **Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 339-344. 1101 p.**

A research study in progress is discussed that deals with the concept of a nonfunctional vegetation inventory based on plant community structure as part of an ecological data base. Congressional mandates that developed the need for coordinated multiresource inventories and vegetation variables and measurement techniques being tested are discussed also.

548. **Francis, Richard E.; Aldon, Earl F. 1987. An ecological approach to classifying semiarid plant communities.** *In:* **Aldon, Earl F.; Gonzales Vicente, Carlos E.; Moir, William H., technical coordinators. Strategies for classification and management of native vegetation for food production in arid zones: symposium proceedings; 1987 October 12-16; Tucson, AZ. General Technical Report RM-150. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 9-14. 257 p.**

The vegetation variables of foliar cover, density, frequency, and subsequent importance values were used with hierarchical cluster analysis to quantify and classify plant communities. As an example of the approach, plant communities were classified for a semiarid watershed in northwestern New Mexico. This approach provides a quantitative ecological base to interpret and monitor ecosystem dynamics (trend).

549. **Francis, Richard E.; Aldon, Earl F. 1983. Preliminary habitat types of semiarid grassland.** *In:* **Moir, William H.; Hendzel, Leonard, technical coordinators. Proceedings of the workshop on southwestern habitat types; 1983 April 6-8; Albuquerque, NM. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region: 62-66. 110 p.**

Twenty-five habitat types, including two phases, were described and quantified for a semiarid grassland in northwestern New Mexico. The vegetation variables of cover, density, and frequency were used to form hierarchical importance values. This study allows for extrapolation of information to similar areas, and acts as an ecological base for management prescriptions.

550. **Francis, Richard E.; Kerbs, Roger R. 1984. The shoelace tie-down for flight line markers. Research Note RM-441. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.**

Flight line markers for aerial photography can be constructed easily using polyethylene butcher paper secured to the ground with nails and light weight string or fishing line in a shoelace design.

551. Francis, Richard E.; Morris, Meredith J.; Myhre, Richard J.; Noble, Daniel L. 1980. Inventory and analysis of leafy spurge *(Euphorbia esula)* sites: a feasibility study. *In:* Proceedings: northern regional leafy spurge conference; 1979 December 17-18; Billings, MT. Helena, Billings, MT: Montana State Department of Agriculture, and Montana Experiment Station, Montana CRD Leafy Spurge Committee, and Montana Cooperative Extension Service. 3 p. (Unpaginated).

Seven scales of color and color infrared aerial photos and 1:1,000,000 scale color infrared composite imagery from Landsat are being tested against ground data in southwestern North Dakota.

552. Francis, Richard E.; Williams, Tod B. 1989. Plant community classification of El Malpais, New Mexico. *In:* Land classifications based vegetation: Applications for resource management; 1987 November 17-19; Moscow, ID. General Technical Report INT-257. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 257. 315 p.

553. Franklin, J. F.; Moir, William H.; Hemstrom, M. A.; Greene, S. E.; Smith, B. G. 1988. The forest communities of Mount Rainier National Park. NPS Scientific Monograph 19. Washington, DC: U.S. Government Printing Office. 194 p.

554. Franzblau, Mark A.; Collins, James P. 1980. Test of a hypothesis of territory regulation in an insectivorous bird by experimentally increasing prey abundance. Oecologia (Berl). 46: 164-170.

555. Franzreb, Kathleen E. 1983. A comparison of avian foraging behavior in unlogged and logged mixed-coniferous forest. Wilson Bulletin. 95: 60-76.

556. Franzreb, Kathleen E. 1984. Foraging habits of ruby-crowned and golden-crowned kinglets in an Arizona montane forest. Condor. 86: 139-145.

557. Franzreb, Kathleen E. 1983. Intersexual habitat partitioning in yellow-rumped warblers during the breeding season. Wilson Bulletin. 95: 581-590.

558. Freeburg, R. S.; Carruthers, G. E.; Duncan, J. B. 1980. Water quality in recreational land use. *In:* Proceedings of the American Society of Agricultural Engineers, summer meeting; 1980 June 15-18; San Antonio, TX. 16 p.

The forest exhibits good self-healing capabilities under recreational land use. construction activities cause sizable perturbations in total solids and chemical transport from these areas. Some of these effects last over a period of years. Actual recreational uses of these lands cause perturbations of smaller magnitude than those caused by construction.

559. Freeman, Duane R. 1982. The fuel management training series. Fire Management Notes. Summer 1982: 10-13.

560. Freeman, Duane R. 1982. Inventory and prediction of forest fuels. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 904-907. 1101 p.

Forest fuels can be inventoried and predicted using procedures that are designed to enable land managers, foresters, and fuel managers to estimate weight per unit area of forest fuels for use in predictions of fire behavior potential, to estimate material for possible energy production, and to use in making better fuel management decisions.

561. French, Norman R.; Mitchell, John E. 1983. Long-term vegetation changes in permanent quadrats at the Idaho National Engineering Laboratory Site. Wildlife and Range Sciences Bulletin No. 36. Moscow, ID: University of Idaho, College of Forestry. 42 p.

Fluctuations in plant species composition were sufficient to mask indications of secondary succession. Shrub populations, however, remained relatively stable, regardless of perturbations caused by climate and/or livestock grazing.

562. Fresquez, Philip R.; Aldon, Earl F.; Dennis, G. L. 1988. Carbon dioxide evolution from an organically amended Rio Puerco soil. Research Note RM-480. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

As a result of organic matter application, microbial populations and activity (CO_2 production) increased

significantly compared to an unamended soil. Carbon dioxide evolution in the unamended soil did not increase with increases in the soil moisture content above 11% (-2 bars). This suggests that soil microbial activity may be limited more by the lack of organic matter rather than by soil moisture above -2 bars. Of the four organic amendments studied, sewage sludge had more desirable effects on soil biotic and abiotic properties than the others.

563. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1986. Changes in microbial populations and enzyme activities resulting from coal mine spoil reclamation. *In:* 1986 national symposium on mining, hydrology, sedimentology, and reclamation; 1986 December 8-11; Lexington, KY. Lexington, KY: University of Kentucky: 63-70.**

This paper reports on research to determine microbial populations, the diversity and composition of fungal groups, and the activities of enzymes on an undisturbed soil and on eight reclaimed nontopsoiled and topsoiled areas varying in ages.

564. **Fresquez, Philip R.; Aldon, Earl F. 1984. Distribution of fungal genera in stockpiled top-soil and coal mine spoil overburden. Research Note RM-447. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Abundances, genera diversity, and similarity coefficients of soil fungi were determined for stockpiled topsoil and spoil overburden at a surface coal mine in New Mexico and were compared to an adjacent undisturbed reference soil. Although the diversity of fungal genera in stockpiled topsoil was somewhat less than in the undisturbed soil, the two were more similar in fungal general diversity and in the types of fungi isolated than was the spoil over-burden material.

565. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1984. The distribution of fungal genera in reclaimed coal mine spoils in the arid Southwest. *In:* 1984 symposium on surface mining, hydrology, sedimentology, and reclamation; 1984 December 2-7; Lexington, KY. Lexington, KY: University of Kentucky: 215-219.**

The degree of soil microbial re-establishment and stability were evaluated on eight reclaimed mine spoil sites varying in age, soil characteristics (topsoiled and nontopsoiled), vegetation, and type of postmining revegetation treatment, and compared with an undisturbed reference site. Emphasis was on the recovery and distribution of fungal populations. The similarity in terms of the low numbers of fungal propagules, the relatively high diversity and evenness of fungal genera, and similarity in genera of fungi isolated between the undisturbed site and the oldest topsoiled mine soil site suggest that the fungal community may have begun to stabilize four years after topsoiling and revegetation.

566. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1987. Diversity and composition of soil fungi associated with reclaimed coal mine spoils and soils. *In:* Billings symposium on surface mining and reclamation in the Great Plains; 1987 March 17-19; Billings, MT. Reclamation Research Unit Report No. 8704. Billings, MT: American Society for Surface Mining and Reclamation: D-2-1 to D-1-7.**

The soil fungal community associated with an undisturbed soil was described and compared with the fungal communities from spoil overburden and stockpiled topsoil materials, and from eight reclaimed topsoiled and nontopsoiled areas of varying ages. The diversity and evenness of fungal genera were higher in the undisturbed soil than in any of the disturbed overburden spoil or stockpiled topsoil materials, or in any of the reclaimed topsoiled and nontopsoiled areas. The composition of fungal genera was related to soil properties and site age. In the topsoiled areas, penicillium dominated the youngest topsoiled site, while aspergillus dominated the oldest topsoiled site. In contrast, aspergillus dominated the youngest nontopsoiled site, while penicillium dominated the oldest nontopsoiled area.

567. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1987. Enzyme activities in reclaimed coal mine spoils and soils. Landscape and Urban Planning. 14: 359-367.**

The segregation and stockpiling of topsoil material may reduce enzymatic activities that may hinder normal nutrient cycling processes in reclaimed minelands. The effects of topsoiling and reclamation age in dehydrogenase, nitrogenase, phosphatase, arylsulphatase, amylase, cellulase, invertase, and uresea activities were evaluated on three reclaimed nontopsoiled and five reclaimed topsoiled areas and compared with an undisturbed reference soil.

568. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1985. Litter decomposition on reclaimed coal mine spoils and soils in the arid Southwest.** ***In:*** **Symposium on surface mining, hydrology, sedimentology, and reclamation; 1985 December 9-13; Lexington, KY. Lexington, KY: University of Kentucky: 157-161.**

Fiberglass litter bags containing stripped alfalfa stem litter and cellulose filter paper were deposited on and buried in an undisturbed soil, and on eight reclaimed topsoiled and nontopsoiled areas. Changes in decomposition potential, especially in the older nontopsoiled areas, at the 6 cm depth adversely influenced the early stages of litter decay. The older 4- and 5-year-old topsoiled area had decomposition parameters more similiar to the undisturbed soil compared to the nontopsoiled spoils.

569. **Fresquez, Philip R.; Aldon, Earl F.; Sorensen, Darwin L. 1985. Microbial and soil enzyme activities in stockpiled top-soil and coal mine spoil materials.** ***In:*** **Williams, Dean; Fisher, Scott E., Jr., editors. Proceedings of the second annual meeting of the American Society for Surface Mining and Reclamation; 1985 October 8-10; Denver, CO. Princeton, WV: American Society for Surface Mining and Reclamation: 340-345. 412 p.**

Dehydrogenase, nitrogenase, urease, phosphatase, arylsulphatase, amylase, cellulase, invertase and protease activities of stockpiled topsoil and coal mine spoil overburden material were determined and compared to an undisturbed reference soil. The undisturbed soil had higher enzyme activities than in the stockpiled topsoil or spoil materials. The low enzymatic activities found in the stockpiled topsoil, and especially in the spoil material, may be partially attributed to the poor chemical and physical environment of these materials, as well as to the low microbial population and diversity of microorganisms.

570. **Fresquez, Philip R.; Aldon, Earl F.; Lindemann, William C. 1986. Microbial re-establishment and the diversity of fungal genera in reclaimed coal mine spoils and soils. Reclamation and Revegetation Research. 4: 245-258.**

The degree of soil microbial re-establishment and the diversity and similarity of fungal genera were evaluated on an undisturbed reference soil and on eight reclaimed coal mine spoil and soil sites varying in age, soil characteristics, vegetation, and type of postmining revegetation treatment. The oldest topsoiled site was considered more stable in that soil chemical, and physical properties were more nearly similar to the undisturbed soil than the oldest nontopsoiled spoil site. Also, the similarity in terms of the populations of soil microorganisms suggest that the microbial community may have begun to stabilize 4 years after topsoiling and revegetation.

571. **Fresquez, Philip R.; Campbell, Larry T.; Aldon, Earl F. 1984. Response of soil fungi and soil and plant parameters to sewage sludge and sawdust amended coal mine spoils. Research Note RM-444. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

The spoil fungal population was not significantly influenced under field conditions. Under greenhouse conditions, sorghum bicolor yields were significantly higher when treated with sewage sludge than with any other treatment. Sawdust treatment had no significant effect on plant yields, probably because of the low nutrient levels from this particular amendment.

572. **Fresquez, Philip R.; Dennis, G. L.; Francis, Richard E. 1989. Soil fungi: an additional parameter for phyto-edaphic community classification.** ***In:*** **Proceedings—land classifications based on vegetation: applications for resource management; 1987 November 17-19; Moscow, ID. General Technical Report INT-257. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 285-287. 315 p.**

The utility of soil fungi in phyto-edaphic community classification was tested by determining the relationships between the soil fungal communities and the physiochemical properties of soils associated with plant communities in the semiarid southwestern United States. Populations of fungi were significantly higher in soils from treeland plant communities. In contrast, the diversity of fungal groups was higher in the shrub and grassland plant communities than in the treeland plant communities. The community composition of fungal groups differed considerably among the three major plant life forms. Fungal parameters in association with the soils' chemistry offer a useful means of describing ecosystem dynamics.

573. **Fresquez, Philip R.; Francis, Richard E.; Dennis, G. L. 1988. Fungal communities associated with phytoedaphic communities in the semiarid Southwest. Arid Soil Research and Rehabilitation. 2: 187-202.**

Soil fungal populations, diversity, and the community composition of fungal groups were determined among soils from 11 plant communities occurring in

the semiarid Southwest. In general, soils associated with treeland plant communities had significantly higher fungal populations than the soils associated with shrub of grassland plant communites. In contrast, the diversity and evenness of fungal groups were higher in soils from the shrub and grassland plant communities than in soils from the treeland plant communities. The composition of fungal groups differed considerably among the soils from the 11 plant communities, indicating that the soils from each plant community had a distinct fungal species composition.

574. **Fresquez, Philip R.; King, Rudy M. 1989. Number of fungal colonies required to describe species differences on reclaimed coal mine areas in New Mexico. Research Note RM-491. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.**

A minimum of 189 soil fungal colonies growing on rose bengal-streptomycin agar plates are required to describe species differences (diversity) in the fungal community from soil collected from an undisturbed pinyon/juniper plant community within the McKinley Coal Mine in West-central New Mexico.

575. **Fresquez, Philip R.; Lindemann, William C. 1983. Greenhouse and laboratory evaluations of amended coal mine spoils. Reclamation and Revegetation Research. 2: 205-215.**

Two greenhouse experiments were conducted to determine the influence of amendments on spoil chemical properties, plant growth, and P And K uptake by plants. The incorporation of topsoil into spoil (as opposed to topsoiling) appeared to be of little value in stimulating plant growth. Instead, the increase in yields of both species was attributed mainly to the addition of organic matter and the application of essential plant nutrients.

576. **Fresquez, Philip R.; Lindemann, William C. 1982. Nitrification potential of amended coal mine spoils. New Mexico Journal of Science. 22(2): 36-42.**

Topsoil inoculation did not increase nitrification potential, nitrate production, or ammonium oxidizer numbers. However, organic amendment with either alfalfa or sludge stimulated nitrification by increasing nitrification potential and nitrate production. Nitrite oxidation was slow in all treatments, indicating that the spoils may inhibit nitrite oxidation rather than ammonium oxidation.

577. **Fresquez, Philip R.; Lindemann, William C. 1982. Soil and rhizophere microorganisms in amended coal mine spoils. Soil Society of America Journal. 46(4): 751-755.**

Topsoil is usually respread over strip-mined land during reclamation. In some instances, spoil could be used as a medium for revegetation. The objectives of this study were to compare microbial parameters in spoil and soil and determine the effect of spoil amendment on these microbial parameters.

578. **Fresquez, Philip R.; Lindemann, William C.; Lindsey, Donald L. 1982. Soil biota in southwestern coal strip-mined spoils. *In:* Aldon, Earl F.; Oaks, Wendell R., co-editors. Proceedings of reclamation of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 24-34. 218 p.**

These studies determined microbial numbers, activities and the fungal general distribution in undisturbed surface soils, stockpiled topsoils, nonvegetated and reclaimed coal mine spoils, and amended and unamended spoils, and also determined their influence on spoil revegetation and reclamation.

579. **Fresquez, Philip R.; Sabey, B. R.; Klein, D. A. 1986. Early successional rhizosphere fungal populations in disturbed semi-arid ecosystems. *In:* Agronomy abstracts; 1986 annual meetings, American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 1986 November 30-December 5; New Orleans, LA. Madison, WI: American Society of Agronomy: 179. (Abstract).**

580. **Fresquez, Philip R.; Sabey, B. R.; Klein, D. A. 1988. Early successional rhizosphere fungal populations in disturbed semi-arid ecosystems. *In:* Beckett, P. J., editor. Canadian Land Reclamation Association: proceedings of the 12th annual meeting; 1987 July 7-11; Sudbury, ON. Sudbury, ON: Laurentain University: 249-254.**

Fungal populations, diversity, and the community composition of fungal groups in the rhizophere and nonrhizophere of several late successional perennial plant species (*Hilaria jamesii, Sporobolus airoides, Agropyron smithii,* and *Atroplex canescens*) were evaluated at disturbed sites in New Mexico after 0.25, 1.25, and 2.25 years, and in Colorado after 0.25 and 1.25 years of plant growth. Fungal populations, diversity, and the composition of fungal groups changed be-

tween rhizophere and nonrhizophere zones, plant types, and the disturbed study areas with ecosystem development.

581. **Fresquez, Philip R.; Sabey, B. R. 1989. Microbial community in the rhizosphere of native plant species growing on reclaimed coal mine soils varying in age. Arid Soil Research and Rehabilitation. 3(3): 369-384.**

In this study, the soil microbial community was evaluated in the rhizosphere and the nonrhizosphere of two grass species, galleta and alkali sacton, and a shrub, fourwing saltbrush, growing on a reclaimed coal mine spoil 3 months to 2.25 years after topsoiling and revegetation. Overall, the results showed that each plant species, via its rhizosphere microflora, may contribute differently to revegetation success.

582. **Fresquez, Philip R.; Sabey, B. R.; Klein, D. A. 1988. Soil fungal community-plant rhizosphere interactions during the early stages of ecosystem development on reclaimed coal mine soils. 1988 mine drainage and surface mine reclamation conference; 1988 April 19-22; Pittsburgh, PA. Information Circular 9184. Washington, DC: U.S. Department of the Interior, Bureau of Mines; 2: 9-14.**

The microfungal community was evaluated in rhizosphere and nonrhizosphere zones of galleta, alkali sacaton, and fourwing saltbrush growing on a reclaimed coal mine soil after 0.25, 1.25, and 2.25 years of plant growth. Higher fungal populations and lower fungal diversities were generally related to higher nutrient contents in the rhizosphere, whereas lower fungal populations and higher fungal diversities were generally related to lower nutrient contents in the nonrhizosphere soil. Fungal groups changed between rhizosphere and nonrhizosphere zones, and among and within plant species as the age of the plants increased.

583. **Frissell, Christopher A.; Liss, William J.; Warren, Charles E.; Hurley, Michael D. 1986. A hierarchical framework for stream habitat classification viewing streams in a watershed context. Environmental Management. 10(2): 199-214.**

584. **Frye, R. H.; Dix, Mary Ellen; Carey, Donald R. 1988. Effect of two insecticides on abundance of insect families associated with siberian elm windbreaks. Kansas Entomological Society. 61(3): 278-284.**

Carbaryl and *Bacillus thuringiensis* apparently had almost no effect on the abundance of most of the insect families associated with single-row Siberian elm windbreaks in north-central and eastern North Dakota. Family abundance varied between regions. Pane traps hung at a height of 1.5 m caught significantly more insects than those hung at 3.6 m.

585. **Frye, R. H.; Hard, John; Carey, Donald R.; Dix, Mary Ellen. 1983. Day and night application of *Bacillus thuringiensis* for cankerworm control. North Dakota Research Report 94. Fargo, ND: North Dakota State University, Agriculture Experiment Station. 10 p.**

586. **Fulton, Gary W.; Barker, William T.; Bjugstad, Ardell J. 1983. Rooted aquatic plant revegetation of strip mine impoundments in the northern Great Plains. *In:* Proceedings, third plains aquatic research conference; 1983 August 24-25; Bozeman, MT. Bozeman, MT: Institute of Natural Resources, Montana State University: 113-117.**

587. **Furman, R. William. 1982. Archiving remote automatic weather station data. Fire Management Notes. Summer 1982: 3-5.**

588. **Furman, R. William. 1982. The effectiveness of weather forecasts in decision making: an example. Journal of Applied Meteorology. 21(4): 532-536.**

Persistence forecasts, professional forecasts, and predictions combining the two have progressively greater utility in predicting weather than do climatological data alone. Actual data show decisions involving an application of prescribed fire would have been most valuable if based on combined forecasts for a prescription limited to a single variable.

589. **Furman, R. William. 1984. Evaluating the adequacy of a fire-danger rating network. Forest Science. 30(4): 1045-1058.**

The method of optimum interpolation was used to analyze the combined fire-danger rating networks of Minnesota, Wisconsin, and upper Michigan. Data from NOAA/NWS Stations were included. Similar analyses can be used as a guide for adjustment to station spacing in other areas.

590. **Furman, R. William. 1981. Weather uncertainty and forest burning decisions. *In:* Weiss, A., editor. Computer techniques and meteorological data applied to problems of agriculture and forestry: a workshop; 1981 March 30-31; Anaheim, CA. Lincoln, NE: University of Nebraska: 290-296.**

591. **Furman, R. William; Wooldridge, Gene L. 1984. Observations of surface flow over a three-dimensional hill in a stable and neutral boundary layer.** *In:* **Third conference on mountain meteorology; 1984 October 16-19; Portland, OR. Boston, MA: American Meteorological Society: 42-45.**

This paper presents the results of a study that examines the qualitative relationship between observed properties of an airstream approaching an axisymmetric three-dimensional hill and the observations of airflow on the surface of the hill. Lacking are field observations of flow over relatively uncomplicated terrain which can be compared to theoretical and physical model results to complete the link between theory and reality.

592. **Galt, H. D.; Theurer, Brent; Martin, S. Clark. 1982. Botanical composition of steer diets on mesquite and mesquite free desert grassland. Journal of Range Management. 35: 320-325.**

593. **Garratt, Michael W.; Lund, H. Gyde; Roberts, Edwin H. 1982. Merging Landsat imagery, terrain tapes, and existing extensive forest inventory information.** *In:* **Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 788-797. 1101 p.**

A project is being conducted to determine the feasibility of merging digital Landsat, terrain, and existing forest inventory data to create a data base. This digital data base will be utilized to produce in-place maps of the forest resource, to detect changes in the forest resource, and to provide a base from which to initiate reinventory of the forest resource.

594. **Garrett, Lawrence D. 1980. Forests and woodlands—stored energy for our use.** *In:* **Cutting energy costs. The 1980 yearbook of agriculture. Washington, DC: U.S. Department of Agriculture: 101-108.**

595. **Garrett, Lawrence D. 1982. Interdisciplinary research for multiresource forest management: an example.** *In:* **Russel, M. G., editor. Enabling interdisciplinary research: perspectives from agriculture, forestry, and home economics. Miscellaneous Publication 19. St. Paul, MN: University of Minnesota Agricultural Experiment Station: 147-152.**

596. **Garrett, Lawrence D. 1983. Multiresource research and its implications to management: the Beaver Creek Biosphere Reserve.** *In:* **Patton, David R. [and others], technical coordinators. Wildlife and range research needs in northern Mexico and southwestern United States: workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36. Washington, DC: USDA Forest Service: 40-44. 108 p.**

A multiresource research project on the Beaver Creek Biosphere Reserve is designed to create management guidelines utilizing integrated multiresource inventory and analysis techniques. The program has completed interim evaluations of multiresource responses to management treatments in ponderosa pine and pinyon-juniper types. Results from the research program, including single and multiresource treatment responses and analytical models, are described.

597. **Garrett, Lawrence D.; Rogers, James J.; Prosser, Joseph M. 1982. Multiresource inventory and analysis systems: gaining maximum benefit for land managers.** *In:* **Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14, 1981; Orono, ME. Washington, DC: Society of American Foresters: 1011-1017. 1101 p.**

A program of multiresource management research in southwestern ponderosa pine and pinyon-juniper type is attempting to provide management guidelines using multiresource inventory, analysis, modeling and user interaction. Descriptions are provided for the multiresource inventories and data base management system being used. Also, a multiresource model for land management planning process is being tested.

598. **Gary, Howard L. 1980. Patch clearcutting to manage snow in lodgepole pine.** *In:* **Proceedings of the 1980 watershed management symposium; 1980 July 21-23; Boise, ID. New York, NY: Irrigation and Drainage Division, American Society of Civil Engineers; 1: 335-346. 597 p.**

Snow-water equivalents were 15 to 35 percent greater in clearcut patches, 1, 3, and 5 tree heights in width,

than in adjacent forest. However, there was decreased snow catch along the downwind forest border. Cut patches influenced snow accumulation no further away than the width of the clearing. Placement of a tree and fence barrier reduced snow deficit along the downwind border of the clearcut patch.

599. **Gary, Howard L. 1982. Stream water quality in a small commercial campground in Colorado. Journal of Environmental Health. 45(1): 5-12.**

Selected physical, chemical and bacteriological qualities of stream water entering and leaving a campground were examined during the summer of 1978 to investigate the influence of recreational use. Water samples were collected and analyzed daily before and after Memorial Day, Fourth of July, and Labor Day weekends. Densities of indicator bacteria in surface water were not significantly increased by recreational use of a campground equipped with modern sanitation facilities.

600. **Gary, Howard L. 1985. A summary of research at the Manitou Experimental Forest in Colorado, 1937-1983. General Technical Report RM-116. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 24 p.**

Results of selected studies for range, watershed, timber and wildlife management research are summarized to provide land managers, land-use planners, and land-use researchers with information to help evaluate consequences of land management practices in the Colorado Front Range ponderosa pine zone.

601. **Gary, Howard L.; Adams, John C. 1985. Indicator bacteria in water and stream sediments near the Snowy Range in southern Wyoming. Water, Air and Soil Pollution. 25: 133-144.**

Water samples were taken at eight pools in streams in the Nash Fork Watershed after snowmelt in the summer of 1980. Principal land uses include skiing and other winter sports, sheep and cattle grazing, camping and fishing, and summer homes. Water samples taken before and after disturbing streambottom sediment were analyzed for fecal coliforms and fecal streptococci. The levels of these indicator bacteria were low, except where sheep and cattle had recently grazed. Recreation use had little effect on bacterial densities.

602. **Gary, Howard L.; Johnson, Steven R.; Ponce, Stanley L. 1983. Cattle grazing impact on surface water quality in a Colorado Front Range stream. Journal of Soil and Water Conservation. 38(2): 124-128.**

Cattle grazing in pastures bisected by a small perennial stream in central Colorado had only minor effects on water quality during two years of study. Suspended solids and nitrate nitrogen did not increase significantly, but ammonia nitrogen increased only once under moderate rates of grazing. Bacteria densities in the stream water were higher when at least 150 cattle were grazing. About 5 percent of the total manure produced by cattle contributed to pollution and/or enrichment of the stream.

603. **Gary, Howard L.; Morris, Meredith J. 1980. Constructing wooden boxes for cavity-nesting birds. Research Note RM-381. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Construction details for two sizes of nest boxes are described. In field trials, eight species of cavity-nesting birds nested in the smaller boxes, and five species, in addition to red squirrels, raised young in the larger nest boxes.

604. **Gary, Howard L.; Ponce, Stanley L.; Dederick, Jim D. 1981. Effects of mountain home developments on surface water quality: a case study. Research Note RM-396. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Four mountain home developments adjacent to perennial streams did not consistently increase orthophosphate, chloride, indicator bacteria, or suspended solids above existing levels of upstream contamination.

605. **Gary, Howard L.; Troendle, Charles A. 1982. Snow accumulation and melt under various stand densitites in lodgepole pine in Wyoming and Colorado. Research Note RM-417. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

606. **Gary, Howard L.; Watkins, Ross K. 1985. Snowpack accumulation before and after thinning a dog-hair stand of lodgepole pine. Research Note RM-450. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Snowpack water equivalents were measured 5 years before and after thinning a 90-year-old stand of lodgepole pine in southern Wyoming. Peak snowpack water equivalent was increased about 30%.

607. Geils, Brian W. 1982. Comandra blister rust on lodgepole pine in the Rocky Mountain Region. *In:* Proceedings, 29th annual western international forest disease work conference; 1981 September 15-17; Vernon, BC, and Juneau, AK. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region: 91-92.

608. Geils, Brian W. 1984. Effects of comandra blister rust on growth and survival of lodgepole pine. *In:* Hunt, R. S., compiler. Proceedings, 32nd western international forest disease work conference; 1984 September 25-28; Taos, NM. Victoria, BC: British Forest Service, Pacific Forest Research Center: 24-25. 37 p.

609. Geils, Brian W. 1987. Status and direction of studies on comandra blister rust in the Rocky Mountains. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Forest Pest Management: 22-23.

610. Geils, Brian W.; Jacobi, William R. 1984. Comandra rust intensity and severity in lodgepole pine. *In:* Proceedings, 31st annual western international forest disease work conference; 1983 August 22-26; Coeur D'alene, ID. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region: 70.

611. Geils, Brian W.; Jacobi, William R. 1987. Commandra blister rust: a threat to lodgepole pine. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 216-217. 253 p.

Commandra blister rust is an important canker disease of lodgepole pine in the central Rocky Mountains. Current research is quantifying the risk of serious disease outbreaks and the magnitude of resulting losses. Rust incidence in lodgepole pine stands is related to the distance and direction from the alternate host and average tree height. Projected losses are influenced by both stand and disease conditions such as percent of trees infected and average canker height.

612. Geils, Brian W.; Jacobi, William R. 1984. Incidence and severity of comandra blister rust on lodgepole pine in northwestern Wyoming. Plant Disease. 68: 1049-1051.

613. Germano, David J.; Hungerford, C. Roger; Martin, S. Clark. 1983. Responses of selected wildlife species to the removal of mesquite from desert grassland. Journal of Range Management. 36(3): 309-311.

Observations on the Santa Rita Experimental Range near Tucson, Ariz. (1976-1978) showed that populations of the common animals and birds were reduced by large-scale clearing of velvet mesquite (*Prosopis juliflora* Var. *velutina*), but removing about one-third of the mesquite stand in spots (3-30 ha) was not detrimental.

614. Gilbert, Brad. 1989. The next generation of planning analysis in the Forest Service. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 187-196. 278 p.

615. Girard, Michele M.; Goetz, Harold; Bjugstad, Ardell J. 1987. Factors influencing woodlands of southwestern North Dakota. Prairie Naturalist. 19(3): 189-198.

Literature pertaining to woodlands of southwestern North Dakota is reviewed. Woodland species composition and distribution, and factors influencing woodland ecosystems, such as climate, logging, fire, and grazing, are described. Potential management and improvement techniques using vegetation and livestock manipulation have been suggested.

616. Girard, Michele M.; Goetz, Harold; Bjugstad, Ardell J. 1984. Native woodlands of southwestern North Dakota. Proceedings of the North Dakota Academy of Science 76th annual meeting; April 1984. 38: 88.

617. **Girard, Michele M.; Goetz, Harold; Bjugstad, Ardell J. 1989. Native woodland habitat types of southwestern North Dakota. Research Paper RM-281. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 p.**

Native woodland habitat types of southwestern North Dakota were classified. Forty-seven sites were sampled using Daubenmire methods and were analyzed using Twinspan classification and Decorana ordination. A key was developed to identify habitat types, and the characteristics of each habitat type are described.

618. **Girard, Michele M.; Goetz, Harold; Bjugstad, Ardell J. 1984. Upland hardwood habitat types in southwestern North Dakota.** *In:* **Characteristics and values for the northern Great Plains: symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication No. 111. Rapid City, SD: South Dakota School of Mines and Technology: 10-14. 52 p.**

The Daubenmire habitat type method was used to classify the upland hardwood draws of southwestern North Dakota. Preliminary data analysis indicates there are four upland habitat types: *Fraxinus pennsylvanica/Prunus virginiana; F. pennsylvanica-Ulmus americana/P. virginiana; Populus tremuloides/Prunus virginiana;* and *Quercus macrocarpa/P. virginiana.*

619. **Girard, Michele M.; Goetz, Harold; Bjugstad, Ardell J. 1983. Woody habitats in southwestern North Dakota.** *In:* **Proceedings of the 35th annual meeting of the Great Plains Agricultural Council, Forestry Committee; 1983 July 11-14; Billings, MT. Helena, MT: Montana Department of State Land: 70-76. 185 p.**

Scattered throughout the prairies of western North Dakota are small pockets and draws of native woodlands. These woody draws represent less than 1 percent of the vegetation in North Dakota. Most of the study area is concentrated in the unglaciated regions of the slope surrounding the Little Missouri River. The northern reaches of the study area include the glaciated regions south of the Missouri River.

620. **Girard, Michele M.; Stotts, Bryan. 1987. Managing impacts of oil and gas development on woodland wildlife habitats on the Little Missouri Grasslands, North Dakota.** *In:* **Proceedings, Thorne Ecological Institute national symposium; 1985 February 4-6; Glenwood Springs, CO. 128-130.**

Native woodlands in the Little Missouri National Grasslands have been impacted by oil and gas development. Impacts include construction activities, toxic fumes, chemical spills, and displacement of wildlife species. A number of rehabilitation and mitigation techniques have been implemented to minimize the damage.

621. **Glinski, Richard L.; Grubb, Teryl G.; Forbis, Larry A. 1983. Snag use by selected raptors.** *In:* **Davis, Jerry W.; Goodwin, Gregory A.; Ockenfels, Richard A., technical coordinators. Snag habitat management: proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. General Technical Report RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service Rocky Mountain Forest and Range Experiment Station: 130-133. 226 p.**

622. **Goodman, Tim D. 1988. Cattle behavior with emphasis on time and activity allocations between upland and riparian habitats. Las Cruces, NM: New Mexico State University. 54 p. M.S. thesis.**

623. **Goodman, Tim D.; Donart, Gary B.; Kiesling, Herman E.; Holchek, Jerry L.; Neel, James P.; Manzanares, Daniel; Severson, Kieth E. 1989. Cattle behavior with emphasis on time and activity allocations between upland and riparian habitats.** *In:* **Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffrey L., editors. Practical approaches to riparian resource management: an educational workshop; 1989 May 8-11; Billings, MT. Billings, MT: U.S. Department of the Interior, Bureau of Land Management: 95-102.**

Cattle distribution and behavior were studied in riparian and upland habitats at Fort Bayard in southwestern New Mexico. Habitat use shifted from heavy use on riparian areas during the growing season to virtually no riparian use during the dormant season. Riparian observations increased significantly during the first collection in a new pasture season. During the dormant season, open-upland and browse-upland were selected. Time spent grazing and distance traveled were greatest during the summer months and least during the winter months.

624. **Gosz, James R. 1980. Biomass distribution and production budget for a nonaggrading forest ecosystem. Ecology. 61(3): 507-514.**

625. **Gosz, James R. 1982. Non-point source pollution of water by recreation: research assessment and research needs. Eisenhower Consortium Bulletin 13. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.**

626. **Gosz, James R. 1980. Nutrient budget studies for forests along an elevational gradient in New Mexico. Ecology. 61(3): 515-521.**

627. **Gosz, James R.; White, Carleton S.; Ffolliott, Peter F. 1980. Nutrient and heavy metal transport capabilities of sediment in the southwestern United States. Water Resources Bulletin. 16(5): 927-933.**

628. **Gottfried, Gerald J. 1980. Control of New Mexican locust and the effect on planted ponderosa pine in central Arizona. Research Note RM-386. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Several herbicide applications were necessary to control New Mexican locust. However, first-year ponderosa pine seedling survival appeared to benefit from partial shade from locust sprouts which were not sprayed a separate study, soil moisture conditions in the top 24 inches (60 cm) were better in 5-year-old locust sites than in grass or 20-year-old locust sites. Managers may be able to manipulate the seral locust cover to speed pine regeneration.

629. **Gottfried, Gerald J. 1987. Effects of modified skidding rules on mixed conifer advance regeneration in Arizona. Research Note RM-479. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.**

Modified skidding rules, which included restricting equipment to precleared skid trails, and winching logs to the skid trails, plus directional felling, were used in a 40-acre special logging unit to evaluate the effects of advance regeneration. Logging resulted in a small (5%) decline in total advance regeneration density in skidding areas. Conifer density was decreased by 14%; but aspen sprouting made up the difference. Total stocking was unaffected. Losses in the special unit were less than in two adjacent areas logged by conventional methods.

630. **Gottfried, Gerald J. 1989. Effects of patch clearcutting on water yield improvement and on timber production in an Arizona mixed conifer watershed. Tucson, AZ: University of Arizona. 184 p. Ph.D. dissertation.**

631. **Gottfried, Gerald J. 1982. Forests and forestry in Israel. Journal of Forestry. 80: 516-520.**

632. **Gottfried, Gerald J. 1987. Regeneration of pinyon. *In:* Proceedings of the pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 249-254. 581 p.**

The current emphasis on management of pinyon-juniper woodlands has resulted in renewed interest in the regeneration characteristics of Colorado pinyon and of singleleaf pinyon. Most pinyon seedlings are observed in the shade of mature trees, shrubs, or of slash, and not in the spaces between trees, although pinyon is generally considered shade-intolerant. Seedling growth rates are low, but early release from shade can be fatal. More research is necessary before general management recommendations can be formulated.

633. **Gottfried, Gerald J. 1983. Stand changes on a southwestern mixed conifer watershed after timber harvesting. Journal of Forestry. 83(5): 311-316.**

An old-growth, mixed conifer stand in eastern Arizona was operationally harvested by diameter-limit and selection methods. Conifer regeneration currently exceeds precutting levels. Aspen sprouting was also heavy, but conifers should remain dominant if the overstory is not drastically reduced by future cuts and logging damage is minimized.

634. **Gottfried, Gerald J.; Debano, Leonard F. 1984. Total shrub biomass of a New Mexico locust site in central Arizona. *In:* New forests for a changing world. Proceedings of the 1983 convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. Washington, DC: The Society of American Foresters: 310-314. 640 p.**

New Mexico locust is a spiny shrub or small tree that invades many ponderosa pine and mixed conifer sites in the Southwest after the mature conifer forests have been harvested. A plot containing 13-year-old locust and bigtooth maple was sampled to determine above- and below-ground shrub biomass. Conifer roots from adjacent sites has greater biomass and extended below 350 cm. Previously reported water yield increases

appear related to replacement of deep-rooted forest vegetation by smaller brush species that have shallower root systems and less transpiring foliar surface area.

635. **Gottfried, Gerald J.; Ffolliott, Peter F. 1983. Annual needle and leaf fall in an Arizona mixed conifer stand. Research Note RM-428. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Annual needle and leaf fall ranged from 0.02 to 1.90 tons per acre, with an average of 0.41 ton per acre. Sites dominated by ponderosa pine had the most needle fall, those dominated by Engelmann spruce-corkbark fir had the least. Other significant differences were determined between these sites and sites containing aspen or mixed conifers. Needle and leaf fall could not be correlated with stand basal area because of the normal variability encountered within mixed conifer stands.

636. **Gottfried, Gerald J.; Ffolliott, Peter F. 1980. An evaluation of snowmelt lysimeters in an Arizona mixed conifer stand.** *In:* **Hydrology and water resources in Arizona and the Southwest. Proceedings of the 1980 meetings of the Arizona Section—American Water Resources Association, and the Hydrology Section—Arizona-Nevada Academy of Science; 1980 April 11-12; Las Vegas, NV. 10: 221-229. 269 p.**

Computer snowmelt models have been developed to simulate the natural processes occurring during the melting of snowpacks. Snowmelt lysimeters are an ideal method of testing the predictability of computer simulated models on a small scale. The results of the evaluations, using 1978 data, are presented here. Comparisons were made among lysimeters and the results discussed with respect to various climatic and forest stand parameters.

637. **Gottfried, Gerald J.; Ffolliott, Peter F. 1981. Evaluation of the use of Soil Conservation snow course data in describing local snow conditions in Arizona forests.** *In:* **Hydrology and water resources in Arizona and the Southwest. Proceedings of the 1981 meetings of the Arizona Section-American Water Resources Association and the Hydrology Section-Arizona-Nevada Academy of Science; 1981 May 1-2; Tucson, AZ. 2: 55-62. 223 p.**

Snowmelt is the major source of runoff from forested watersheds in Arizona. The Soil Conservation Service maintains a system of snow courses to provide an index of snow conditions within river basins. Experimental watersheds in central Arizona are near SCS snow courses. Comparisons were made between data from the two types of snow courses to determine whether the SCS courses adequately represent conditions in surrounding areas.

638. **Gottfried, Gerald J.; Heidmann, L. J. 1986. Effects of cold stratification and seed coat sterilization treatments on pinyon (*Pinus edulis*) germination.** *In:* **Proceedings, conifer tree seed in the inland Mountain West symposium; 1985 August 5-6; Missoula, MT. General Technical Report INT-203. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 38-43. 289 p.**

One experiment compared germination capacity and energy on pinyon (*Pinus edulis* Engelm.) after 30- and 60-day cold stratification. Seed from five Arizona seed sources were compared. Both treatments did not affect germination capacity, but increased speed of germination. A second study evaluated the effects of six hydrogen peroxide treatments designed to improve germination and suppress mold growth during prolonged tests. Results varied. Except for one seedlot, treatment did not improve germination capacity or energy, nor did it suppress mold. The most concentrated treatment tended to suppress germination.

639. **Gottfried, Gerald J.; Patton, David R. 1984. Pocket gopher food habits on two disturbed forest sites in central Arizona. Research Paper RM-255. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.**

Pocket gopher food habits were studied in two nonstocked forest sites. Grasses, especially bromegrass, were between 84% and 44% of the diet on the seeded grass site. Forbs supplied 51% of the diet on a site with forb-grass-brush cover. Ponderosa pine was not used heavily. High use of grasses has management implications.

640. **Graham, L. P.; Labadie, J. W.; Hutchison, I. P. G.; Ferguson, K. A. 1986. Allocation of augmented water supply under a priority water rights system. Water Resources Research. 22(7): 1083-1094.**

641. **Green, Norman; Smith, Michael D.; Beavis, William D.; Aldon, Earl F. 1983. Influence of vesicular-arbuscular mycorrhizal fungi on the nodulation and growth of subclover. Journal of Range Management. 36(5): 576-578.**

Inoculation with the correct VAM fungal species is as important as the selection of the rhizobium species for subclover growth and development.

642. **Greenland, David E. 1980. Atmospheric dispersion in a mountain valley. Annals of the Association of American Geographers. 70(2): 199-206.**

643. **Greenland, David E. 1980. The use of modeled mixing height data with the Box Model applied to mountain valleys. *In:* Second joint conference on applications of air pollution meteorology; 1980 March 24-28; New Orleans, LA. Boston, MA: American Meteorological Society: 510-514.**

644. **Greer, Richard D. 1988. Effects of habitat structure and productivity on grassland birds. Laramie, WY: University of Wyoming. 129 p. Ph.D. dissertation.**

645. **Gregoire, Timothy G.; Driver, B. L. 1987. Analysis of ordinal data to detect population differences. Psychological Bulletin. 101(1): 159-165.**

The performance of selected parametric and nonparametric tests of location and sale differences are compared on the basis of sampling results from simulated populations of Likert-scale response ordinal data. Additionally, an omnibus test of distributional equality was examined. Type I and type II error rates for all procedures examined do not indicate any clearcut superiority for either type of test (parametric vs. nonparametric). Moreover, when sampling from disparate populations, the nonparametric tests of median equality are as sensitive to heterogeneous variances as the parametric test of mean equality.

646. **Gregoire, Timothy G.; Driver, B. L. 1987. Type II errors in leisure research. Journal of Leisure Research. 19(4): 261-272.**

Statistical tests can lead to erroneous conclusions about the null hypothesis. Attention frequently is focused exclusively on the probability of incorrectly rejecting the null hypothesis when it is true. We argue that the probability of failing to reject the null hypothesis in favor of an alternative hypothesis deserves increased attention and emphasis in exploratory research.

647. **Gregory, Robin; Bishop, Richard C. 1988. Willingness to pay or compensation demanded: Issues in applied resource valuation. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 135-142.**

648. **Grubb, Teryl G. 1980. An artificial bald eagle nest structure. Research Note RM-383. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Construction procedures are described for an artificial bald eagle nest support structure made of 4-inch aluminum pipe. The hinged, three-pole design permits complete assembly on the ground prior to raising and spreading the legs. The resulting tripod is inherently stable and offers natural support for a bald eagle nest and several perch branches more than 35 feet above the ground.

649. **Grubb, Teryl G. 1983. Bald eagle activity at an artificial nest structure in Arizona. Raptor Research. 17(4): 114-121.**

Bald eagle nesting activity was recorded with time-lapse photography at an artificial structure in central Arizona during the 1978-79 breeding season. Nest repair was evident more than 4 months before egg laying, with most activity initially concentrated at dawn and dusk. Management implications of artificial nests, survey techniques, and postfailure activity are discussed.

650. **Grubb, Teryl G. 1988. Pattern recognition—a simple model for evaluating wildlife habitat. Research Note RM-487. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Pattern recognition (PATREC) uses information on the frequency of specific habitat characteristics in areas of a particular habitat suitability class. The result is a simple probability that the sample being evaluated belongs to the designated suitability class. With habitat data obtained from aerial photography and topographic maps, a PATREC model has been developed on environmental features necessary for bald eagle (*Haliaeetus leucocephalus*) breeding occupancy in Arizona.

651. Grubb, Teryl G. 1988. A portable rocket-net system for capturing wildlife. Research Note RM-484. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Construction, use, and safety of a portable rocket-net system for use in wildlife capture are described, including the standard 3-rocket system, an experimental 2-rocket system, and a remote-controlled firing unit. Results of extensive system testing, as well as comments on field application to capture wintering bald eagles in Northern Arizona, are presented.

652. Grubb, Teryl G. 1984. Winter activity of bald eagles *(Haliaeetus leucocephalus)* at Navajo Lake, New Mexico. The Southwestern Naturalist. 29(3): 335-341.

Bald eagles wintering at Navajo Lake, New Mexico, were studied by ground observation and aerial surveys between November 1978 and April 1979. The population varied between 15 and 77, with peaks in January and March before and after maximum ice coverage on the lake. Most roosts were in small stands of ponderosa pine in sheltered drainages within 2 km of the lake. perch use was highly variable. Big game carrion was the primary food source, followed in order by small mammals, waterfowl, and fish.

653. Grubb, Teryl G.; Coffey, Michael A. 1982. Evidence of bald eafles feeding on freshwater mussels. Wilson Bulletin. 94(1): 84-85.

In 1978, a high incidence of freshwater mussel was evidenced in the diet of wintering bald eagles on the Coconino National Forest, in north-central Arizona.

654. Grubb, Teryl G.; Eakle, Wade L. 1987. Comparative morphology of bald and golden eagle nests in Arizona. Journal of Wildlife Management. 51(4): 744-748.

Seventeen bald *(Haliaeetus leucocephalus)* and 12 golden *(Aquila chrysaetos)* eagle nests in similar habitat in central Arizona were measured to determine whether unoccupied nests of these two species could be differentiated. Measurements included the diameter, length, and weight of nest sticks and overall dimensions of the nests. Sticks comprising bald eagle nests were consistently and significantly thicker and longer than those used by golden eagles ($P = 0.001$). Although there was much overlap in the sizes of nests and their sticks, the differences were visually evident in the field and can be used for distinguishing unoccupied nests of these two species.

655. Grubb, Teryl G.; Eakle, Wade L.; Tuggle, Benjamin N. 1985. *Haematosiphon inodorus* (Hemiptera: Cimicidae) in a nest of a bald eagle *(Haliaeetus leucocephalus)* in Arizona. Journal of Wildlife Diseases. 22(1): 125-127.

During the late spring/early summer of 1985, the first and second authors examined 31 eagle nests (18 bald and 13 golden) in central Arizona, including the 1984 infested nest described in this paper. Two young successfully fledged from the same nest in 1985, but there was no evidence of *H. inodorus*. However, another successful bald eagle nest had a concentration of 0.1 bugs/cm^2 weeks after fledging. Concentrations of 0.2 bugs/sq cm were found in two successful golden eagle nests within 1 week after fledging.

656. Grubb, Teryl G.; Eakle, Wade L. 1988. Recording wildlife locations with the universal transverse mercator (UTM) grid system. Research Note RM-483. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

The universal transverse mercator (UTM) international, planar, grid system is described and shown to offer greater simplicity, efficiency, and accuracy for plotting wildlife locations than the more familiar latitude-longitude (latilong) and section-township-range (cadastral) systems, and the state planar system. Use of the UTM system is explained with examples.

657. Grubb, Teryl G.; Forbis, Larry A.; McWhorter, Marta; Sherman, David R. 1988. Adaptive perch selection as a mechanism of adoption by a replacement bald eagle. Wilson Bulletin. 100(2): 302-305.

This paper describes the first recorded mate replacement within the same season for bald eagles and the full adoption (including incubation and/or brooding) by the replacement male. Location of perches and frequency of use for the new male indicate an adaptive selection process for optimal, or preferred, perches within the breeding area.

658. Grubb, Teryl G.; Kennedy, Charles E. 1982. Bald eagle winter habitat on southwestern national forests. Research Paper RM-237. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p.

An extensive, winter survey and habitat study in 1978 located about 100 bald eagles in Arizona and 350 in

New Mexico. Perching habits varied greatly but predictably. Study results offer some qualitative insights for habitat managers.

659. **Grubb, Teryl G.; Kennedy, Charles E. 1982. RUN WILD wildlife/habitat relationships: 1978 bald eagle winter habitat on the National Forest System in the Southwest. Wildlife Unit Technical Series. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 116 p.**

The most extensive search ever was conducted for bald eagle winter habitat in the Southwest. This report documents the winter habitat identified on National Forest System lands, records the 1978 bald eagle population distribution, and summarizes the reported and historical data collected.

660. **Grubb, Teryl G.; Knight, Richard L.; Rubink, Duane M.; Nash, Charles H. 1983. A five-year comparison of bald eagle productivity in Washington and Arizona.** *In:* **Bird, David M., editor. Proceedings of the first international symposium on bald eagles and ospreys; 1981 October 28-29; Montreal, Quebec. Montreal, Quebec: McDonald Raptor Research Centre, McGill University: 35-45. 325 p.**

Extensive bald eagle surveys from 1975 through 1980 in Washington and Arizona permitted quantitative and qualitative comparisons of occupancy, activity, and productivity within and between the two states. Variations in breeding chronology, habitat, climate, and other factors affecting productivity and subsequent research/management efforts are discussed also.

661. **Grubb, Teryl G.; Nagiller, Sandra J.; Eakle, Wade L.; Goodwin, Gregory A. 1989. Winter roosting patterns of bald eagles (Haliaeetus leucocephalus) in north-central Arizona. Southwestern Naturalist. 34(4): 453-459.**

Between 12 February and 4 April 1986, 93 nocturnal observations were recorded representing 28 separate roost locations for four immature, transmitter-equipped bald eagles (Haliaeetus leucocephalus) wintering in north-central Arizona. Analysis of behavioral and habitat data indicates independent movement and preferential habitat selection.

662. **Grubb, Teryl G.; Rubink, Duane M.; Hoffman, Stephen W.; Forbis, Larry A. 1983. Management of breeding bald eagles in Arizona—problems and perspectives.** *In:* **Ingram, Terrence N., editor. Proceedings of the bald eagle conference on "bald eagle resoration"; 1982 August 13-15; Rochester, NY. Apple River, IL: Eagle Valley Environmentalists: 73-88. 220 p.**

The 12 bald eagle breeding areas in Arizona have recently been the subject of intensive research and management, including extensive surveys, a nest watch program, artificial nests, nest site modifications, color making, telemetry, and fostering. Despite record productivity, the question of how much manipulation is enough remains.

663. **Gubler, Hans; Hiller, M.; Schmidt, Ralph A. 1985. FMCW-radar for snow cover investigations. Interner Bericht Nr. 627. Davos, Switzerland: Eidgenrossisches Institut Frur Schnee-Und Lawinenforschung. 36 p.**

664. **Guldin, Richard W. 1989. An analysis of the water situation in the United States: 1989-2040: a technical document supporting the 1989 U.S. Department of Agriculture, Forest Service RPA Assessment. General Technical Report RM-177. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 178 p.**

665. **Guthery, Fred S. 1980. Bobwhites and brush control. Rangelands. 2: 202-204.**

666. **Guthery, Fred S. 1980. Must the prairie gobbler fade? The Cattleman. 67: 132-134.**

667. **Guthery, Fred S. 1981. Playa basins and resident wildlife in the Texas Panhandle.** *In:* **Playa Lakes symposium proceedings; 1979 December 4-5; Arlington, TX. FWS/OBS-81/07. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service: 47-51.**

668. **Guthery, Fred S.; Custer, Jay; Owen, Mike. 1980. Texas Panhandle pheasants: their history, habitat needs, habitat development opportunities, and future. General Technical Report RM-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

Pheasants (*Phasianus colchicus*) colonized the Texas Panhandle in the late 1930's. Panhandle habitat is deficient in travel lanes, secure nesting cove, and overwinter cover. The high value of cropland limits habitat developmrent, but cover plantings may be feasible on idle areas. Aquifer depletion will probably decrease pheasant populations in the future.

669. **Guthery, Fred S.; Pates, Jean M.; Stormer, Fred A. 1982. Characterization of playas of north-central Llano Estacada in Texas.** *In:* **Sabol, Kenneth, editor. Transactions of the 47th North American wildlife and natural resources conference; 1982 March 26-31; Portland, OR. Washington, DC: Wildlife Management Institute. 722 p.**

The purpose of this study was to characterize playas in the north-central Llano Estacado by describing their physical features, identifying the physiognomic plant communities present, determining extent and type of land-use practices, and examining the effects of land use on physiognomic communities and floristics.

670. **Guthery, Fred S.; Stormer, Fred A. 1982. Brush, brush control, and wildlife in Texas.** *In:* **Proceedings, Great Plains Agricultural Council; 1982 June 7-9; North Platte and Lincoln, NE. 1-6.**

671. **Gutzwiller, Kevin J.; Anderson, Stanley H. 1987. Habitat suitability index models: marsh wren. Biological Report 82 (10.137). Washington, DC: USDI Fish and Wildlife Service. 16 p.**

672. **Gutzwiller, Kevin J.; Anderson, Stanley H. 1987. Multiscale associations between cavity-nesting birds and features of Wyoming streamside woodlands. Condor. 89(3): 534-548.**

673. **Gutzwiller, Kevin J.; Anderson, Stanley H. 1987. Short-term dynamics of cavity-nesting bird communities in disjunct floodplain habitats. Condor. 89(4): 710-712.**

674. **Gutzwiller, Kevin J.; Anderson, Stanley H. 1987. Trees used simultaneously and sequentially by breeding cavity-nesting birds. Great Basin Naturalist. 46(2): 358-360.**

675. **Gutzwiller, Kevin J.; Anderson, Stanley H. 1986. Use of abandoned cliff swallow nests by breeding house wrens. Prairie Naturalist. 18(1): 53-54.**

676. **Haas, Glenn E.; Driver, B. L.; Brown, Perry J. 1980. Measuring wilderness recreation experiences.** *In:* **Proceedings of the wilderness psychology group annual conference; 1980 August 14-15; Durham, NH. Durham, NH: New England Center for Continuing Education, University of New Hampshire: 20-40. 219 p.**

Users of three Colorado wildernesses share common experience preferences. Users of each area can be statistically classified into subgroups having distinct types of preferences. Managers can take specific actions to help provide those desired experiences.

677. **Haas, Glenn E.; Driver, B. L.; Brown, Perry J. 1980. A study of ski touring experiences on the White River National Forest.** *In:* **Proceedings of the national symposium on the dispersed winter recreation; 1980 February 27-29; University of Minnesota, St. Paul, MN. Education Series 2-3. St. Paul, MN: Office of Special Programs, University of Minnesota: 25-30. 171 p.**

Based upon 115 returned mail questionnaires, three types of ski touring experiences were identified: security- and achievement-oriented; solitude-oriented; and those with no strong feelings abaout risk-taking or meeting people. Implications demonstrate how an understanding of experience opportunities might be useful to recreation planners and managers.

678. **Haas, Glenn E.; Driver, B. L.; Brown, Perry J.; Lucas, Robert G. 1987. Wilderness management zoning: wilderness managers must have flexibility to administer different areas differently. Journal of Forestry. 85(12): 17-21.**

Our experience with managers and citizens in developing a wilderness opportunity zoning scheme for the Maroon Bells-Snowmass Wilderness has shown us its usefulness in developing management prescriptions and in communicating with interested citizens. We conclude that zoning is not only effective but inevitable. Zoning can help maintain diversity and enhance protection of wilderness as well as improve the quality of wilderness experience.

679. **Haase, Sally M. 1986. Effect of prescribed burning on soil moisture and germination of southwestern ponderosa pine seed on basaltic soils. Research Note RM-462. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Prescribed burning created a more favorable seedbed by exposing mineral soil and increasing soil moisture, resulting in a twenty-fold increase in the number of seeds germinating on burned compared to unburned sites.

680. **Hagihara, James S. 1982. Summary of existing classification techniques. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 611. 1101 p.**

681. **Hamala, James A.; Duncan, Scott W.; Blinn, Dean W. 1981. A portable pump sampler for lotic periphyton. Hydrobiologia. 80: 189-191.**

682. **Hamm, Phillip B.; Hansen, Everett M.; Hennon, Paul E.; Shaw, Charles G., III. 1987. Pears, bears, and *Phytophthora* in S.E. Alaska (or indication that *P. dreschleri* is endemic to S.E. Alaska). *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 68-71.**

683. **Hanks, Jess P.; Fitzhugh, E. Lee; Hanks, Sharon R. 1983. Habitat type classification system for ponderosa pine forests of northern Arizona. General Technical Report RM-97. Fort Collins, CO: U.S. Department of Agriculture, Forest Service Rocky Mountain Forest and Range Experiment Station. 22 p.**

Four major habitat types (HT's), divided into 12 phases (P's), are described for the ponderosa pine forests of northern Arizona addition, five community types (CT's) are described for the same area. On a wet to dry gradient, the HT's are (1) *Pinus ponderosa/Muhlenbergia virescens*, (2) *Pinus ponderosa/Muhlenbergia virescens-Festuca arizonica*, (3) *Pinus ponderosa/Festuca arizonica*, and (4) *Pinus ponderosa/Bouteloua gracilis*.

684. **Hansen, Paul L.; Hoffman, George R.; Steinauer, Gerry A. 1984. Upland forest and woodland habitat types of the Missouri Plateau, Great Plains Province. *In:* Noble, Daniel L.; Winokur, Robert P., editors. Wooded draws: characteristics and values for the northern Great Plains: symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication 111. Rapid City, SD: South Dakota School of Mines and Technology: 15-26.**

685. **Hansen, Paul L.; Hoffman, George R.; Bjugstad, Ardell J. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: a habitat type classification. General Technical Report RM-113. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 55 p.**

Vegetation of the Theodore Roosevelt National Park, North Dakota, was characterized according to habitat type based on concepts and methods developed by Daubenmire. Ten habitat types were described: seven-three grassland and four wooded types-occurred on upland plateaus, slopes, and relatively narrow benches along contours of the hills above the stream valleys; three-all wooded occurred in valley bottoms. A key to identify the habitat types and discussion on the validation of the habitat type classification and species diversity are provided.

686. **Hansen, Paul L.; Hoffman, George R. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. General Technical Report RM-157. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 68 p.**

A vegetation classification was developed, using the methods and concepts of Daubenmire, on the Ashland, Sioux, and Grand River/Cedar River Districts of the Custer National Forest. Of the 26 habitat types delimited and described, eight are steepe, nine shrub-steepe, four woodland, and five forest. Two community types also are described. A key to the habitat types and some of the changes resulting from disturbances of the vegetation also are included.

687. **Hansen-Bristow, Katherine J. 1983. Herbaceous vegetation changes resulting from sewage effluent applications, Colorado Front Range. Great Plains-Rocky Mountain Geography Journal. 10: 54-65.**

688. **Hansen-Bristow, Katherine J.; Flack, J. Ernest; Plam, Misha. 1982. Bacterial densities within recreational stream waters during summer holiday weekends, Indian Peaks Study Area, Colorado Front Range. Great Plains-Rocky Mountain Geography Journal. 10: 32-40.**

689. **Harding, Benjamin L.; Brown, Thomas C.; Payton, Elizabeth A.; Rozaklis, L. T.; Lord, William B. 1988. Market-based operation to improve the efficiency of water supplies from the Colorado River basin.** *In:* **U.S. Committee on Irrigation and Drainage: 181-191.**

690. **Harper, Kimball T.; Shane, John D.; Jones, John R. 1985. Taxonomy. DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 7-8. 283 p.**

691. **Harrell, Mark O. 1986. Control of combined population of *Dioryctria ponderosae* and *D. tumicolella*, two phloem borers of pine. Insecticide and Acaricide Tests. 11: 425.**

692. **Harrell, Mark O. 1986. Control of *Dioryctria tumicolella*, a phloem borer of pine. Insecticide and Acaricide Tests. 11: 426.**

693. **Harrington, Michael G. 1987. Characteristics of 1-year-old natural pinyon seedlings. Research Note RM-477. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Pinyon seedlings on high elevation basaltic sites were larger than those on limestone sites. Additionally, seedlings growing away from the overstory were larger than those found under"nurse" trees. Partial shading is still considered necessary for seedling establishment. Lateral roots of 1-year-old seedlings were distinctly sparse in the surface 4 cm of soil.

694. **Harrington, Michael G. 1983. Climate class adjustments improve accuracy of predicted fuel moisture stick values. Research Note RM-431. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

In the National Fire-Danger Rating System (NFDRS), a correction is added to fuel moisture stick values to offset weathering effects. This correction is now being adjusted to compensate for different weathering rates in different climates. The corrections for NFDRS climate class 2 appear quite representative of actual fuel stick weight losses in the Southwest. This climate class adjustment improves fire-danger assessment.

695. **Harrington, Michael G. 1986. Comparison of forest floor depth to loading relationships from several Arizona ponderosa pine stands. Research Note RM-463. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

The forest floor depth to loading relationships of a southeastern Arizona ponderosa pine stand was developed for use in general fuel loading assessments. A comparison of this relationship with those from other Arizona ponderosa pine stands revealed some large differences. Therefore, users are cautioned about the widespread application of individual depth to loading relationships.

696. **Harrington, Michael G. 1985. The effects of spring, summer, and fall burning on Gambel oak in a southwestern ponderosa pine stand. Forest Science. 31(1): 156-163.**

Prescribed fires were conducted in the spring, summer, and fall on a ponderosa pine-Gambel oak site to test the potential for oak control at various times of the year. One burn generally resulted in large (100-150 percent) oak density and (10-40 Percent) frequency increases, and only temporary cover decreases. A second burn in either the spring of fall failed to reduce the large number of oak sprouts contrast, a second midsummer burn resulted in reductions of 20 percent density, 16 percent frequency, and 12 percent cover. This should reduce the competitive status of the oak, favoring pine growth and natural pine regeneration.

697. **Harrington, Michael G. 1982. Estimating ponderosa pine fuel moisture using national fire-danger rating moisture values. Research Paper RM-233. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Comparisons were made between moisture contents of natural ponderosa pine fuels and the corresponding timelag moisture values calculated using the National Fire Danger Rating System. The two variables correlated well at the driest moisture levels, but

precipitation influenced each differently. Empirically derived equations permit adequate estimates of actual fuel moisture for burning projects.

698. **Harrington, Michael G. 1989. Gambel oak root carbohydrate response to spring, summer, and fall prescribed burning. Journal of Range Management. 42(6): 504-507.**

Nonstructural root carbohydrates were measured in understory Gambel oak in a dense ponderosa pine stand following prescribed fire. Concentrations of carbohydrates in roots of 1- to 2-year-old sprouts after a single fire treatment were similar to those in unburned, mature oaks. Two prescribed burns, 2 years apart during the summer carbohydrate depression, caused these root reserves to remain low into fall dormancy and probably contribute to an observed oak reduction.

699. **Harrington, Michael G. 1987. Phytotoxic potential of Gambel oak on ponderosa pine seed germination and initial growth. Research Paper RM-277. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Water soluble leachates from Gambel oak leaves reduces speed of germination and initial radicle growth of ponderosa pine seeds in laboratory and greenhouse experiments. The combined effects of Gambel oak competition and allelopathy are implicated as contributing factors limiting natural regeneration of ponderosa pine in many forest stands in the Southwest.

700. **Harrington, Michael G. 1987. Ponderosa pine mortality from spring, summer, and fall crown scorching. Western Journal of Applied Forestry. 2(1): 14-16.**

Mortality was compared among ponderosa pines with various degrees of crown damage sustained during fall, spring, and summer prescribed burns. After 5 years, 12% of the trees scorched in the fall had died compared to 26% scorched in the spring, and 29% scorched in the summer. Eighty-five percent of this mortality occurred in trees less than 7 inches d.b.h. scorch damage of up to 90% of the crown caused minimal mortality.

701. **Harrington, Michael G. 1987. Predicting reduction of natural fuels by prescribed burning under ponderosa pine in southeastern Arizona. Research Note RM-472. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Results from 10 prescribed burns conducted under different weather and fuel conditions in ponderosa pine stands in southeastern Arizona indicate that forest floor fuel consumption can be estimated using H-layer moisture content and either preburn forest floor depth or stand density. Equations presented give forest managers the ability to estimate and thus prescribe amounts of fuel that would be consumed by prescribed fire or unplanned ignition.

702. **Harrington, Michael G. 1981. Preliminary burning prescriptions for ponderosa pine fuel reductions in southeastern Arizona. Research Note RM-402. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Natural ponderosa pine fuels can be safely burned with air temperatures between 55°and 75°F, relative humidities between 25 percent and 50 percent, and windspeeds less than 10 miles per hour. Burning under these conditions will lessen the wildfire hazard by reducing fuel loadings, thinning the stand, removing ladder fuels, and raising the canopy level.

703. **Harrington, Michael G. 1982. Stand, fuel, and potential fire behavior characteristics in an irregular southeastern Arizona ponderosa pine stand. Research Note RM-418. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Arizona's natural ponderosa pine stands are characterized by open, mature groups and adjacent closed, dense thickets. The open structure of the mature groups permits a warm, dry environment, resulting in very low fuel moisture during much of the fire season and creating high ignition and fire spread potential in the abundant fuels. These findings suggest a need for fuel management activities where values-at-risk are high.

704. **Harris, Charles C. 1982. Recreation satisfaction: visitor evaluation of forest recreation experiences as a decisionmaking process. *In:* Lime, David W., technical coordinator. Forest and river recreation: research update; 1981 October 25-27; Minneapolis, MN. Miscellaneous Publication 18-1982. St. Paul, MN: University of Minnesota, Agricultural Experiment Station: 160-163.**

705. **Harris, Charles C.; Driver, B. L.; Bergersen, Eric P. 1984. Do choices of recreation areas reflect angler preferences for site attributes? *In:* Proceedings, 1984 Northwestern Science Association meeting; 1984 March 22-23; Missoula, MT. General Technical Report INT-184. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 46-54.**

706. **Harris, Charles C.; Driver, B. L.; Mclaughlin, William J. 1989. Improving the contingent valuation method: a psychological perspective. Journal of Environmental Economics and Management. 17(3): 213-229.**

Results of research on the social psychology of human decision making that offer direction for improving the Contingent Valuation Method are reviewed. Within the context of this literature, specific research directions are recommended that can improve the validity and reliability of the results of contingent valuation studies. More multidisciplinary studies are encouraged.

707. **Harris, Charles C.; Driver, B. L. 1987. Recreation user fees: pros and cons. Journal of Forestry. 85(5): 25-29.**

This paper covers the evolution of recreation fees, arguments for both free access and user fees, and recreation management concerning questions as to how charges will be assigned, what form they will take, cost effective collection of fees, and how user fees will be used.

708. **Harris, Charles C.; Tinsley, Howard E. A.; Donnelly, Dennis M. 1988. Research methods for public amenity resource valuation: issues and recommendations. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 201-218.**

The authors analyze conceptual and theoretical underpinnings of economic methods for estimating values for nonmarket goods. They assess existing evidence about, and suggest additional research to, examine the validity and reliablity of these methods. They consider alternative concepts and measurement approaches to complement and enhance reliability and validity of monetary measures of value.

709. **Harvey, Michael D.; Pitlick, John; Laird, Jeffrey R. 1987. Temporal and spatial variability of sediment storage and erosion in Ash Creek, Arizona. *In:* Erosion and sedimentation in the Pacific Rim; 1987 August 3-7; Corvallis, OR. IAHS-165. Corvallis, OR: International Association of Hydrological Sciences: 281-282.**

710. **Hawkes, Clifford L. 1980. Aquatic habitat of wetlands, ponds, and lakes of semiarid regions—an annotated bibliography of selected literature. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. (Unnumbered Publication).**

Contains 953 citations prepared to meet the needs of research and management groups interested in developing water quality guidelines and designing management requirements for water impoundments in strip mine areas of the northern Great Plains. Covers a wide range of subject areas in geographic regions of the world. Includes a subject work index with listings of titles.

711. **Hawkes, Clifford L. 1982. A conceptual framework of procedures to support national assessments of renewable resources. *In:* Armantrout, Neil B., editor. Proceedings of acquisition and utilization of aquatic habitat inventory information symposium; 1981 October 28-30; Portland, OR. Western Division of the American Fisheries Society: 10-16.**

712. **Hawkes, Clifford L.; Chalk, David E.; Hoekstra, Thomas W.; Flather, Curtis H. 1983. Prediction of wildlife and fish resources for national assessments and appraisals. General Technical Report RM-100. Fort Collins, CO: U.S. Department of Agriculture, Forest Service Rocky Mountain Forest and Range Experiment Station. 21 p.**

The ecological analysis techniques discussed are useful in models to assess the renewable resources of the nation's forests, rangelands, agricultural lands, and associated waters.

713. **Hawkes, Clifford L.; Miller, David L.; Layher, William G. 1986. Fish ecoregions of Kansas: stream fish assemblage patterns and associated environmental correlations. Environmental Biology of Fishes. 17(4): 267-279.**

Principal components analysis was performed on fish presence/absence data for 39 common fish species from 410 stream sites in Kansas. The analysis confirmed 10 ecologically meaningful fish assemblages,

based on species associations. Factor scores based on these assemblages were then clustered into six geographic areas or fish ecoregions. Mean annual runoff, mean annual growing season, and discharge appear most important. The multivariate statistical approach used to classify fish ecoregions should have considerable potential value for fish assessment and management purposes in areas other than Kansas.

714. **Hawksworth, Frank G. 1987. Cacti as parasites? Haustorium. 18: 1.**

715. **Hawksworth, Frank G. 1986. Insect-dwarf mistletoe associations. *In:* Proceedings, 36th annual western forest insect work conference; 1986 May 4-7; Boulder, CO. Edmonton, Alberta, Canada: Canadian Forestry Service: 49-50.**

716. **Hawksworth, Frank G. 1981. Los Muerdagos Enanos *(Arceuthobium)* y Su Importancia en la Silvicultura de Mexico. *In:* Memoria del primer simposio de parasitologia forestal; 1980 February 18-19; Uruapan, Michoacan, Mexico. Champingo, Mexico: Sociedad Mexicana de Entomologia Y Patologia Forestal. Universidad Autonoma de Champingo, Departmento de Bosques.**

717. **Hawksworth, Frank G. 1982. Mistletoes. *In:* You and your tree. Fort Collins, CO: Colorado State University, Extension Service: 13.**

718. **Hawksworth, Frank G. 1982. Mistletoes of New Mexico. Native Plant Society of New Mexico Newsletter. 7(6): 9-10.**

The raising of the former subfamilies Viscoideae and Loranthoideae to family status had generally been accepted. This places the two U.S. genera (*Phoradendron* and *Arceuthobium*) in the Viscadeae. The Lorahtaceae, in the strict sense, is more typical.

719. **Hawksworth, Frank G. 1983. Mistletoes as forest parasites. *In:* Clader, Malcom; Bernhardt, Peter, editors. Biology of mistletoes. Sydney, Australia: Academic Press: 317-333.**

This paper discusses the importance and control of mistletoes in natural forests and plantations in various parts of the world.

720. **Hawksworth, Frank G. 1983. Mistletoe literature of the world. The Golden Bough. 2: 5-8. (Royal Botanic Garden, Kew, England).**

721. **Hawksworth, Frank G. 1987. Mistletoe and its lore. The World and I. 2(12): 196-199.**

Mistletoe is unique in that its folklore and mythology date back to antiquity in many parts of the world. Its reputation as a medicinal and mystic plant has been known for at least 5,000 years. The origins of the plant's lore are obscure; even the derivation of its name appears uncertain.

722. **Hawksworth, Frank G. 1987. Mistletoes of Colorado. The Green Thumb. 42(2): 56-59.**

There are six mistletoes that grow in Colorado, all in the family Viscaceae. (These were formerly considered to be in the family Loranthaceae, but it is agreed now that mistletoes of the Loranthaceae are tropical and do not occur in the United States.) One species of Phoradendron, the genus that includes the leafy mistletoes to the South, and five dwarf mistletoes (genus *Arceuthobium*) are found in the state. All our species occur only on conifers.

723. **Hawksworth, Frank G. 1987. Mistletoes of Nevada. Northern Nevada Native Plant Society Newsletter. 14: 2.**

724. **Hawksworth, Frank G. 1980. Modeling and prediction of losses caused by dwarf mistletoes. *In:* Crop loss assessment: proceedings of the E. C. Stakman Commemorative symposium. Minnesota Agricultural Experiment Station Miscellaneous Publication 7. St. Paul, MN: University of Minnesota: 223-228.**

Development of yield simulation procedures for dwarf mistletoe-infested stands and overview of the various models are discussed.

725. **Hawksworth, Frank G. 1987. Paleobotany and evolution of the dwarf mistletoes *(Arceuthobium). In:* Weber, H.; Forstreuter, W., editors. Proceedings of the 4th international symposium on parasitic flowering plants; 1987 August 2-7; Marburg, West Germany. 309-316.**

726. **Hawksworth, Frank G. 1987. Parasitism in flowering plants, with emphasis on the mistletoes. *In:* Proceedings of the 14th International Botanic Congress; 1987 July 24-August 1; Berlin, West Germany. 370. (Abstract).**

727. **Hawksworth, Frank G. 1989. A second introduction of *Viscum album* in North America. The Golden Bough, Royal Botanic Gardens Kew, England. 11: 5.**

728. **Hawksworth, Frank G. 1982. Seed plants. *In:* Plant pathology. Encyclopedia of science and technology for 1981-1982. New York, NY: McGraw Hill, Inc. 452.**

Parasitic seed plants occur in at least 15 different families some families, all members are parasitic; in others, only a single genus is parasitic.

729. **Hawksworth, Frank G. 1987. Taxonomy on hemlock dwarf mistletoe. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 45-46.**

730. **Hawksworth, Frank G.; Bailey, D. K. 1980. Bristlecone pine, type 209. Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 89-90. 148 p.**

Bristlecone pines seem to have no particularly damaging pests except the dwarf mistletoes; *Arceuthobium microsarpum* causes severe mortality locally on the San Francisco Peaks, Arizona, and *A. cyanocardum* damages many stands in southern Utah and southern Nevada. Both pines are quite susceptible to the introduced white pine blister rust, although the fungus has not yet invaded the type.

731. **Hawksworth, Frank G.; Bailey, D. K. 1989. Pine trivia. Journal of Forestry. 87(11): 28-30.**

Pines are the most widely distributed and certainly the best known conifers. They are also the largest group of conifers. They are certainly the most important conifers for commercial wood production, but they are also valuable for their scenic beauty, use as ornamentals, watershed protection, and for other forest products use such as resin. This paper contains questions on pines that may cause some headscratching and some controversy.

732. **Hawksworth, Frank G.; Dixon, Christine S.; Krebill, Richard G. 1983. *Peridermium bethelii*: a rust associated with lodgepole pine dwarf mistletoe. Plant Disease. 67(7): 729-733.**

The rust fungus *Peridermium bethelii*, which is associated with dwarf mistletoe in lodgepole pine, has generally been considered synonymous with *Cronartium comandrae*. Attempts to infect mistletoe-infected pines were either unsuccessful or inconclusive and potential alternate hosts have not been found. Field evidence suggests the rust may be autoecious.

733. **Hawksworth, Frank G.; Dooling, Oscar J. 1984. Lodgepole pine dwarf mistletoe. Forest Insect and Disease Leaflet 18. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p. (Revised).**

734. **Hawksworth, Frank G.; Edminster, Carleton B. 1981. Carlos Bates' dwarf mistletoe resistant ponderosa pine: a postscript after a half century. Research Note RM-412. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Progeny of ponderosa pines presumably resistant to dwarf mistletoe were planted in Colorado in 1932. When trees were examined in 1979, no difference was found in mistletoe susceptibility between supposedly resistant trees and trees thought to be susceptible. The study is of historical significance as it is one of the first attempts to breed forest trees for resistance to disease in North America.

735. **Hawksworth, Frank G.; Geils, Brian W. 1985. Vertical spread of dwarf mistletoe in thinned ponderosa pine in Arizona. Research Note RM-460. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.**

Upward rate spread of southwestern dwarf mistletoe in pinus poinderosa was measured in a even-aged, 60-year-old stand near Flagstaff, Ariz. Upward rate of mistletoe spread in 343 trees averaged 10 cm per year over a 6-year period. This was about 2/3 the height growth rate of the same trees. No significant relationship was found between vertical spread of mistletoe and site index or thinning intensity.

736. **Hawksworth, Frank G.; Gilbertson, Robert L.; Wallis, Gordon W. 1985. Common names for tree diseases in the Western United States and western Canada. *In:* Hunt, R. S., compiler. Supplement to the proceedings, 32nd western international forest disease work conference; 1984 September 25-28; Taos, NM. Victoria, BC: British Columbia Forest Service, Pacific Forest Research Center. 37 p.**

737. **Hawksworth, Frank G.; Johnson, David W. 1989. Biology and management of dwarf mistletoe in lodgepole pine in the Rocky Mountains. General Technical Report RM-169. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 p.**

This publication synthesizes the vast literature on lodgepole pine dwarf mistletoe and adds some new information on biology of the parasite. Although dwarf mistletoe has been recognized as a serious parasite of lodgepole pine for more than 75 years, its routine operational control through forest management has developed primarily over the past two decades. This report discusses silvicultural control of dwarf mistletoe in various types of stands where fiber production is the primary goal, and also in forests used mainly for recreation.

738. **Hawksworth, Frank G.; Johnson, David W. 1989. Mistletoe control with ethephon: introduction. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 29-31.**

739. **Hawksworth, Frank G.; Johnson, David W.; Geils, Brian W. 1987. Sanitation thinning in young, dwarf mistletoe-infested lodgepole pine stands. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station: 218-219. 253 p.**

A study was begun in 1965 to evaluate sanitation and thinning in young mistletoe-infested lodgepole pine in northern Colorado. After 21 years, the average dwarf mistletoe rating of the treated plots was less than one- fourth that on the untreated plots. Stand projections suggest that in 20 years the merchantable cubic foot yields on the treated plots will be more than three times that on the untreated plots.

740. **Hawksworth, Frank G.; Laut, John G. 1981. Scots pine is susceptible to southwestern dwarf mistletoe. Plant Disease. 65: 263.**

In a small field test in Colorado, *Pinus sylvestris* was found to be very susceptible to the ponderosa pine dwarf mistletoe *Arceuthobium vaginatum* subsp. *cryptopodum*. Twelve of 16 seedlings were infected after exposure for eight seasons. Thus, Scots pine is not suitable for underplanting in infected ponderosa pine forests.

741. **Hawksworth, Frank G.; Lister, C. Kendall; Cahill, Donn B. 1983. Phloem thickness in lodgepole pine: its relationship to dwarf mistletoe and mountain pine beetle (Coleoptera: Scolytidae). Environmental Entomology. 12(5): 1447-1448.**

A generally accepted hypothesis is that lodgepole pines infected by dwarf mistletoe, *Arceuthobium americanum*, are less susceptible to mountain pine beetle because they have thinner phloem than uninfected trees. This study concludes that there is little correlation between dwarf mistletoe and mountain pine beetle activity, at least in Colorado.

742. **Hawksworth, Frank G.; Nicholls, Thomas H.; Merrill, Laura M. 1987. Long-distance dispersal of lodgepole pine dwarf mistletoe. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 220-226. 253 p.**

A total of 721 birds and 290 mammals were captured at the Fraser Experimental Forest during the autumns of 1982, 1983, and 1986 and examined for seeds of *Arceuthobium americanum*. Eighty-one mistletoe seeds were found on 75 trapped animals of 14 species (10 birds and 4 mammals). The gray jay and least chipmunk were the most common transporters of seed. During the peak period of seed dispersal in 1982, 22% of the individual birds and 20% of the individual mammals carried mistletoe seeds a 70-year-old stand of lodgepole pine that was otherwise mistletoe-free, we found 1.7 isolated infection centers per hectare, concentrated primarily near large stand openings. Such openings are apparently attractive habitats for birds that may transport dwarf mistletoe seeds for long distances. Thus, there is some evidence that these animals are vectors of dwarf mistletoe seeds, and that they are occasionally responsible for long-distance spread of the parasite.

743. **Hawksworth, Frank G.; Scharpf, Robert F. 1984. Biology of dwarf mistletoes: proceedings of the symposium. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 131 p.**

The dwarf mistletoes are the most damaging group of parasitic seed plants in North America. This symposium concentrated on their basic biology, with 16

papers summarizing current world research on various fields, including ecology, biosystematics, evolution, cytogeography, host parasite physiology, and anatomy of the parasite root system.

744. **Hawksworth, Frank G.; Scharpf, Robert F. 1987. Mistletoe literature of the world. *In:* Weber, H.; Forstreuter, W., editors. Proceedings of the 4th international symposium on parasitic flowering plants; 1987 August 2-7; Marburg, West Germany. 317.**

745. **Hawksworth, Frank G.; Scharpf, Robert F. 1981. Phoradendron on conifers. Forest Insect and Disease Leaflet 164. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.**

746. **Hawksworth, Frank G.; Scharpf, Robert F. 1986. Spread of european mistletoe *(Viscum album)* in California, U.S.A. European Journal of Forest Pathology. 16: 1-5.**

Viscum album was introduced in about 1900 into an area north of San Francisco, California. By 1984, the gross area covered by the parasite had spread to about 114 km^2. The average distance of spread from the point on introduction was 5.8 km. *Viscum* occurs on at least 22 hosts in California; the most common are *Acer saccharinum, Malus sylvestris, Robinia pseudoacacia, Alnus rubra, Populus fremontii,* and *Salix lasiandra.*

747. **Hawksworth, Frank G.; Shaw, Charles G., III. 1984. Damage and loss caused by dwarf mistletoes in coniferous forests of western North America. Wood, R. K. S.; Jellis, G. J., editors. Plant diseases: infection, damage and loss. Oxford, England: Blackwell Scientific Publications: 285-297.**

Dwarf mistletoes (genus *Arceuthobium,* family Viscaceae) are a unique group of forest tree pathogens that attack conifers in many parts of the northern hemisphere much of western North America, they are considered to be the single most damaging disease agent for many commercially important conifers. Oddly enough, *Juniperus,* which is the main host genus of *Arceuthobium* in the Old World, is not attacked in North America southern Asia *Juniperus* and other conifers are damaged by *Arceuthobium.* Although the dwarf mistletoes have a wide geographic distribution, they are considered serious forest parasites primarily in North America.

748. **Hawksworth, Frank G.; Shaw, Charles G., III. 1988. Damage and control of major diseases of ponderosa pine. *In:* Baumgartner, David M.; Lotan, James E., editors. Ponderosa pine: the species and its management: symposium proceedings; 1987 September 29-October 1; Spokane, WA. Pullman, WA: Washington State University: 99-108.**

Dwarf mistletoes, root diseases, stem rusts, heartrots, and needle and twig blights are important disease agents of ponderosa pine. The dwarf mistletoes are the most damaging although they can be controlled by silvicultural practices. Root diseases seriously affect yields in some areas. Growth and yield models have been modified to include the effects of dwarf mistletoes and root diseases.

749. **Hawksworth, Frank G.; Shaw, Charles G., III; Tkacz, Borys M. 1989. Damage and control of diseases of southwest ponderosa pine. *In:* Tecle, Aregai; Covington, W. Wallace; Hamre, Robert H., technical coordinators. Multiresource management of ponderosa pine forests: proceedings of the symposium; 1989 November 14-16; Flagstaff, AZ. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 116-129. 282 p.**

Ponderosa pine is affected by an array of tree diseases in the Southwest. The most serious of these are dwarf mistletoes, root diseases, trunk decays, limb rust, needlecasts, and abiotic disorders (drought and winter drying). Research is ongoing to quantify the effects of diseases on various resource values including timber, recreation, scenic beauty, wildlife habitat, biodiversity, and water yields.

750. **Hawksworth, Frank G.; Shaw, Charles G., III; Beatty, J. S. 1987. Forest pathology trivial pursuit. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 72-73.**

751. **Hawksworth, Frank G.; Shigo, Alex L. 1980. Dwarf mistletoe on red spruce in White Mountains, New Hampshire. Plant Disease Reporter. 64(9): 880-882.**

Arceuthobium pusillum has been generally regarded as a botanical curiosity. However, our observations in the White Mountains show that it is a damaging parasite of red spruce. The parasite causes growth reduction, tree mortality, and marked trunk swellings, which are a serious degrade factor.

752. **Hawksworth, Frank G.; Wiens, Delbert. 1984. Biology and classification of *Arceuthobium*: an update. *In:* Hawksworth, Frank G.; Scharpf, Robert F., technical coordinators. Biology of dwarf mistletoes: proceedings of the symposium; 1984 August 8; Fort Collins, CO. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 2-17. 131 p.**

Arceuthobium is the only mistletoe genu we recognized 32 taxa; 28 in the New World and 4 in the Old. Since then, 9 new taxa have been described or recognized; 5 in the New World and 4 in the Old. The greatest increase in the number of known taxa since 1972 has been in China (From 2 To 6), Guatemala (2 To 5), and Mexico (16 To 19). *Arceuthobium* is reported for the first time in El Salvador and Cuba. *Pinus* is the primary host of the genus (25 of 41 taxa), but for only 2 of the 8 Old World taxa.

753. **Hawksworth, Frank G.; Wiens, Delbert. 1980. A new species of *Arceuthobium* (Viscaceae) from central Mexico. Brittonia. 32(3): 348-352.**

Arceuthobium pendens, a parasite of the pinyons *Pinus discolor* and *P. cembroides*, is described from San Luis Potosi and Veracruz, Mexico. *Arceuthobium pendens* is distinct from *A. divaricatum* Engelm. In its long, slender, greenish shoots, formation of systemic witches brooms, and frequency on various species of pinyons.

754. **Hawksworth, Frank G.; Wiens, Delbert. 1989. Two new species, nomenclatural changes, and range extensions in Mexican *Arceuthobium* (Viscaceae). Phytologia. 66: 5-11.**

Two new species of *Arceuthobium* are described as parasites of pines *(Pinus)* in Mexico: *A. yecorence* infects several species of pines in eastern Sonora, western Chihuahua, and western Durango; *A. oaxacanum* is known only from two populations in one locality in southern Oacaca. With these additions, 22 taxa of *Arceuthobium* are known from Mexico.

755. **Hawksworth, Frank G.; Zakaullah. 1985. Observations on dwarf mistletoe on Himalayan blue pine in Pakistan. The Golden Bough, No. 7. Kew, Richmond, Surrey, UK: Royal Botanic Gardens: 1-2.**

756. **Hayes, D. C.; Seastedt, T. R. 1989. Nitrogen dynamics of soil water in burned and unburned tallgrass prairie. Soil Biology and Biochemistry. 21(8): 1003-1007.**

757. **Heberlein, Thomas A. 1988. Economics and social psychology in amenity valuation. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 235-244.**

758. **Heede, Burchard H. 1981. Analysis and guidelines for watershed rehabilitation. *In:* Coats, Robert N., editor. Proceedings of a symposium on watershed rehabilitation in Redwood National Park and other Pacific Coastal areas; 1981 August 24-28; Sacramento, CA. The Center for Natural Resource Studies, JMI, Inc., in cooperation with the USDI National Park Service: 103-117. 360 p.**

Analysis of gully networks and subsequent ranking of the network gullies for treatment priority leads to highest benefits for least cost. Ranking is suggested as a stepwise process consisting of determining stream order, number of tributaries, and stages of development. Development stages are interpreted in terms of present and expected future erosion rates.

759. **Heede, Burchard H. 1985. Application of geomorphological concepts to evaluate timber harvest influences on a stream channel—a case study. Zeitschrift Fur Geomorphologie N.F. Suppl.-BD. 55: 121-130.**

This case study demonstrated the usefulness of geomorphologic considerations in the assessment of land management effects on streams. It was shown that probably reduction of transpiration due to timber removal and not the logging operation per se caused increased adjustment (erosion) rates.

760. **Heede, Burchard H. 1986. Balance and adjustment processes in stream and riparian systems. *In:* Proceedings, Wyoming water 1986 and streamside zone conference; 1986 April 28-30; Casper, WY. Laramie, WY: Wyoming Water Research Center, University of Wyoming, Agricultural Extension Service: 3-8. 181 p.**

All natural systems are dynamic and are changing regardless of man's or other influences. Natural processes within and between systems will eventually restore dynamic equilibrium after disturbances, but control measures may be desirable to speed the processes after serious disruptions. Control measures must work with rather than against, ongoing natural adjustment processes.

761. **Heede, Burchard H. 1985. Channel adjustments to the removal of log steps: an experiment in a mountain stream. Environmental Management. 9(5): 427-432.**

In this experiment, all log steps were removed from a stream and the formation of new log steps was prohibited by periodic removal of fallen trees and branches. Five years later, 74% of all removed log steps had been replaced by gravel bars, thus providing the hypothesis that increased bedload movement was required to offset the loss of log steps. Implications are that streamside forests should be managed so that they can provide a steady supply of debris for a channel stability.

762. **Heede, Burchard H. 1989. Complex erosional processes on a chaparral watershed: 28 years after a wildfire. *In:* Erosion knows no boundaries: proceedings of conference 20; 1989 February 15-18; Vancouver, BC, Canada. Vancouver, BC, Canada: International Erosion Control Association: 389-396.**

Vegetation restoration on a burned chaparral watershed prevents sediment delivery into the channels by regrowth of natural vegetation buffer strips. Sediment clogged tributary channels are excavating the deposits due to clear water entering the channels. This sediment is deposited in the main channel that cannot transport it due to lack of competent flows.

763. **Heede, Burchard H. 1983. Control of rills and gullies in off-road vehicle traffic areas. *In:* Webb, Robert H.; Wilshire, Howard G., editors. Environmental effects of off-road vehicles—impacts and management in arid regions. New York, NY: Springer-Verlag: 245-264. 514 p.**

In most desert environments, off-road vehicle traffic causes plant and surface soil destruction that leads to local base level changes and loss of equilibrium condition. While natural adjustments may take thousands of years, artificial control of rills and gullies, by stabilizing base levels, will hasten attainment of new equilibrium.

764. **Heede, Burchard H. 1986. Designing for dynamic equilibrium in streams. Water Resources Bulletin. 22(3): 351-357.**

Streams are dynamic systems, so steady state does not exist for any appreciable period of time. Streams in dynamic equilibrium respond quickly to change, regaining a new equilibrium. Examples are presented of treatments causing new critical situations and measures to correct them.

765. **Heede, Burchard H. 1981. Dynamics of selected mountain streams in the western United States of America. Zeitschrift Fur Geomorphologie. 25(1): 17-32.**

In the study streams, only knowledge of the longitudinal profile and the yearly runoff characteristics is required to determine the dynamic equilibrium condition. Dynamic equilibrium existed if the profile was concave and streamflow was perennial; it did not exist if the profile was convex or linear and streamflow ephemeral.

766. **Heede, Burchard H. 1984. The evolution of salmonid stream systems. *In:* Richardson, Frank; Hamre, Robert H., editors. Wild Trout 3. Proceedings of the symposium; 1984 September 24-25; Yellowstone National Park, WY. Vienna, VA: Trout Unlimited: 33-37. 192 p.**

Evolution of salmonid stream systems is described in light of terrestrial history. The last ice age was responsible for the macro land forms in high mountain areas, the location of most salmonid streams. In terms of man, long time spans were required to create a quasi-equilibrium condition within the stream systems as well as with other systems. Interaction with other systems is demonstrated for small salmonid streams running through forests by the incorporation of fallen logs into the channels, providing additional adjustment to overly steep stream gradients. If not disturbed by man, the interaction between the systems is harmonious and quasi-balance prevails.

767. **Heede, Burchard H. 1982. Gully control: determining treatment priorities for gullies in a network. Environmental Management. 6(5): 441-451.**

This report is about a newly developed procedure for setting priorities in gully control. Classifying gullies into continuous and discontinuous types not only allows determination of network types but also points to critical locations that must be considered by the designer.

768. **Heede, Burchard H. 1980. Gully erosion—a soil failure: possibilities and limits of control. *In:* Proceedings of symposium interpraevent 1980; 1980 September 8-12; Bad Ischel, Austria.**

Although American gullies and European torrents have certain similarities, they have differences caused by their origins; gullies are soil failures; torrents are rock failures. Gully erosion is not a new phenomenon in the western United States. Gully control objectives

must be analyzed realistically to permit selection of successful treatments. Different control methods exist.

769. **Heede, Burchard H. 1987. The influence of pinyon-juniper on microtopography and sediment delivery of an Arizona watershedp. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 195-198. 253 p.**

Hummocks formed by litter fall of pinyon-juniper trees resulted in soil formation. Overland flows were diverted and slope gradients decreased by about 57%. in turn, streampower decreased. It is proposed that this was responsible for the decreased sediment delivery. Where buffer strips exist below nonwooded areas, sediment delivery was practically nullified.

770. **Heede, Burchard H. 1988. The influence of vegetation and its spatial distribution on sediment delivery from selected Arizona forests and woodlands. *In:* Erosion control: stay in tune: proceedings of the 19th international erosion control association conference; 1988 February 25-26; New Orleans, LA. Steamboat Springs, CO: International Erosion Control Association: 383-392.**

Overland flow and sediment delivery processes in ponderosa pine, mixed conifer, pinyon-juniper, and chaparral watersheds showed that for erosion control, the spatial vegetation distribution is more important than the vegetation type. Nonwooded sites without buffer strips delivered substantially more sediment than wooded sites. Delivery was practically nonexistent where buffer strips grew below nonwooded areas.

771. **Heede, Burchard H. 1985. Interactions between streamside vegetation and stream dynamics. *In:* Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 54-58. 523 p.**

Interrelationships between vegetation and hydrologic processes in riparian ecosystems must be considered by managers before they attempt to alter these natural systems. A 5-year experiment demonstrated that logs that fall across the channel from streamside forests dissipate flow energy, maintain channel stability, decrease bedload movement, and increase water quality.

772. **Heede, Burchard H. 1987. Opportunities and limits of erosion control in stream and gully systems. *In:* Erosion control...you're gambling without it. Proceedings of conference 18; 1987 February 26-27; Reno, NV. Pinole, CA: International Erosion Control Association: 203-209. 335 p.**

The selection of erosion control projects should be based on expected returns from the project. Returns are influenced by the ongoing physical processes and the advance of the system toward a new dynamic equilibrium. If the ongoing adjustment processes can attain equilibrium within an acceptable period of time, human interference would not be required. Interactions between gullying and soil piping processes in sodic soil are an example. Other examples demonstrate the intricate erosional processes in streams and gullies, and stress the interactions between different natural systems. Thus, gully erosion may be caused by a degrading river system a great distance from the gully or a river may aggrade its bed because a riparian community upstream was destroyed. Cause and effect must be determined for effective control, which often is difficult due to separation in time and space. The scope of investigation should include the major interacting natural systems, which may require specialists from different disciplines.

773. **Heede, Burchard H. 1984. Overland flow and sediment delivery: an experiment with small subdrainage in southwestern ponderosa pine forests (Colorado, U.S.A.). Journal of Hydrology. 72: 261-273.**

Overland flow and sediment delivery were insignificant on 14 small subdrainages of southwestern ponderosa pine forests. Sediment delivery from undisturbed forest floor practically was nil. Sources for sediment production were roads and erosion pavements and were not universally disturbed on the watersheds. Most erosion pavements were believed to be the result of selected timber harvest 42 years ago. Hypotheses on the development of these pavements were proposed.

774. **Heede, Burchard H. 1987. Overland flow and sediment delivery five years after timber harvest in a mixed conifer forest (Arizona). Journal of Hydrology. 91(1987): 205-216.**

Timber was harvested for the first time in a mixed conifer forest of the Arizona White Mountains by patch cuts and group selection. After harvest, 19 small subdrainages were equipped with runoff and sediment collectors. The forest floors in the subdrainages were classed as undisturbed, moderately disturbed or severely disturbed. Severe disturbance, caused by logging and monitoring activities, was associated with a pre-existing erosion pavement that had developed for unknown reasons. Although overland flow and sediment delivery differed significantly between the severely disturbed and undisturbed groups during the 5 year postharvest period, all quantities were practically insignificant.

775. **Heede, Burchard H. 1981. Rehabilitation of disturbed watersheds through vegetation treatment and physical structures.** ***In:*** **Interior West watershed management proceedings; 1980 April 8-10; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension Service: 257-268. 288 p.**

A case study of a disturbed watershed in the southern Rocky Mountains of Colorado demonstrated that a watershed can be successfully rehabilitated by combining physical structures with vegetation treatment. The results clearly demonstrated the need for basing successful watershed rehabilitation treatments on basic geomorphic processes.

776. **Heede, Burchard H. 1983. Sediment source areas after timber harvest in mixed conifer.** ***In:*** **Proceedings of the third annual AGU Front Range Branch hydrology days; 1983 April 19-21; Fort Collins, CO. Fort Collins, CO: Colorado Water Resources Research Institute, Colorado State University: 139-156. 179 p.**

Overland flow and sediment delivery were insignificant the first 2 years after harvest, although disturbed forest floors had higher sediment production than undisturbed floors. This production originated from point sources only. an erosion pavement area was one of the highest sediment producers, substantiating findings from ponderosa pine forests.

777. **Heede, Burchard H. 1984. Sediment source areas related to timber harvest on selected Arizona watersheds.** ***In:*** **O'Loughlin, C. L.; Pearce, A. J., editors. Symposium on effects of forest land use on erosion and slope stability; 1984 May 7-11; Honolulu, HI. Honolulu, HI: Environment and Policy Institute, East-West Center, University of Hawaii: 123-130. 310 p.**

In all watersheds, overland flow and sediment delivery were of no practical importance, but significant differences existed where the forest land was disturbed by logging or monitoring activities. Where undisturbed forest floor was located downslope from source areas, sediment was caught by the buffer strip because of increased infiltration.

778. **Heede, Burchard H. 1980. Stream dynamics: an overview for land managers. General Technical Report RM-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p.**

Concepts of stream dynamics are demonstrated through discussion of processes and process indicators; theory is included only where helpful to explain concepts. Present knowledge allows only qualitative prediction of stream behavior. However, such predictions show how management actions will affect the stream and its environment.

779. **Heede, Burchard H.; DeBano, Leonard F. 1984. Gully rehabilitation—a three-stage process in a sodic soil. Soil Science Society of America. 48(6): 1416-1422.**

The geomorphic, adaphic, and vegetation changes occurring in sodic soils were studied during a gully rehabilitation project in western Colorado. Rehabilitation occurred in three stages; nonvegetated sodium banks disintegrated; the colluvial material from these eroded banks was weathered and leached; and, finally, when enough sodium has been leached from the eroded material, it was stabilized adn vegetated as older colluvial material at the base of high sodium gully banks or as channel alluvium deposited behind gully structures. These changes led to an overall stabilization of the gullies and reduced suspended sediment and peak flows.

780. **Heede, Burchard H.; Harvey, Michael D.; Laird, Jeffrey R. 1988. Sediment delivery linkages in a chaparral watershed following a wildfire. Environmental Management. 12(3): 349-358.**

Vegetation recovery after a wildfire caused cessation of sediment delivery from the watershed into the stream system, but sediment transport from tributaries into the main stream continues. This asynchronous behavior requires the study of both watershed area and channel network before management decisions can be made.

781. **Heede, Burchard H.; Rinne, John N. 1989. Flowing water, stream form, and trout: interactions and implications for research and management. *In:* Richardson, Frank; Hamre, Robert H., technical editors. Wild Trout IV: proceedings of the symposium; 1989 September 18-19; Yellowstone National Park, WY. 219-227.**

The disciplines of hydrology, fluvial morphology, and fisheries have developed separately. Functionally, they have largely remained that way. There is a need for land managers and researchers to bridge the gaps between these disciplines in order to improve our understanding in their (1) complex interactions, and (2) implications for management of our valuable salmonid fishery resource.

782. **Heede, Burchard H.; Weatherred, James D. 1981. CAGCOM: a program for designing dams for gully control. WSDG Application Document WSDG-AD-00003. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Watershed Systems Development Group.**

This paper provides great flexibility in the use of CAGCOM, so that it can be applied in regions or countries where conditions differ from those of the southwestern United States. Primary topics of this report are key equations, field and computer input procedures, and sample problem.

783. **Hegg, Karl M.; Larson, Frederic R.; Mead, Debert R. 1981. Multiresource inventory in interior Alaska. *In:* Proceedings, eighth biennial workshop on color aerial photography in the plant sciences; 1981 April 21-23; Luray, VA. Falls Church, VA: American Society of Photogrammetry: 59-68.**

784. **Heidmann, L. J. 1986. Acetone is unreliable as a solvent for introducing growth regulators into seeds of southwestern ponderosa pine (*Pinus ponderosa* var. *scopulorum*). *In:* Proceedings, conifer seed in the Inland Mountain West symposium; 1985 August 5-6; Missoula, MT. General Technical Report INT-203. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 44-46. 289 p.**

Acetone is reported to be a reliable solvent for introducing plant growth regulators into various seeds without affecting germination. Several experiments in which southwestern ponderosa pine seeds were soaked in acetone for periods of 1 to 24 hours, then germinated under various temperature regimes, gave negative results, even at soaking periods as short as 1 hour.

785. **Heidmann, L. J. 1982. The effect of natural and selected synthetic growth regulators on the growth of ponderosa pine seedlings. Forest Science. 28(1): 156-160.**

Experiments with selected, naturally occuring and synthetic plant growth regulators applied as a root soak to dormant southwestern ponderosa pine seedlings revealed that only gibberellins significantly increased height growth. The effects of gibberellins on root growth were variable. The regulator o-coumaric acid significantly increased root ovendry weight. Application of hormones and regulators as a top dip was ineffective.

786. **Heidmann, L. J. 1984. Fertilization increases cone production in a 55-year-old ponderosa pine stand in central Arizona. Forest Science. 30(4): 1079-1083.**

Female flowering and number of cones in ponderosa pine were linearly related to urea ammonium phosphate application. A rate of 1,121 kg/ha produced about four times as many cones as controls; 560 kg/ha produces twice as many as controls. Fertilizer had no effect on male flower production. Increased cone production seems to be related to inherent ability to flower and heavy fertilizer application.

787. **Heidmann, L. J. 1985. Heavy fertilization increases diameter growth slightly in a 55-year-old ponderosa pine stand in central Arizona. Research Note RM-452. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.**

In a stand of Rocky Mountain ponderosa pine thinned to a minimum spacing of 20 by 20 feet (6.10 by 6.10 m), 0, 500, and 1,000 pounds of urea ammonium phosphate (28-28-0) per acre (0, 560.19 and 1,120.38 kg/ha) were applied annually from 1974 to 1977, to six replications of four trees in randomized blocks. Although fertilization at the heavier rate significantly increased diameter growth, height growth was not affected by any of the treatments.

788. **Heidmann, L. J. 1989. Induction of buds on juvenile conifers with N-6-benzylaminopurine and phloroglucinol. Plant Propagator. 1(1): 12-13.**

789. **Heidmann, L. J. 1983. An initial determination of the "lifting window" for ponderosa pine raised at Albuquerque, New Mexico. *In:* Proceedings of the 1982 western nurserymen's conference; 1982 August 10-12; Medford, OR. Ashland, OR: Southern Oregon Regional Services Institute, Southern Oregon State College: 77-84. 211 p.**

Initial results for each forest indicate the later the trees are lifted, the higher the survival rate.

790. **Heidmann, L. J. 1986. The interaction of gibberellic acid, n-6-benzylaminopurine and abscisic acid in the germination of *Pinus ponderosa* var. *scopulorum*. *In:* 21st International Seed Testing Association (ISTA) Congress; 1986 July 10-19; Brisbane, Australia. Zurich, Switzerland: ISSA Secretariat.**

Gibberellic acid, abscisic acid, and n-6-benzylaminopurine, singly or in combination, were applied to *Pinus ponderosa* var. *scopulorum* Engelm. seeds after a 20-minute vacuum, using either distilled water or acetone as a solvent. Acetone alone appears to repress germination; but the hormones appear able to reverse this effect.

791. **Heidmann, L. J. 1981. Overcoming temperature-dependent dormancy of southwestern ponderosa pine seed. Research Note RM-406. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Germination of seeds of *Pinus ponderosa* var. *scopulorum* is temperature-dependent. A laboratory experiment under fluctuating warm (16 hours at 24-27° C) and cold (8 hours at 3-4° C) temperatures showed that seeds given 48-hour aerated soaks of gibberellic acid (Ga_3), thiamin, or nine other materials, including water, germinated faster than controls.

792. **Heidmann, L. J. 1985. Ponderosa pine regeneration in the Southwest. *In:* Foresters future: leaders or followers? Proceedings of the 1985 Society of American Foresters national convention; 1985 July 28-31; Fort Collins, CO. Bethesda, MD: Society of American Foresters: 228-232. 445 p.**

Regenerating ponderosa pine (*Pinus ponderosa* var. *scopulorum*) in the Southwest is difficult because of limited soil moisture, damage from animals, and frost heaving. Successful plantations can be established on igneous and sedimentary soils if proper-size nursery stock is lifted at the right time and planted carefully on well-prepared sites. Plantations must be protected from livestock. On sedimentary soils, natural regeneration can be established by timing site preparation with cone crops. Rodent control and exclusion of livestock are essential. In recent years, more than 4,453 ha (11,000 acres) of natural regeneration have been established on the Apache-Sitgreaves National Forest in Arizona, at a cost of about $101/ha ($41/acre).

793. **Heidmann, L. J. 1989. Regeneration strategies for ponderosa pine. *In:* Ponderosa pine-the species and its management; 1987 September 29-October 1; Spokane, WA. 227-233.**

794. **Heidmann, L. J. 1983. Seed production in southwestern ponderosa pine on a sedimentary soil. Research Note RM-434. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.**

Original estimates of seed production in southwestern ponderosa pine were probably low. In this study, an estimated 350,000 seeds per acre were produced. This is approximately six times as much as early estimates and about equal to production observed in a virgin stand on basalt-derived soils.

795. **Heidmann, L. J. 1983. Silvicultural control of dwarf mistletoe in southwestern ponderosa pine. Research Note RM-433. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Three treatments—light improvement selection, limited control, and complete control—were tested. After 27 years, it appears that complete removal of infected overstory and understory trees is the only effective silvicultural method of controlling dwarf mistletoe in mature stands of southwestern ponderosa pine.

796. **Heidmann, L. J. 1984. Using herbicides for reforestation purposes in the Southwest. General Technical Report RM-103. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

Site preparation is essential to successfully regenerate conifer stands in the Southwest. Selection of herbicides used to prepare regeneration sites, calibration of equipment, methods of application, and safety are discussed.

797. **Heidmann, L. J.; Cornett, Zane J. 1986. Effect of various nutrient regimes and ectomycorrhizal inoculations on field survival of ponderosa pine (*Pinus ponderosa* var. *scopulorum* Engelm.) container seedlings in Arizona. Tree Planters' Notes. 37(2): 15-19.**

Pinus ponderosa var. *scopulorum* Engelm. container seedlings raised under four nutrient and three mycorrhizal inoculation treatments survived well in the field. Trees inoculated with forest duff survived bet-

ter than noninoculated seedlings. Generally, seedlings raised under high nitrogen regimes had greater growth.

798. **Heidmann, L. J.; Haase, Sally M. 1989. Causes of mortality in outplanted ponderosa pine container seedlings in the Southwest. Tree Planters' Notes. 40(3): 16-19.**

Rocky Mountain ponderosa pine (*Pinus ponderosa* var. *scopulorum* Engelm.) seedlings, raised in containers under a low N regime, were planted on a 1-year-old burn in central Arizona and were protected from wildlife. Survival after 1 year was 90%. There were no differences in survival between naturally shaded and unshaded plots. Mortality was caused primarily by frost heaving and drought.

799. **Heidmann, L. J.; Haase, Sally M. 1985. Herbicides for controlling weeds at the Albuquerque forest tree nursery. *In:* Proceedings: Western Forest Nursery Council-Intermountain Nurseryman's Association combined meeting; 1984 August 14-16; Coeur d'Alene, ID. Lakewood, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region: 91-94.**

In 1982, a study was initiated at Albuquerque, New Mexico, to test oxyfluorfen, bifenox, and propazine for controlling grasses and forbs in ponderosa pine nursery beds. Propazine was highly toxic to pine seedlings. Oxyfluorfen at a rate of 0.5 pound ai per acre controlled vegetation without damage to tree seedlings.

800. **Heidmann, L. J.; Johnsen, Thomas N., Jr.; Cole, Quinten; Cullum, George. 1982. Establishing natural regeneration of ponderosa pine in central Arizona. Journal of Forestry. 80(2): 77-79.**

Since 1968, more than 11,000 acres of Rocky Mountain ponderosa pine natural regeneration have been established on the Chevelon District of the Apache-Sitgreaves National Forest, by timing site preparation and rodent control with seedfall. Domestic livestock is excluded from regeneration areas.

801. **Held, R. Burnell. 1980. Bridging the knowledge gap from landscape architect to natural resource manager. Landscape Research. 5(3): 28.**

802. **Hennon, Paul E.; Shaw, Charles G., III. 1985. A management strategy for stands suffering from Alaska-cedar decline. *In:* Technology and the scientist, proceedings 1985 arctic science conference; 1985 September 27-29; Fairbanks, AK. Fairbanks, AK: American Association for the Advancement of Science-Arctic Division, 36th Alaska Science Conference: 1.**

803. **Hennon, Paul E.; Shaw, Charles G., III. 1987. Noteworthy forest diseases in Alaska. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 13-19.**

804. **Hennon, Paul E.; Shaw, Charles G., III; Hansen, Everett M. 1987. Onset, spread, and community relationships of decline of *Chamaecyparis nootkatensis* in southeast Alaska. *In:* Laderman, A. D., editor. Proceedings of the Atlantic white cedar wetlands symposium; 1984 October; Woods Hole, MA. Boulder, CO: Westview Press: 331-337.**

805. **Henry, Stephen E.; Raphael, Martin G. 1989. Observations of copulation of free-ranging American marten. Northwestern Naturalist. 70(2): 32-33.**

806. **Herrick, David E.; Clark, Elmer C. 1980. Priorities for food, forestry, and agricultural sciences research through 1984: western region. Fort Collins, CO: Research Committee, Western Regional Council on Food and Agricultural Sciences. 31 p.**

807. **Hess, Karl; Alexander, Robert R. 1986. Forest vegetation of the Arapaho and Roosevelt National Forest in north-central Colorado: a habitat type classification. Research Paper RM-266. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 48 p.**

A vegetation classification based on concepts and methods developed by R. Daubenmire and refined by others was used to identify 30 forest habitat types on the Arapaho and Roosevelt National Forests. Included were five habitat types in the *Pinus ponderosa* series; four each in the *Pseudotsuga menziesii*, *Pinus contorta*, and *Abies lasiocarpa* series; three each in the *Juniperus scopulorum*, *Pinus flexilis*, and *Populus tremuloides* series, and one each in the *Populus angustifolia*, *Picea pungens*, *Picea engelmannii*, and *Pinus*

aristata series. A key to identify the habitat types and the management implications associated with each is provided.

808. Hess, Wilford M.; Nelson, David L.; Sturges, David L. 1985. Morphology and ultrastructure of a snowmold fungus on sagebrush (*Artemisia tridentata*). Mycologia. 77(4): 637-645.

809. Hibbert, Alden R. 1981. Opportunities to increase water yield in the Southwest by vegetation management. *In:* Proceedings of the Interior West watershed management symposium; 1980 April 8-10; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension Service: 223-230. 288 p.

Management of vegetation to reduce evapotranspiration can increase water yield in forests and brushlands of the Southwest. However, multiple use and other considerations tend to reduce both amount of treatable area and effectiveness of treatments. Only three vegetation types—mixed conifers, ponderosa pine, and chaparral—offer significant opportunity to increase the water supply.

810. Hibbert, Alden R. 1986. Storm runoff and sediment production after a wildfire in chaparral. *In:* Proceedings of the 1985 meetings Arizona Section, American Water Resources Association, Hydrology Section Arizona-Nevada Academy of Sciences; 1985 April 27; Las Vegas, NV. Tucson, AZ: Arizona Water Resources Association: 31-42.

811. Hibbert, Alden R. 1984. Stormflows after fire and conversion in chaparral. *In:* Bell, B., editor. Medecos IV. Proceedings, fourth international conference on Mediterranean ecosystems; 1984 August 13-17; Perth, Western Australia. Nedlands, Australia: University of Western Australia, Botany Department: 71-72.

812. Hibbert, Alden R. 1983. Water yield improvement potential by vegetation management on western rangelands. Water Resources Bulletin. 19(3): 375-381.

813. Hibbert, Alden R. 1986. Water yield from channelside, ridgeline, and mosaic treatment patterns in chaparral. *In:* 30th annual Arizona water symposium; 1986 September 17; Scottdsale, AZ. Phoenix, AZ: Arizona Water Resources Committee: 13-25.

814. Hibbert, Alden R. 1987. Water yield improvement in chaparral: A summary of experimental results. *In:* Challenges and opportunities in chaparral management: Proceedings of the Southwestern Society of American Foresters annual fall meeting; 1986 November 12-14; Prescott, AZ. Flagstaff, AZ: San Francisco Peaks Chapter of the Society of American Foresters and Northern Arizona University; SAF0: 15-26.

815. Hibbert, Alden R.; Davis, Edwin A. 1986. Streamflow response to converting Arizona chaparral in a mosaic pattern. *In:* Hydrology and water resources in Arizona and the Southwest; 1986 April 19; Glendale Community College, AZ. Tucson, AZ: American Water Resources Association; 16: 123-131.

Converting 55% of an Arizona chaparral watershed to grass in a mosaic pattern, giving major consideration to wildlife habitat values, water quality, and landscape esthetics, produced an average of 68 mm of extra streamflow per year from the watershed during a 4-year evaluation period. When the increased streamflow was prorated to the area actually treated, the increase amounted to 124 mm. Increases in streamflow were largest in winter, and streamflow was extended considerably longer into the dry periods than before treatment.

816. Hibbert, Alden R.; Davis, Edwin A.; Knipe, O. D. 1982. Water yield changes resulting from treatment of Arizona chaparral. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 382-389. 637 p.

Annual streamflow from small chaparral watersheds in a 600-700 mm rainfall zone, was increased 75-100 mm and changed from intermittent to perennial flow by converting brush to grass with herbicides. About 85 percent of the increase occurs in 6 fall-winter months which get 60 percent of the precipitation. Yearly increases tend to be exponentially related to precipitation.

817. **Hibbert, Alden R.; Gottfried, Gerald J. 1987. Stormflow responses to forest treatments on two Arizona mixed conifer watershed.** ***In:*** **Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 189-194. 253 p.**

Forty years of hydrological records from the North and South Forks of Workman Creek were analyzed to estimate the effects of several treatments on stormflow volumes and peaks. Summer stormflows and peaks increased exponentially with size of storm after each treatment. Although percent changes were large, actual increases were very small. Winter stormflow increases were smaller on a percent basis but were larger in volume.

818. **Hibbert, Alden R.; Knipe, O. D.; Davis, Edwin A. 1986. Streamflow response to control of chaparral shrubs along channels and upper slopes.** ***In:*** **Chaparral ecosystems research conference; 1985 May 16-17; Santa Barbara, CA. Davis, CA: University of California: 95-103.**

Chemical control of channel-side shrubs on 15.4 ha of a chaparral watershed created perennial flow in an intermittent stream and increased annual streamflow on the watershed by 16 mm. No additional increase in streamflow resulted from treatment of 20 ha on the upper slopes of the watershed. Presumably the water saved by reducing transpiration on the upper slopes was lost to downslope shrubs as the soil water migrated toward the channel. Treatments designed to increase water yield in chaparral should be concentrated as near to the channels as possible, consistent with other resource values.

819. **Hibbert, Alden R.; Troendle, Charles A. 1987. Streamflow generation by variable source area: chapter 8.** ***In:*** **Swank, Wayne T.; Crossley, D. A., Jr., editors. Forest hydrology and ecology at Coweeta. New York, NY: Springer-Verlag: 111-127.**

The variable source area concept proposes that the portion of a drainage basin yielding surface water to the stream varies with time, and that, for well-vegetated basins, subsurface flow not only sustains base flow but is also a major component of storm flow. A variable source area conceptual model was developed, and a simulator is available that addresses the flow dynamics described in this paper.

820. **Hinds, Thomas E. 1985. Diseases.** ***In:*** **DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 87-106. 283 p.**

821. **Hinds, Thomas E. 1981. Etiology of *Cryptosphaeria* canker and *Libertella* decay of aspen. Phytopathology. 71(11): 1137-1144.**

A recently discovered, widely distributed canker disease of aspen and other poplars throughout the Rocky Mountain region is described. Other aspen canker and decay fungi and their cultural filtrates exhibit similar flourescence, which suggests that sapwood discoloration may be the result of materials produced by fungal pathogens rather than by the host response.

822. **Hinds, Thomas E.; Fuller, L. R.; Lessard, E. D.; Johnson, W. D. 1984. Mountain pine beetle infestation and *Armillaria* root disease of ponderosa pine in the Black Hills of South Dakota. Denver, CO: U.S. Department of Agriculture, Forest Service, Timber Forest Pest, and Cooperative Forestry Management. 7 p.**

A significant association was found between *Armillaria mellea* root disease and ponderosa pine tree mortality attributed to mountain pine beetle infestation. Seventy-five percent of the dead trees, 28% of the currently beetle-infested trees, but none of the live trees had *A. mellea* root infection. All trees had good crown ratios and were equally distributed between single- and two-storied stands of moderate basal area on good quality sites.

823. **Hinds, Thomas E.; Harrell, Mark O. 1986. Hypoxylon canker of aspen. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 58-59. 149 p.**

824. **Hinds, Thomas E.; Riffle, Jerry W. 1986. *Cryptoshpaeria* canker of cottonwood and aspen. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 56-57. 149 p.**

825. **Hinds, Thomas E.; Ryan, Michael G. 1985. Expansion of sootybark and *Ceratocystis* cankers on aspen. Plant Disease. 69(10): 842-844.**

Expansion of sooty-bark cankers, caused by *Encoelia pruinosa*, was measured on 143 aspen to predict years to tree mortality. The mean vertical expansion of 87 cankers was 44.9 • 3.7 cm/yr. Cankers expanded circumferentially at a mean rate of 16.3 • 0.7 cm/yr. Tree longevity can be predicted by dividing the circumference of the trunk not yet invaded by the canker by the horizontal expansion rate of the canker and adding 1 yr. *Ceratocystis fimbriata* seldom girdles a tree. The mean horizontal and vertical growth rates for 26 Ceratocystis cankers examined were 1.3 • 0.2 and 2.8 • 0.4 cm/yr.

826. **Hinds, Thomas E.; Shepperd, Wayne D. 1987. Aspen sucker damage and defect in Colorado clearcut areas. Research Paper RM-278. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

External damage and associated internal defect in aspen suckers from 1 to 19 years old were assessed in 32 clones on previously clearcut areas in eight national forests in Colorado. A total of 591 of the tallest suckers on 640 milacre plots contained 1,613 cases of damage. The highest frequency of damage was caused by disease, followed, in decreasing order, by dead terminal leaders, insects, broken branches, wetwood, trunk wounds, companion stems, and mortality. Internal defect was present in 82% of the suckers examined. Bacteria and 29 fungi were associated with internal stains, wetwood, and decay. The potential timber quality of aspen suckers in these regenerated stands cannot be fully assessed until they approach a merchantable size.

827. **Hinds, Thomas E.; Shepperd, Wayne D.; Laurent, Thomas H. 1985. *Dothiorapolyspora* on aspen. Plant Disease. 69(12): 1100.**

828. **Hinds, Thomas E.; Wood, Robert E.; Bassett, Richard L. 1983. Wounds and decay in residual corkbark fir. Research Paper RM-247. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Decay associated with 11- to 17-year-old wounds on residual corkbark fir in the Apache-Sitgreaves National Forest in Arizona was analyzed. More than 95 percent of the open scars in different positions, sizes, and depth, and 86 percent of broken or dead tops were infected with decay fungi. *Amylostereum chailletii* and *Hematostereum sanguinolentum* were the most common trunk decayers, and *Fomitopsis annosa* and *Armilariella mellea* the common root rotters.

829. **Hingten, Terrence M.; Clark, William R. 1984. Impact of small mammals on the vegetation of reclaimed land in the northern Great Plains. Journal of Range Management. 37(5): 438-441.**

830. **Hingten, Terrence M.; Clark, William R. 1984. Small mammal recolonization of reclaimed coal surface-mined land in Wyoming. Journal of Wildlife Management. 48(4): 1255-1261.**

831. **Hirsch, Stanley N.; Radloff, David L.; Schopfer, Walter C.; Wolfe, Marvin N.; Yancik, Richard F. 1981. The activity fuel analysis process: instructions and examples. General Technical Report RM-83. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 46 p.**

This quantitative process for appraising fire hazard from activity fuels combines fire- and fuel-modeling with decision analysis principles to produce an estimate of expected burned area. Expected fire occurrence, climate, fuel loads, fire behavior, and suppression capability are considered in the fuel appraisal process. two case study examples are presented.

832. **Hirsch, Stanley N.; Radloff, David L. 1981. A method for making activity fuel management decisions. Fire Management Notes. 42(3): 5-9.**

A quantitative fuel appraisal process for consistent weighting of fire hazard factors that affect activity fuel management decisions is described.

833. **Hobbs, N. Thompson; Spowart, R. A. 1984. Effects of prescribed fire on nutrition of mountain sheep and mule deer during winter and spring. Journal of Wildllife Management. 48(2): 551-560.**

834. **Hodge, Winifred; Anderson, Robert James; Schmidgall, Doug. 1985. Chaparral watershed management: a systems approach. *In:* Jones, Bruce E.; Ward, Timothy J., editors. Watershed management in the eighties: symposium proceedings; 1985 April 30-May 1; Denver, CO. New York, NY: American Society of Civil Engineers: 69-76.**

835. **Hodges, Charles S., Jr.; Peterson, Glenn W. 1989. Cercospora blight of juniper. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 29-30. 184 p.**

In forest nurseries, Cercospora blight of juniper, caused by the fungus Cercospora sequoiae, had been reported only on eastern redcedar and giant sequoia. However, it also occurs in plantation and ornamental plantings of other species, especially Arizona cypress, oriental arborvitae, and cryptomeria. The closely related fungus *C. sequoiae* var. *juniperi* sometimes causes severe damage to eastern redcedar in plantations but has not yet been observed in nurseries.

836. **Hodorff, Robert A.; Sieg, Carolyn Hull. 1986. Bird species associated with green ash woodlands in the Slim Buttes, South Dakota. South Dakota Bird Notes. 38(3): 56-60.**

Research in North Dakota indicates that green ash woodlands provide critical habitat for many bird species. However, little is known about how stand condition of green ash woodlands influences their use by birds. This paper, the result of a 2-year study, presents a complete bird list for both open and closed-canopy green ash woodlands in northwestern South Dakota.

837. **Hodorff, Robert A.; Sieg, Carolyn Hull; Linder, Raymond L. 1988. Wildlife response to stand structure of deciduous woodlands. Journal of Wildlife Management. 52(4): 667-673.**

Vegetation, birds, and mammals were sampled in two stand types of green ash woodlands in northwestern South Dakota. Closed-canopy stands were multilayered communities with dense overstories of several age classes and sizes of trees and a variety of shrubs. Open-canopy stands lacked foliage layers and had sparse overstories of decadent trees. Fifteen birds and mammals occurred in significantly greater numbers in closed-canopy stands compared to open stands; Numbers of two species were higher in open stands. Nearly two times as many birds were observed in closed-canopy stands than were observed in open-canopy woodlands. Lack of tree reproduction in these riparian-like woodlands decreases wildlife habitat and eventually leads to the loss of this community.

838. **Hoehn, John P.; Sorg, Cindy F. 1988. Toward a satisfactory model of contingent valuation behavior in a policy valuation context. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 149-158.**

An individual's ability to make economic choices is limited by many factors. Some of these factors are elements of the choice context-the structure of information, penalties, and rewards. Other factors are cognitive. This paper incorporates these contextual and cognitive constraints into the standard economic choice model in order to better understand contingent valuation behavior.

839. **Hoekstra, Thomas W. 1982. Information needs and use assessments. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 10-13. 1101 p.**

Information needs and use assessments (INA) identify an organization's requirements for the least quantity of information at the highest quality that can be made available in a timely manner. To accomplish that purpose, an ina can be conducted at four levels of intensity.

840. **Hoekstra, Thomas W.; Chalk, David E.; Hawkes, Clifford L.; Miller, Stephen A. 1983. Monitoring regional wildlife and fish habitat and populations for national assessments and appraisals. *In:* Transactions of the 48th North American wildlife and natural resources conference; 1983 March 20-23; Kansas City, MO. Washington, DC: Wildlife Management Institute: 308-314. 565 p.**

The analyses for assessments and appraisals of wildlife and fish include: (1) inventories of current land and water area, wildlife and fish populations, and production capability of habitat; (2) projections of resource inventories and use; and (3) implications and opportunities for improving the current situation by alternative land and resource management programs. This paper reports on the data and regional analyses that are being assembled and developed to support each of these three activities.

841. **Hoekstra, Thomas W.; Dyer, A. Allen; Lemaster, Dennis C. 1987. FORPLAN: an evaluation of a forest planning tool. Proceedings of a symposium; 1986 November 4-6; Denver, CO. General Technical Report RM-140. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 164 p.**

The Forest Service, Colorado State University, and Washington State University, with the co-sponsorship of the American Forestry Association, organized the symposium for two reasons. The need for evaluations of FORPLAN by non-Forest Service experts was a major rationale for conducting the symposium. The second and equally important reason was to provide an opportunity for Forest Service client groups and other interested people to participate in a review of FORPLAN. The symposium was organized into three separate sessions which included presentation of papers by their authors, formal discussions of the papers, and open discussion with the symposium participants.

842. **Hoekstra, Thomas W.; Flather, Curtis H.; Flebbe, Patricia A. 1987. Regional fish and wildlife habitat models: application for national multiple resource planning. *In:* Land and resource evaluation for national planning in the tropics, international conference and workshop; 1987 January 25-31; Chetumal, Mexico. General Technical Report WO-39. Washington, DC: U.S. Department of Agriculture, Forest Service: 404-409.**

843. **Hoekstra, Thomas W.; Flather, Curtis H. 1986. Theoretical basis for integrating wildlife in renewable resource inventories. Journal of Environmental Management. 24: 95-110.**

Niche, island biogeography, succession, and hierarchy theory, in that combined order, provide a framework for inventoried wildlife environmental descriptors. Niche theory provides the basis for describing the environmental variables needed for individuals, populations, and communities. Island biogeography theory defines the geographic extent of animal communities. Succession theory addresses the temporal dynamics of ecological systems. Hierarchy theory deals with scale, and is used to determine relationships between ecological systems and their respective levels of organization. Recommendations are given for inventory variables at population and community levels.

844. **Hoekstra, Thomas W.; Hof, John G. 1985. National assessments of wildlife and fish: a technical framework. General Technical Report RM-122. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

A national assessment of wildlife and fish can be accomplished by completing three analytical components of the Forest and Rangeland Renewable Resources Planning Act: providing a statement of historical and current land, wildlife, and fish population and habitat production capability; projecting future production and comsumption; and identifying opportunities for improving the future renewable resource situation regarding wildlife and fish and their habitats.

845. **Hoekstra, Thomas W.; Joyce, Linda A.; Hamilton, Thomas. 1987. Estimation of regional multiresource interactions. *In:* Land and resource evaluation for national planning in the tropics, international conference and workshop; 1987 January 25-31; Chetumal, Mexico. General Technical Report WO-39. Washington, DC: U.S. Department of Agriculture, Forest Service: 386-391.**

846. **Hoekstra, Thomas W.; Thomas, J. W.; Lennartz, Michael R.; Worley, David P. 1981. Managing of federal lands for production and use of wildlife and fish. *In:* Transactions of the 46th North American wildlife and natural resources conference. Washington, DC: Wildlife Management Institute: 336-344.**

The demand for wildlife and fish resorces is described, and some of the important big game and threatened or endangered species associated with federally administered lands and the uses of those resources are identified.

847. **Hof, John G. 1983. Comparing management alternatives with low and high energy input levels for Florida slash pine plantations. Forest Science. 29(1): 78-84.**

848. **Hof, John G. 1987. Discussion of FORPLAN: an economic perspective. *In:* FORPLAN: an evaluation of a forest planning tool; 1986 November 4-6; Denver, CO. General Technical Report RM-140. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 96-99. 164 p.**

849. Hof, John G. 1983. Estimating the effects of multiresource and environmental objectives in modeling timber supply. *In:* Proceedings of North American conference on forest sector models; 1981 December 2-4; Williamsburg, VA. Berkhamsted, England: AB Academic Publishers: 215-228.

A multilevel operations research modeling approach can be used in analyzing supply-side trade-offs in national assessments of renewable resources. The reasons for making such an analysis are discussed and the need for joint cost analysis is analyzed cursorily. The advantages and disadvantages of the proposed analysis approach are identified.

850. Hof, John G. 1980. Problems in projecting recreation resource use through supply and demand analysis. *In:* Hawkins, D. D. [and others], editors. Tourism planning and development issues. Washington, DC: George Washington University Press: 443-461.

851. Hof, John G. 1987. Uncertainty and response bias in contingent valuation of forest uses. *In:* 18th IUFRO World Congress, Project 4.08; 1986 September 7-21; Ljubljana, Yugoslavia. Corvallis, OR: Deptartment of Resource Recreation Management, Oregon State University: 181-190.

852. Hof, John G.; Baltic, Tony J. 1988. Forest and rangeland resource interactions: a supporting technical document for the 1989 RPA Assessment. General Technical Report RM-156. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 31 p.

This paper provides an analysis of the resource interactions implied by the forest planning alternatives for the National Forest System.

853. Hof, John G.; Field, Richard C. 1987. On the possibility of using joint cost allocation in forest management decision making. Forest Science. 33(4): 1035-1046.

A refutable hypothesis is developed theoretically that joint cost allocation schemes are not likely to lead to correct output level decisions. This hypothesis is supported in a test case experiment involving a managed forest in Alabama. Seven allocation schemes are tested: separable cost-remaining benefits, nucleolus, proportional nucleolus, weak nucleolus, benefit-included nucleolus, shapley value, and a generalized shapley value. None of these schemes indicate, in the test case, correct timber output levels based on timber benefits and allocated cost alone.

854. Hof, John G.; Joyce, Linda A.; Alward, Gregory S.; Hoekstra, Thomas W. 1983. Multilevel analysis of forest and rangeland resources. *In:* Range economics symposium and workshop proceedings; 1982 August 31-September 2; Salt Lake City, UT. General Technical Report INT-149. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 43-49. 151 p.

This paper presents a multilevel analytical system for national-level forest and rangeland planning. The purpose of this system of models is to determine efficient production possibilities for the entire multilevel system. Because this system concentrates on efficiency considerations, a multilevel socioeconomic impact model structure is also described that would address equity-oriented considerations.

855. Hof, John G.; Joyce, Linda A.; Pickens, James B. 1986. The use of forest planning information in national (RPA) assessments. *In:* Workshop on lessons from using FORPLAN; 1986 April 29-May 1; Denver, CO. Washington, DC: U.S. Department of Agriculture, Forest Service, Land Management Planning: 234-242.

856. Hof, John G.; Kaiser, H. Fred. 1983. Long-term outdoor recreation participation projections for public land management agencies. Journal of Leisure Research. 5(1): 1-14.

This paper presents a theoretical structure for developing long-term outdoor recreation projections for public agencies. The suggested approach is demonstrated using data from the 1977 national outdoor recreation survey of the Department of Interior. On the basis of this data, substational increases in outdoor recreation participation are anticipated in the future.

857. Hof, John G.; Kaiser, H. Fred. 1983. Projections of future recreation use. Resource Bulletin WO-2. Washington, DC: U.S. Department of Agriculture, Forest Service. 9 p.

Outdoor recreation is expected to increase in the next 50 years. The level of participation appears to be very sensitive to the availability of recreation facilities; therefore, managers cannot simply plan for a "target level" of activity without considering supply-demand interactions.

858. **Hof, John G.; King, David A. 1982. On the necessity of simultaneous recreation demand equation estimation. Land Economics. 58(4): 547-552.**

859. **Hof, John G.; Lee, Robert D.; Dyer, A. Allen; Kent, Brian M. 1985. An analysis of joint costs in a managed forest ecosystem. Journal of Environmental Economics and Management. 12: 338-352.**

860. **Hof, John G.; Loomis, John B. 1986. A note on marginal valuation of underpriced facilities. Public Finance Quarterly. 14(4): 489-498.**

861. **Hof, John G.; Loomis, John B. 1983. A recreation optimization model based on the travel cost method. Western Journal of Agricultural Economics. 8(1): 76-85.**

862. **Hof, John G.; Marose, Robin K.; King, David A. 1986. Potential pitfalls in renewable resource decision making that utilizes convex combinations of discrete alternatives. Western Journal of Agriclutural Economics. 10(2): 391-400.**

This paper analyzes the economic tenability of simply interpolating (taking convex conbinations of) initial alternatives to generate new alternatives in this process. Convex combinations of outputs are feasible with the interpolated input levels, under common conditions. In fact, the cost estimate resulting from interpolating the cost of two (or more) alternatives generally will be an overestimate. The magnitude of this overestimate is investigated in test case. This cost overestimate can be rather large, and is not systematically predictable. Only when the output sets in the original alternatives are very similar are the interpolated cost estimates fairly accurate.

863. **Hof, John G.; McKean, John R.; Taylor, R. G.; Bartlett, E. T. 1989. Contingent valuation of a quasi-market good: an exploratory case study of federal range forage. Research Paper RM-283. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

The contingent valuation method (CVM) is applied in four different formats to value federal range forage. Price-response formats tend to elicit bids reflecting either the current federal lease rate (willingness to pay) or the current private selling price (willingness to sell). This type of influence from real world prices may explain some of the large difference often observed between willingness-to-pay and willingness-to-sell contingent valuations. Quantity-response formats tend to elicit all or nothing bids. Logic demand functions are estimated for a quantity-response willingness-to-pay format, and the results are compared with other market-based valuations of federal range forage in Colorado.

864. **Hof, John G.; Pickens, James B.; Bartlett, E. T. 1986. A maxmin approach to nondeclining yield timber harvest scheduling problems. Forest Science. 32(3): 653-666.**

This paper investigates an alternative approach to scheduling timber harvests when nondeclining yield is desired. The approach maximizes the minimum harvest during any one time period, across all time periods in the planning horizon. This approach tends to create an even flow harvest pattern, but allows more flexibility than rigid nondeclining yield or even flow constraints. The approach is tested in a case study involving conversion of an unregulated forest into a regulated state. The results suggest that the approach, in combination with other approaches, may have the potential to generate useful solutions to this type of timber harvest scheduling problem.

865. **Hof, John G.; Pickens, James B. 1986. A multilevel optimization system for large-scale renewable resource planning. General Technical Report RM-130. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.**

This report analyzes and evaluates one approach to utilizing local planning analyses of public renewable resource management agencies as an input in developing large-scale (national) resource management plans. A type of multilevel approach (referred to as the Barlett-Wong approach) Is discussed and is evaluated in a test case. This prototype performed well at the highest level of analysis, but was less reliable in terms of its implications for the lower level planning units.

866. **Hof, John G.; Pickens, James B. 1987. A pragmatic multilevel approach to large-scale renewable resource optimization: a test case. Natural Resource Modeling Journal. 1(2): 245-264.**

In recent years, public renewable resource management agencies have devoted substantial effort to local planning. This paper analyzes and evaluates a multilevel approach to utilizing these local planning analyses as an input in developing large-scale (national) resource management plans. This approach is evaluated in a test case with a two-level prototype model

that is built from a global model that serves as a standard of comparison. The two-level prototype performs well at the highest level of analysis (involving aggregated variables) but is less reliable in terms of its implications for the lower level planning units.

867. **Hof, John G.; Robinson, Kent S.; Betters, David R. 1988. Optimization with expected values of random yield coefficients in renewable resource linear programs. Forest Science. 34(3): 634-646.**

This paper analyzes the problem of optimization when the yield coefficients are random variables with known (or acceptably approximated) means. An important distiction is demontrated between the case where only land area constraints are included and where both area and yield constraints are included. A test case that addresses the latter case empirically is presented. A bootstrap technique and monte carlo repetitions are used to simulate the expected value of optimum.

868. **Hof, John G.; Rosenthal, Donald H. 1987. Valuing the opportunity cost of travel time in recreation demand models: an application to aggregate data. Journal of Leisure Research. 19(3): 174-188.**

The travel cost model was used to estimate the opportunity cost of travel time for recreation trips to 11 U.S. Army Corps of Engineers Reservoirs in Kansas and Missouri. The analyses are based on a 1982 sample of 60,000 day-use recreationists. The mean and median value of travel time, expressed as a proportion of the hourly wage rate, at the 11 reservoirs were 0.122 and 0.04.

869. **Hoffman, George R. 1985. Germination of herbaceous plants common to aspen forests of western Colorado. Bulletin of the Torrey Botanical Club. 112(4): 409-413.**

870. **Hoffman, George R.; Alexander, Robert R. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: a habitat type classification. Research Paper RM-221. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 41 p.**

A vegetation classification based on concepts and methods developed by Daubenmire were used to identify 11 forest habitat types in the Routt National Forest. Included were five habitat types in the Populus Tremuloides series, two in the Abies Lasiocarpa series, and one each in the *Pinus contorta, Pseudotsuga menziesii, Pinus flexilis,* and *Quercus gambelii* series. A key to identify the habitat types and the management implications associated with each are provided.

871. **Hoffman, George R.; Alexander, Robert R. 1983. Forest vegetation of the White River National Forest in western Colorado: a habitat type classification. Research Paper RM-249. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 p.**

A vegetation classification based on concepts and methods developed by Daubenmire were used to identify eleven forest habitat types in the White River National Forest. Included were five habitat types in the *Populus tremuloides* series, two in the *Abies lasiocarpa* series, and one each in the *Pseudotsuga menziesii, Pinus edulis, Picea pungens,* and *Quercus gambelii* series. A key to identify the habitat types and the management implications associated with each are provided.

872. **Hoffman, George R.; Alexander, Robert R. 1987. Forest vegetation of the Black Hills National Forest of South Dakota and Wyoming: a habitat type classification. Research Paper RM-276. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 48 p.**

A vegetation classification based on concepts and methods developed by Daubenmire was used to identify 12 forest habitat types and one shrub habitat type in the Black Hills. Included were two habitat types in the *Quercus macrocarpa* series, seven in the *Pinus ponderosa* series, one in the *Populus tremuloides* series, two in the *Picea glauca* series, and one in the *Cercocarpus montanus* series. A key to identify the habitat types and the management implications associated with each are provided.

873. **Hogan, Timothy D.; Hora, Stephen C. 1982. Management costs of operating forest recreation areas in the Southwest. Eisenhower Consortium Institutional Series Report 5. Tempe, AZ: College of Business Administration, Arizona State University. 83 p.**

874. **Hopkins, Rick B. 1984. Avian species associated with prairie woodland types.** *In:* **Noble, Daniel L.; Winokur, Robert P., editors. Wooded draws: characteristics and values for the northern Great Plains: symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication 111. Rapid City, SD: South Dakota School of Mines and Technology: 27-35.**

875. **Hopkins, Rick B.; Cassel, J. Frank; Bjugstad, Ardell J. 1986. Relationships between breeding birds and vegetation in four woodland types of the Little Missouri National Grasslands. Research Paper RM-270. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.**

Bird species richness was greater in the cottonwood type than in the juniper, pine, and ash woodland types. Total breeding bird densities were greatest in the green ash woodland type. The densities of 25 bird species were significantly different among the four woodland types. The densities of birds in five foraging guilds and four nesting guilds were significantly different among the four woodland types. The influence of vegetation on bird community structure is discussed and suggestions are made for preserving and reestablishing woodlands threatened by the strip-mining of lignite coal.

876. **Hopkins, Rick B.; Schwartz, M. D. 1982. Avian community studies in North Dakota. American Birds. 35: 91-94.**

877. **Howe, Marmion; Noble, Daniel L. 1985. Effect of cyanide residue on vegetation bordering a Black Hills stream.** *In:* **Senior research papers: 70th annual meeting of the South Dakota Academy of Science; 1985 July 15; Mitchell, SD. Pierre, SD: South Dakota Academy of Science: 112-122.**

878. **Hulbert, C.; Funkhouser, E. A.; Soltes, E. J.; Newton, R. J. 1988. Inhibition of protein synthesis in loblolly pine hypocotyls by mannitol-induced water stress. Tree Physiology. 4: 19-26.**

I

879. **Irwin, Larry L.; Mason, Mark; Ward, A. Lorin. 1981. Lead compounds in mule deer and vegetation, southeastern Wyoming. National Transportation Research Record 786.**

J

880. **Jacobi, William R.; Boyd, J. E.; Zentz, W. R. 1987. Comandra rust damage and risk rating research.** *In:* **The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 29-30.**

881. **Jacobi, William R.; Boyd, J. E. 1987. Comandra rust risk-rating research.** *In:* **The 35th annual western forest disease work conference; 1987 August 18-21; Nanaimo, BC. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 21-24.**

882. **Jacobi, William R.; Riffle, Jerry W. 1989. Effects of water stress on Thyronectria canker of honeylocusts. Phytopathology. 79(1333-1337).**

883. **Jairell, Robert L. 1989. Harvest the snow. Successful Farming. February(87): 60.**

884. **Jairell, Robert L.; Schmidt, Ralph A. 1987. Constructing scaled models for snowdrift tests outdoors.** *In:* **Proceedings, 55th annual western snow conference; 1987 April 14-16; Vancouver, BC. Seattle, WA: Western Snow Conference: 166-169.**

885. **Jairell, Robert L.; Schmidt, Ralph A. 1988. Portable animal protection shelter and wind screen.** *In:* **Proceedings, 56th western snow conference; 1988 April 19-21; Kalispell, MT. Fort Collins, CO: Colorado State University: 170-173.**

Two steel corral panels pinned in a "V" pointing into the wind and covered with reinforced plastic tarp or plastic snowfence provide temporary protection during blizzards or strong winds to aid stockmen by protecting problem animals during calving, to facilitate machinery repair, or for construction outdoors.

886. **Jairell, Robert L.; Tabler, Ronald D. 1985. Model studies of snowdrifts formed by livestock shelters and pond embankments.** *In:* **53rd western snow conference proceedings; 1985 April 16-18; Boulder, CO. Spokane, WA: Western Snow Conference: 167-170. 183 p.**

Although artificial barriers are commonly used to protect livestock from winter winds, the optimum design has yet to be determined for locations with blowing snow. By reducing wind speed, barriers also cause snowdrifts that can bury livestock during major storms. A separate but related problem is how to desigh pit reservoirs to maximize snow deposition as a water source. This paper presents results from studies of small-scale models comparing alternative designs of shelters and pond embankments.

887. **Jairell, Robert L.; Tabler, Ronald D.; Schmidt, Ralph A. 1984. Portable ten-meter instrument mast. *In:* Proceedings of the western snow conference, 52nd annual meeting; 1984 April 17-19; Sun Valley, ID. Spokane, WA: Executive Secretary of the Conference: 168-171. 192 p.**

This paper describes a portable 10-m mast that can be used for supporting vertical arrays of meteorological imstruments. The mast is designed to be used over snow as well as on bare ground or ice, and it is easily adjusted to be plumb over uneven or sloping surfaces.

888. **James, Robert L.; Staley, John M. 1980. Photochemical air pollution damage survey of ponderosa pine within and adjacent to Denver, Colorado: a preliminary report. Forest Insect and Disease Management, Report R2-80-6. Denver, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region. 21 p.**

Five evaluation plots were established near Denver to monitor oxidant injury on ponderosa pine over time.

889. **Jameson, Donald A.; Moore, Mary Ann Dohn; Case, Pamela J. 1982. Principles of land and resource management planning. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office, Land Management Planning Staff. 325 p.**

890. **Jasmer, Gerald E.; Donart, Gary B.; Aldon, Earl F. 1983. Responses of reestablished vegetation to simulated grazing. *In:* Aldon, Earl F.; Oaks, Wendell R., editors. Proceedings of the symposium on reclamation of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 188-191.**

891. **Jayne, Joann. 1985. Use of riparian lands on the Navajo Nation Watersheds. *In:* Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, Robert H., technical coordinators. Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the first North American riparian conference; 1985 April 16-18; Tucson, AZ. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agricuture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 479-481. 523 p.**

892. **Jennings, Daniel T. 1981. Observations on *Olios fasciculatus* Simon, a giant crab spider (Araneae: Sparassidae). The Southwestern Naturalist. 26(4): 437-439.**

Collections of *Olios fasciculatus* Simon sent to the Rocky Mountain Forest and Range Experiment Station in Albuquerque, New Mexico, provide new information on geographical and altitudinal distributions, habitat association, seasonal development, and "egg-retreat" construction. The collections are deposited in the American Museum of Natural History, New York.

893. **Jennings, Daniel T.; Penfield, Frederick B.; Stevens, Robert E.; Hawksworth, Frank G. 1989. Spiders (Araneae) associated with dwarf mistletoes (*Arceuthobium* sp.) in Colorado. Southwestern Naturalist. 34(3): 349-355.**

Spiders of 10 families, 18 genera, and 22 species were associated with three species of *Arceuthobium* in northern Colorado. Spider-species composition varied among species of dwarf mistletoe. Spider-mistletoe relationships are discussed, and presence of mistletoe pollen on spiders is recorded for the first time.

894. **Jennings, Daniel T.; Stevens, Robert E. 1982. Southwestern pine tip moth. Forest Insect and Disease Leaflet 58. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.**

This leaflet summarizes information on hosts, evidences of infestation, damage, description of life stages, life history and habits, and control of this species.

895. Johnson, Craig W.; Brown, Thomas C.; Timmons, Michael L. 1986. Esthetics and landscaping. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station: 185-188. 283 p.

896. Johnson, Curtis M. 1980. Computer techniques for land management planning. Research Note RM-387. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

A computer system for storage and retrieval of approximately 200 land management planning techniques for the Rocky Mountain and Southwestern Regions of the USDA Forest Service has been placed on the USDA UNIVAC 1100 computer at Fort Collins, Colo. An abstract of each technique can also be retrieved from remote terminals via telephone.

897. Johnson, David W.; Hawksworth, Frank G.; Drummond, David B. 1980. 1979 dwarf mistletoe loss assessment survey on national forest lands in Colorado. Report 80-6. Washington, DC: U.S. Department of Agriculture, Methods Application Group, Forest Pest Management.

A road/plot survey, conducted on six national forests in Colorado, showed infestation ranging from 0 percent on the Rio Grande National Forest to 52.1 percent on the Routt National Forest. Loss ranged from 31.2 m^3 on the White River National Forest to 2,398.6 m^3 on the Arapaho and Roosevelt National Forests.

898. Johnson, David W.; Hawksworth, Frank G. 1985. Dwarf mistletoes: candidates for control through cultural management. *In:* Insect and disease conditions in the United States 1979-83. General Technical Report WO-46. Washington, DC: U.S. Department of Agriculture, Forest Service: 48-55.

899. Johnson, David W.; Hawksworth, Frank G. 1989. Mistletoe control with ethephon: conclusions. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 44-45.

900. Johnson, David W.; Hawksworth, Frank G.; Merrill, Laura M. 1984. Ponderosa pine dwarf mistletoe loss assessment survey on national forest lands in Colorado. Technical Report R2-27. Denver, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region. 13 p.

During 1981-1982, a roadside/plot survey indicated that 18 percent of the ponderosa pine type was infested by dwarf mistletoe. The total annual loss of ponderosa pine to dwarf mistletoe is estimated at 885,000 cubic feet. This is equivalent to 57 percent of the 1981 annual harvest of ponderosa pine for the forests surveyed.

901. Johnson, David W.; Hawksworth, Frank G.; Drummond, David B. 1981. Yield loss of lodgepole pine stands to dwarf mistletoe in Colorado and Wyoming national forests. Plant Disease. 65: 437-438.

902. Johnson, David W.; Hildebrand, D.M.; Hawksworth, Frank G. 1989. Effects of application rate and timing of ethephon treatments on abscission of ponderosa pine dwarf mistletoe. Forest Pest Management Technical Report R2-44. Lakewood, CO: U.S. Department of Agriculture, Rocky Mountain Region, Timber, Forest Pest, and Cooperative Forestry Management. 8 p.

903. Johnson, David W.; Hildebrand, D. M. 1989. Ethephon tests for ponderosa pine dwarf mistletoe in Colorado. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 37-18.

904. Johnson, David W.; Peterson, Glenn W.; Dorset, R. D. 1984. *Diplodia* tip blight of ponderosa pine in the Black Hills of South Dakota. Plant Disease. 69(2): 136-137.

Diplodia tip blight was found for the first time on native ponderosa pine at scattered locations in the Black Hills of South Dakota. Infection of new shoots uccurred annually in 1979-1982; however, extensive infection of second-year needle and branch tissues uccurred only in 1979 after an unusually cold winter. Black Hills isolates of *Diplodia pinea* did not differ significantly from isolates from other areas in spore dimensions, spore septations, spore germination, germ tube growth, or growth in culture.

905. Johnson, David W.; Riffle, Jerry W. 1986. Wetwood (slime flux) of elm, cottonwood, and mulberry. *In:* Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 64-65. 149 p.

906. Johnson, F. Reed. 1988. Blind men and elephants: prospects for integrating disparate approaches to natural resource values. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 221-224.

907. Johnson, James E.; Rinne, John N. 1982. The endangered species act and southwest fishes. Fisheries. 7(4).

The native fish fauna of the American Southwest is an endangered group. The article discusses the 1973 Endangered Species Act, recent and on-going recovery actions for selected species, and suggests the direction future recovery actions should take. Color photos of live endangered fishes are included.

908. Johnson, Lynn A.; Driver, B. L. 1983. An approach to measuring the perceived benefits to volunteers in natural resource agencies. *In:* Merrill, Amanda A., editor. Proceedings of volunteers in the backcountry; 1982 May 26-28; Durham, NH. Durham, NH: University of New Hampshire: 80-96. 219 p.

A five-year program of cooperative research was begun in 1978 by the USDA Forest Service's Rocky Mountain Forest and Range Experiment Station and Colorado State University to evaluate long-term benefits of the youth conservation corps (YCC) program to enrollees and to communities near YCC camps. The research approach used to evaluate the benefits to enrollees in the YCC program, as perceived by enrollees and their parents, can be applied to evaluate the benefits to volunteers.

909. Johnson, R. Roy; Carothers, Steven W. 1982. Riparian habitats and recreation: interrelationships and impacts in the Southwest and Rocky Mountain Region. Eisenhower Consortium Bulletin 12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 31 p.

910. Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, Robert H. 1985. Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 523 p.

These proceedings include 105 papers and 12 poster presentations. Primary topics include: physical characteristics, hydrology, and ecology of riparian ecosystems; riparian resources: recreation, agriculture, wildlife, livestock use, fisheries, and amphibians and reptiles; multiple-use planning and management; legal and institutional needs; and riparian ecosystems in dryland zones of the world.

911. Jones, John R. 1985. Distribution. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 9-10. 283 p.

912. Jones, John R.; DeByle, Norbert V. 1985. Climates. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 57-64. 283 p.

913. Jones, John R.; DeByle, Norbert V. 1985. Fire. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 77-81. 283 p.

914. Jones, John R.; DeByle, Norbert V. 1985. Genetics and variation. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 35-39. 283 p.

915. Jones, John R.; DeByle, Norbert V.; Bowers, Diane M. 1985. Insects and other invertebrates. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 107-114. 283 p.

916. Jones, John R.; DeByle, Norbert V. 1985. Morphology. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 11-18. 283 p.

917. Jones, John R.; DeByle, Norbert V. 1985. Other physical factors. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 83-86. 283 p.

918. Jones, John R.; DeByle, Norbert V. 1985. Soils. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 65-70. 283 p.

919. Jones, John R.; DeByle, Norbert V.; Winokur, Robert P. 1985. Wood resource. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 161-167. 283 p.

920. Jones, John R.; Kaufmann, Merrill R.; Richardson, E. Arlo. 1985. Effects of water and temperature. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 71-76. 283 p.

921. Jones, John R.; Schier, George A. 1985. Growth. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 19-24. 283 p.

922. Jones, John R.; Shepperd, Wayne D. 1985. Harvesting. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 219-222. 283 p.

923. Jones, John R.; Shepperd, Wayne D. 1985. Intermediate treatments. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 209-216. 283 p.

924. Jones, John R.; Shepperd, Wayne D. 1985. Rotations. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 217-218. 283 p.

925. Jones, John R.; Winokur, Robert P.; Shepperd, Wayne D. 1985. Management overview. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 193-195. 283 p.

926. Jones, Lawrence L. C.; Raphael, Martin G. 1989. Geographic distribution: *Aneides ferreus*. SSAR Herpetological Review. 20(1): 11.

927. Joyce, Linda A. 1989. An analysis of the range forage situation in the United States: 1989-2040: a technical document supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-180. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 136 p.

928. **Joyce, Linda A. 1987. A discussant's view of an ecogical evaluation of FORPLAN. *In:* FORPLAN: an evaluation of a forest planning tool; 1986 November 4-6; Denver, CO. General Technical Report RM-140. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 122-127. 164 p.**

929. **Joyce, Linda A. 1983. Multiresource production at the regional level. *In:* Range economics symposium and workshop proceedings; 1982 August 31-September 2; Salt Lake City, UT. General Technical Report INT-149. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 50-56. 151 p.**

This paper presents a modeling approach to analyzing the muliresource production response to alternative management activities used in national assessments of forest and range resources. Primary models are developed in a framework that integrates the current strengths in single resource modeling efforts.

930. **Joyce, Linda A.; Baker, R. L. 1987. Forest overstory-understory relationships in Alabama forests. Forest Ecogy and Management. 18: 49-59.**

This study developed regional overstory-understory models for four forest types in southeastern Alabama and tested the ability of these models to predict understory vegetation using overstory data from southern and southwestern Alabama. Cross-sectional data from the USDA Forest Service Forest Inventory and Analysis Unit Multiresource Survey of Alabama was used to analyze the relationship between timber stand characteristics and herbaceous cover under planted pine, natural pine, mixed pine-hardwoods, and upland hardwoods. Herbaceous cover was significantly related to total growing stock volume of time in all forest types. Stand characteristics and management activities that affected herbaceous cover varied by forest type. The models for planted pine, mixed pine-hardwoods, and upland hardwoods captured a significant amount of the variation in the original data. Extrapolation of southeastern Alabama overstory-understory relationships to southern and southwestern forests was not possible with these models.

931. **Joyce, Linda A.; Chalk, David E.; Vigil, Andy. 1986. Description of range forage data base. General Technical Report RM-133. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 17 p.**

This paper documents the development and structure of the range forage data base, a subset of information from all soil conservation service range site descriptions for 20 states: Arkansas, Arizona, California, Corado, Florida, Idaho, Louisiana, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming. Information in the data set includes range site name, location identifiers, total annual production, soils information, and initial stocking level rates. data are accessible via tape from the USDA Fort Collins Computer Center. These data can be used to analyze range site productivity within a state, between states, or across regions.

932. **Joyce, Linda A.; Hoekstra, Thomas W. 1984. A national perspective on information needs from inventories. *In:* Lund, H. Gyde, editor. Proceedings of the forest land inventory workshop: preparing for the 21st century; 1984 March 26-30; Denver, CO. Washington, DC: U.S. Department of Agriculture, Forest Service, Timber Management Staff: 218-227.**

933. **Joyce, Linda A.; Hoekstra, Thomas W.; Alig, Ralph J. 1986. Regional multiresource models in a national framework. Environmental Management. 10(6): 761-771.**

A national assessment of all forest and range land resources requires an assessment of the current resource production, an analysis of the future multiresource production based on likely resource management, and an analysis of the future multiresource production based on alternative management scenarios. This paper presents the theoretical background and modeling approach for analyzing multiresource production at a regional scale under a likely future or under alternative management scenarios. Primary models are developed in a framework that integrates the current strengths in single resource modeling efforts to predict the multiresource response to management.

934. **Joyce, Linda A.; Kickert, Ronald N. 1987. Applied plant growth models for grazinglands, forest, and crops. *In:* Wisiol, Karin; Hesketh, John D., editors. Volume 1. Current models and methods. Plant growth modeling for resource management. Boca Raton, FL: CRC Press, Inc. 17-55. (Chapter 2).**

This review presents recent developments in applied plant growth modeling for commercially important plants of grazinglands, forestlands, and croplands. Plant growth modeling encompasses several research efforts in agronomy, range science, and forestry;

however, not all of the models resulting from these efforts have been or are likely to be applied to resource management.

935. **Joyce, Linda A.; McKinnon, B.; Hof, John G.; Hoekstra, Thomas W.; Whelan, Jill A. 1983. Analysis of multiresource production for national assessments and appraisals. General Technical Report RM-101. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 20 p.**

This report gives an overview of the analytical methods used in integrated (multidisciplinary, multiresource, and multilevel) land management production analyses. The ecogical and economic theory underlying both simulations and optimization methods are also reviewed.

936. **Joyce, Linda A.; Mitchell, John E. 1989. Understory cover/biomass relationships in Alabama forest types. Agroforestry Systems. 9: 205-210.**

Significant cover/biomass relationships were developed for four major Alabama forest types. Conversion factors varied by forest type. These relationships provide practical application of understory cover measurements taken in forest inventories for use in multiresource assessments and in designing agroforestry systems.

937. **Joyce, Linda A.; Skold, Melvin D. 1988. Implications of changes in the regional ecogy of the Great Plains.** *In:* **Mitchell, John E., editor. Impacts of the Conservation Reserve Program in the Great Plains: proceedings of the symposium; 1987 September 16-18; Denver, CO. General Technical Report RM-158. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 115-127. 134 p.**

Environmental, ecogical, and economical factors are shown to affect land use in the Great Plains. The most recent government-sponsored conservation program will induce another series of changes in the landscape of the Great Plains. However, other potential changes in the Great Plains may overshadow the impact of the Conservation Reserve Program.

938. **Judson, Arthur. 1983. On the potential use of index paths for avalanche assessment. Journal of Glaciology. 29(101): 178-184.**

The possible use of index paths to assess avalanche potential in large avalanche samples was evaluated with probability theory on 56 uncontrolled avalanche paths in Colorado. Results showed the technique yields limited information of little diagnostic value because of low conditional probabilities of joint occurrence and high yearly variance. Ninety percent of pairs tested had probabilities less than 0.20 for a 6-year period. Implications for researchers and field personnel are discussed.

939. **Judson, Arthur; King, Rudy M. 1984. Effect of simple terrain parameters on avalanche frequency.** *In:* **Proceedings of the international snow science workshop; 1984 October 24-27; Aspen, CO. P.O. Box 4446, Aspen, CO: ISSW Workshop Committee: 12-20. 218 p.**

Analysis of avalanche frequency as a function of topographic parameters in Colorado found that the path angle (P) and angle (R) in the last 100 m to the highway explained 80 to 90 percent of the variance. An exponential frequency model with r was developed and successfully tested on independent data from Colorado and Utah.

940. **Judson, Arthur; King, Rudy M. 1985. An index of regional snow-pack stability based on natural slab avalanches. Journal of Glaciology. 31(108): 67-73.**

An index of regional snow-pack stability based on occurrences of natural slab avalanches was developed using a statistical distribution and a sequential testing procedure. The study interprets avalanche information on 185 paths in the Colorado Front Range. Results show general agreement with operational hazard estimates; test results have real-time evaluation potential.

941. **Judson, Arthur; King, Rudy M.; Brink, Glen E. 1986. Multi-basin avalanche simulation: a model. Cold Regions Science and Technology. 13: 35-47.**

A process oriented avalanche prediction model for wide-area use was developed using five winters' data from Berthoud Pass, Colorado. The model was successfully tested on independent data from the Colorado Front Range and San Juan Mountains. This research model is driven by temperature, precipitation, wind, and radiation; it simulates snow transport and deposition in starting zones and the development of a layered snow cover in forest sheltered clearings. Probabilities of avalanche occurrence are estimated according to recent loading and simulated regional snowpack stratigraphy.

942. **Judson, Arthur; King, Rudy M. 1984. Spatial variations in snow stability inferred from artillery control. Journal of Glaciology. 29(103): 508-511.**

Decisions on snow stability are strongly influenced by the presence of fresh avalanches. An analysis of 18 pairs of controlled avalanche paths in Colorado indicates most behave independently. The study supports the hypothesis that spatial variations in slope stability are common in unstable snow.

943. **Judson, Arthur; Leaf, Charles F.; Brink, Glen E. 1980. A process oriented model for simulating avalanche danger. Journal of Glaciology. 26(94): 53-63.**

A simulation process model is developed for rating avalanche danger for 12 east-facing avalanche paths loaded by westerly winds. Conditioned on avalanches alone, the model predicted avalanche potential on 86 percent of the 175 avalanche days, during an 8-year period. A sensitivity analysis is underway to improve model performance, and simulation of danger from additional avalanche samples is planned.

944. **Juzwik, Jennifer; French, D. W.; Hinds, Thomas E. 1987. *Encoelia pruniosa* on *Populus tremuloides* in Minnesota: occurrence, pathogenicty, and comparison with Colorado isolates. Canadian Journal of Forest Research. 64: 2728-2731.**

945. **Juzwik, Jennifer; Hinds, Thomas E. 1984. Ascospore germination, mycelial growth, and micronidial anamorphs of *Encoelia pruinosa* in culture. Canadian Journal of Botany. 62: 1916-1919.**

946. **Kais, Albert G.; Peterson, Glenn W. 1986. Brown spot needle blight of pines. *In:* Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 118-119. 149 p.**

947. **Kaiser, H. Fred; Brown, Perry J.; Davis, Robert K. 1988. The need for values of amenity resources in public natural resources management. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 7-12.**

948. **Kaufmann, Merrill R. 1985. Annual transpiration in subalpine forests: large differences among four tree species. Forest Ecology and Management. 13: 235-248.**

A canopy transpiration model, RM-CWU, was used to estimate transpiration of subalpine forest trees. Simulations indicate a threefold difference in annual transpiration among species in the central Rocky Mountains. Ratios of annual transpiration for stands of equal basal area are 3.2: 2.1: 1.8: 1 for Englemann spruce, subalpine fir, lodgepole pine, and aspen, respectively. Species differences may be attributed to differences in leaf conductance, leaf-air temperature difference, leaf area index, and length of the transpiration season. The large range of annual transpiration suggests that manipulation of stand composition and density is a viable approach to influence water yield from subalpine watersheds.

949. **Kaufmann, Merrill R. 1981. Automatic determination of conductance, transpiration, and environmental conditions in forest trees. Forest Science. 27(4): 817-827.**

An automatic system was developed to determine water vapor conductance, transpiration, and environmental conditions of forest trees. Data were collected at hourly intervals throughout an entire season of water use. Missing data, resulting primarily from effects of nearby lightning strikes, was limited to 2.7 percent of a possible 35,288 measurements.

950. **Kaufmann, Merrill R. 1984. A canopy model (RM-CWU) for determining transpiration of subalpine forest. I. Model development. Canadian Journal of Forest Research. 14: 218-226.**

Consumptive water use (CWU) is calculated for Rocky Mountain forests using submodels for estimating stomatal behavior and weather conditions. Annual CWU is estimated from instantaneous transpirational flux density calculated for layers of leaf area for each of four species—Engelmann spruce, subalpine fir, lodgepole pine, and aspen.

951. **Kaufmann, Merrill R. 1984. A canopy model (RM-CWU) for determining transpiration of subalpine forests. II. Consumptive water use in two watersheds. Canadian Journal of Forest Research. 14: 227-232.**

Consumptive water use (CWU) for the forested areas of two watersheds varied from 305 to 460 mm per year^{-1}. After combining these CWU rates with estimates for nonforested areas of the watersheds, annual CWU was 264 and 352 mm per year^{-1} for the entire

watersheds. These values agree within 2.5% of values for evapotranspiration estimated independently from mass water balance observations.

952. **Kaufmann, Merrill R. 1981. Chapter 4: water relations during drought.** *In:* **Paleg, L. G.; Aspinall, D., editors. Physiology and biochemistry of drought resistance in plants. Sydney, Australia: Academia Press: 55-70. 492 p.**

Water transport and development of water stress in plants is described in the context of gradients and resistances in the soil-plant-atmosphere continuum. Water status of plant tissue is discussed in relation to water potential components, stress hardening, and drought avoidance or tolerance.

953. **Kaufmann, Merrill R. 1981. Development of water stress in plants. Hortscience. 16(1): 34-36.**

Water stress in plants is the direct result of conditions in the shoot and root environments. Atmospheric factors, such as absolute humidity gradient and light intensity, and edaphic factors, such as soil water potential and soil temperature, are independent environmental variables which control transpiration and leaf water potential.

954. **Kaufmann, Merrill R. 1984. Effects of weather and physiographic conditions on temperature and humidity in subalpine watersheds of the Fraser Experimental Forest. Research Paper RM-251. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.**

Air and canopy temperatures in subalpine watersheds were similar to air temperature measured at a centrally located valley weather station after adjusting for adiabatic effects. Nocturnal cold air drainage and midafternoon thunderstorms influenced predicted canopy temperatures, but differences in direct beam irradiance had very little effect on canopy temperatures.

955. **Kaufmann, Merrill R. 1982. Evaluation of season, temperature, and water stress effects on stomata using a leaf conductance model. Plant Physiology. 69: 1023-1026.**

A model was developed earlier describing conductance for three conifers and one hardwood using only two terms, photosynthetic photon flux density (PPFD) and absolute humidity difference from leaf to air (DAH). Using residual analysis techniques (actual minus estimated conductance), it was determined that no seasonal or temperature effects existed that were not taken into account with PPFD and DAH. However, conductance was reduced on days following cold nights (below 4°C), or in aspen, when xylem pressure potential was below -20 bars (1 bar = 105 PA).

956. **Kaufmann, Merrill R. 1982. Leaf conductance as a function of photosynthetic photon flux density and absolute humidity difference from leaf to air. Plant Physiology. 69: 1018-1022.**

For an entire season of stomatal activity, leaf or needle conductance was observed on four species, each in a different genus: Engelmann spruce, subalpine fir, lodgepole pine, and aspen. Conductance in the natural environment was described for all species by photosynthetic photon flux density (PPFD) and absolute humidity difference from leaf to air (DAH). The only data not fitting this relationship were conifer data collected after freezing nights or aspen data collected during a short period in August when water stress occurred. In both cases, leaf conductance was reduced.

957. **Kaufmann, Merrill R. 1982. Leaf conductance during the final season of a senescing aspen branch. Plant Physiology. 70: 655-657.**

Leaf conductance, transpiration, and environmental conditions were measured on two aspen branches in a natural stand, using an automatic cuvette system. Leaves on one branch senesced about 10 days early, allowing comparison between a senescing branch and a normal branch. Terminal bud development was retarded on the senescent branch.

958. **Kaufmann, Merrill R. 1985. Modelling transpiration of subalpine trees in the central Rocky Mountains.** *In:* **Proceedings of symposium sponsored by Committee on Watershed Management/Irrigation & Drainage Division; 1985 May 1; Denver, CO. New York, NY: American Society of Civil Engineers: 61-68. 319 p.**

The transpiration model provides reasonable estimates of instantaneous, daily, and annual transpiration that are based upon the physiological and environmental factors believed to be important. The model also makes clear the importance of leaf area index in determining annual transpiration.

959. **Kaufmann, Merrill R. 1985. New silvicultural options for timber and water yield in the Rocky Mountains. *In:* Foresters future: leaders or followers? Proceedings of the 1985 Society of American Foresters national convention; 1985 July 28-31; Fort Collins, CO. Bethesda, MD: Society of American Foresters: 237-242. 445 p.**

Recent studies of transpiration indicate a threefold range of annual water loss among the four major subalpine tree species. Annual transpiration is highest for Engelmann Spruce, followed by subalpine fir, lodgepole pine, and aspen. The differences are so large that management of the species composition and density of forests may be a viable alternative for influencing water yield as well as timber yield. Preliminary calculations indicate that during the first 120 years after clearcutting, transpiration is considerably higher for an Engelmann spruce stand than for a lodgepole pine stand; yet, timber volume production is slightly larger for the pine stand. Thus, pine has a much higher water use efficiency with no reduction in timber production. Silviculture soon may include a consideration of species effects on water as well as timber yield.

960. **Kaufmann, Merrill R. 1985. Species differences in stomatal behavior, transpiration, and water use efficiency in subalpine forests. *In:* Tigerstedt, R. M. A.; Puttonen, P.; Koski, V., editors. Crop physiology of forest trees; 1984 July 23-28; Helsinki, Finland. Helsinki, Finland: Helsinki University Press: 39-52.**

Estimates of long-term transpiration and water use efficiency of trees in the natural environment have been very difficult to obtain because of limitations in methodology. Recently, a model was developed for estimating annual transpiration of subalpine forests using stomatal behavior as a key element. This model, RM-CWU, was used to estimate transpiration throughout forest rotations for lodgepole pine and for Engelmann spruce-subalpine fir. Computations were based upon environmental and physiographic conditions found in subunits watersheds in the central Rocky Mountains.

961. **Kaufmann, Merrill R. 1989. Trees and drought. The World and I. 4(8): 330-333.**

962. **Kaufmann, Merrill R.; Edminster, Carleton B.; Troendle, Charles A. 1982. Leaf area determinations for subalpine tree species in the central Rocky Mountains. Research Paper RM-238. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Needle area of Engelmann spruce, subalpine fir, and lodgepole pine and leaf area of aspen are predicted from d.b.h. or tree height. Leaf area index can be calculated from stand basal area.

963. **Kaufmann, Merrill R.; Fiscus, Edwin L. 1985. Water transport through plants—internal integration of edaphic and atmospheric effects. Acta Horticulturae. 171: 83-93.**

Water transport through plants is influenced by plant structure along the transport pathway, physiological processes, and environmental conditions. Water movement follows standard transport principles, but the gradients and resistances within pathway segments are not independent of those in the rest of the transport system. In horticultural trees, water transport apparently is not strongly influenced by solute absorption by roots, partitioning of water for growth, or diurnal changes in stored water. Furthermore, the size of the absorbing root system conducting tissue in the xylem, and leaf transpiring surface appear to remain in balance through physiological feedback mechanisms.

964. **Kaufmann, Merrill R.; Ryan, Michael G. 1986. Physiographic, stand, and environmental effects on individual tree growth and growth efficiency in subalpine forests. Tree Physiology. 2: 47-59.**

Annual volume growth of subalpine trees in the central Rocky Mountains was studied in relation to site and stand conditions. Growth of individual trees was most strongly influenced by estimated potential absorbed radiation, which varied with physiographic conditions and tree leaf area. Growth efficiency was estimated by the ratio of annual volume growth to potential radiation absorption by the crown. Growth efficiency was higher in young lodgepole pine than in Engelmann spruce or subalpine fir. In all species, growth efficiency declined sharply with age, and suppressed and overtopped trees had growth efficiencies equal to the highest efficiencies observed for dominant/codominant or intermediate trees. Lodgepole pine growth was most responsive to site and stand variables, Engelmann spruce was intermediate, and subalpine fir was rather unresponsive.

965. **Kaufmann, Merrill R.; Stevens, Robert E. 1984. Vigor of ponderosa pine trees surviving mountain pine beetle attack. Research Note RM-448. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Some ponderosa pine trees survived attack by mountain pine beetles, even though their sapwood was partially blocked by blue-stain fungi. Seven years after a beetle outbreak in the Colorado Front Range, these trees had decreased foliage area and radial growth, indicating low vigor. These surviving trees should be considered for removal during salvage logging operations.

966. **Kaufmann, Merrill R.; Thor, Gary L. 1982. Measurement of water stress in subalpine trees: effects of temporary tissue storage methods and needle age. Canadian Journal of Forest Research. 12(4): 969-972.**

Water stress of subalpine conifer species may be measured with the pressure chamber after several hours of tissue storage. Tissue samples stored in cool, humid vials exhibited very little change in xylem pressure potential over a 4-h period. However, xylem pressure potential declined steadily when a source of water vapor was not available. Xylem pressure potentials of current-year and 1-year-old needles of lodgepole pine were slightly lower than those of older needles.

967. **Kaufmann, Merrill R.; Troendle, Charles A. 1981. The relationship of leaf area and foliage biomass to sapwood conducting area in four subalpine forest tree species. Forest Science. 27(3): 477-482.**

Leaf dry weight and area were strongly correlated with sapwood area measured at 1.37 m, but leaf area per unit sapwood area varied widely among species: 1.88 square meters per square centimeter for subalpine fir, 0.72 for Engelmann spruce, 0.44 for lodgepole pine, and 0.19 for aspen. This supports the hypothesis that a physiological balance exists between conducting tissue and the water requirements of the shoot.

968. **Kaufmann, Merrill R.; Troendle, Charles A.; Ryan, Michael G.; Mowrer, H. Todd. 1987. Trees—the link between silviculture and hydrology. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 54-60. 253 p.**

Water and timber are forest products that result from complex processes at the watershed, stand, and tree levels. Subalpine forest ecosystems receive inputs of energy, carbon, water, and nutrients. Within the ecosystem, a wide array of processes involves conversions and exchange of these components. The net result of these processes and transformations affects the quantity of water available for streamflow and biomass production, including merchantable bole volume. This paper focuses on how trees influence various aspects of the water and carbon cycles, and discusses how tree processes are involved in subalpine forest hydrology and silviculture.

969. **Kaufmann, Merrill R.; Weatherred, James D. 1982. Determination of potential direct beam irradiance. Research Paper RM-242. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.**

Procedures are presented for calculating potential direct beam solar irradiance, corrected for latitude, azimuth and inclination of slope, date, and time of day. Equations are structured to permit the user to calculate instantaneous or total daily irradiance using total (daily irradiance using total) incoming shortwave irradiance or any selected portion of the solar spectrum.

970. **Kelly, E. F.; Aguilar, Richard D.; Heil, D.; Deutsch, P. C.; Muhaimeed, A. S. 1989. Profile reconstruction: a method to quantify changes in soil properties resulting from cultivation. Agriculture Ecosystems and Environment. 21: 153-162.**

971. **Kent, Brian M. 1989. Forest Service land management planners' introduction to linear planning. General Technical Report RM-173. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 p.**

This report provides a detailed explanation of basic concepts of linear programming for forest planners and others who must use the technique to develop national forest land management plans. No prior background in operations research is assumed on the part of the reader.

972. Kent, Brian M.; Bevers, Michael. 1988. Design considerations for LP-based forest planning systems: perspectives from FORPLAN. *In:* Kent, Brian M.; Davis, Lawrence S., technical coordinators. The 1988 symposium on systems analysis in forest resources: proceedings; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 197-202. 278 p.

Over the past decade, FORPLAN has evolved into a large and complex linear program modeling system for decision support in forest planning. Although FORPLAN employs a highly sophisticated data deck design and reporting system for card image batch processing and high speed printing, recent strides in user interfaces on desktop and office machines present new opportunities for future planning systems. Design considerations for this new processing environment, including possibilities such as an interactive desktop data set manager, a mainframe batch submittal system, dynamic core allocation, heap storage, and flexible array packing, are discussed.

973. Kent, Brian M.; Davis, Lawrence S. 1988. The 1988 symposium on systems analysis in forest resources: proceedings; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 278 p.

These proceedings contain the papers of the third symposium on systems analysis in forest resources management, held at Asilomar Conference Center, in Pacific Grove, Calif. In the spring of 1988, as with two previous meetings, a diverse and interesting group of papers was presented. General topic areas include land management planning, artificial intelligence, miltricriteria optimization and fuzzy systems, regional timber supply analysis, stand level optimizations, and timber harvest scheduling.

974. Kent, Brian M.; Hof, John G.; Joyce, Linda A. 1988. Experiences with FORPLAN—a distillation to two proceedings from a research prospective. *In:* Kent, Brian M.; Davis, Lawrence S., technical coordinators. The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 203-215. 278 p.

In 1986, the U.S. Department of Agriculture, Forest Service, sponsored two meetings focusing on the forest planning tool FORPLAN. The first meeting was an internal workshop addressing the topic of lessons learned during the first round of national forest planning. The second meeting was a symposium involving participants from both in and outside the agency and its purpose was to provide an evaluation of FORPLAN. This paper contains a review of the proceedings published for the meetings. The focus of this review is on potential research topics that would address problems relating to future planning efforts.

975. Kerbs, Roger R.; Davey, Patrick; Francis, Richard E. 1983. A multipurpose inventory tool. Journal of Range Management. 35(5): 675-676.

A collapsable, graduated, multipurpose rod was designed and used in a multiresource inventory. The rod is lightweight and variable in length. It can be used to estimate several vegetation and soil variables, measure water depth, or function as an equipment support and reference point.

976. Khorram, S.; Knight, A. W.; Catts, G. P.; Cloern, J. E. 1987. Modeling of estuarine chlorophyll a from an airborne scanner. IEEE Transactions on Geoscience and Remote Sensing. GE25(6): 662-670.

977. Kimes, D. S.; Smith, J. A. 1980. Simulation of solar radiation absorption in vegetation canopies. Applied Optics. 19(16): 2801-2811.

978. Kimes, D. S.; Smith, J. A.; Ranson, K. J. 1980. Vegetation reflectance measurements as a function of solar zenith angle. Photogrammetric Engineering and Remote Sensing. 46(12): 1563-1573.

979. King, David A.; Hof, John G. 1985. Experiential commodity definition in recreation travel cost models. Forest Science. 31(2): 519-529.

980. Kleindorfer, Paul R.; Kunreuther, Howard. 1988. Ex ante and ex post valuation problems: economic and psychological consideration. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 77-86.

981. Klemmedson, J. O.; Meier, C. E.; Campbell, Ralph E.; Marx, D. B. 1983. Effect of stand composition and season on chemistry of throughfall and streamflow of ponderosa pine forests. Forest Science. 29: 871-887.

982. Klemperer, W. David; Buhyoff, Gregory J.; Verbyla, Paul S.; Joiner, Linda D. 1986. Valuing white-water river recreation by the travel cost method. *In:* Proceedings 1984 national river recreation; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 709-719.

983. Klock, Glen O.; Krammes, J. Sam. 1981. Watershed management research in the Interior West. *In:* Baumgartner, David M., editor. Interior West watershed management symposium proceedings; 1980 April 8-10; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension Service: 13-17.

984. Klopatek, Carole Coe; DeBano, Leonard F.; Klopatek, Jeffrey M. 1987. Effects of fire on vesicular-arbuscular mycorrhizae in pinyon-juniper woodlands. *In:* Sylvia, D. M.; Hung, L. L.; Graham, J. H., editors. Practical applications and research priorities: Proceedings of the 7th North American conference on mycorrhizae; mycorrhizae in the next decade: practical applications and research priorities; 1987 May 3-8; Gainesville, FL. Gainesville, FL: Institute of Food and Agriculture Sciences, University of Florida. 155 p.

Because fires, both wild and prescribed, are recurring phenomena, we wanted to determine if fire affected mycorrhizae in this system. This ecosystem has both ecto- (pinyon pine) and endomycorrhizal (juniper) associations, yet numerous vam propagules occur around the base of pinyon (probably due to aeolin deposition). We chose to look only at the VAM component since the majority of plants in the mature community are colonized with VAM and are therefore necessary for recovery after disturbance. Our objective was to determine if VAM propagules are reduced following fire.

985. Klopatek, Carole Coe; DeBano, Leonard F.; Klopatek, Jeffrey M. 1988. Effects of simulated fire on vesicular-arbuscular mycorrhizae in pinyon-juniper woodland soil. Plant and Soil. 109(2): 245-250.

Effects of fire on vesicular-arbuscular mycorrhizal fungi were tested. Burning was conducted over wet and dry soils. Soil temperatures were monitored continuously during burning. Plants grown in soils burned when dry had a lower VAM colonization than soils burned when wet. Plants grown in interspace soils burned when wet were least affected. There was a positive correlation between the decrease in VAM colonization and the soil temperature as a result of the fire. Temperature effects, and associated reductions in VAM, were related to amount of litter burned in each microcosm and the moisture content of the soils.

986. Klopatek, Carole Coe; Klopatek, Jeffrey M. 1985. Four-wing saltbush response to indigenous mycorrihizae (Arizona). Restoration and Management Note. 3: 89.

987. Klopatek, Carole Coe; Klopatek, Jeffrey M. 1987. Mycorrhizae, microbes, and nutrient cycling processes in pinyon-juniper systems. *In:* Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 360-364.

988. Knipe, O. D. 1982. Angora goats for conversion of Arizona chaparral: early results. *In:* Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. General Technical Report PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 264-269. 637 p.

Use of goats to convert chaparral to brush-grass to increase water and forage may be an alternative to chemical and mechanical means. Results indicate that trampling of grass seed by goats in burned-over chaparral promotes germination and establishment. Since goats relish young grasses, areas must be protected during grass establishment.

989. Knipe, O. D. 1983. Effects of angora goat browsing in burned-over Arizona chaparral. Rangelands. 5(6): 252-255.

The objective of this study was to determine if prescribed burning, seeding, and goat browsing in the fall can be a useful tool for conversion of Arizona chaparral.

990. **Knipe, O. D. 1985. Effects of reducing shrub cover on moisture stress in mountainmahogany. Journal of Soil and Water Conservation. 40(5): 445-447.**

Shrub cover was thinned on portions of the Sierra Ancha Experimental Forest in Arizona from 65% to 45.5%, 21.5%, and 4.5%. Moisture tension was then measured in residual mountainmahogany shrubs to determine effects of thinning on moisture tension. A cover reduction of about 20% was necessary before moisure stress declined significantly in the remaining shrubs.

991. **Knipe, O. D. 1985. Predator deterrent electric fence for rough terrain. Rangelands. 7(4): 148-153.**

This paper describes the electric fence configuration used and discusses problems associated with its construction in rough, rocky terrain. A quality deterrent electric fence has requirements common to other types.

992. **Knipe, O. D. 1982. The use of angora goats in converting Arizona chaparral to grassland. *In:* Proceedings of the third international conference on goat production and disease; 1982 January 10-15; Tucson, AZ. Scottsdale, AZ: Dairy Goat Journal Publishing Company: 411-416. 604 p.**

The objective of this study was to determine whether prescribed burning, seeding, and goat browsing in the fall is a useful tool for conversion of Arizona chaparral.

993. **Knopf, Richard C.; Peterson, George L.; Leatherberry, Earl C. 1983. Motives for recreational river floating: relative consistency across settings. Leisure Sciences. 5(3): 231-254.**

Motive profiles for recreational travel on rivers by canoe, kayak, raft, and inner tube were analyzed for 11 different rivers in the United States. River recreation motives also were compared with those for 17 other forms of recreation. The data supported questioning the assumption that relationships are strong between the environmental character of outdoor recreation settings and the goal orientations of people attracted to them.

994. **Komarkova, Vera; Alexander, Robert R.; Johnston, Barry C. 1988. Forest vegetation of the Gunnison and parts of the Uncompahgre National Forests: a preliminary habitat type classification. General Technical Report RM-163. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 65 p.**

A vegetation classification based on a combination of concepts and methods developed by Braun-Blanquet and Daubenmire was used to identify 37 tentative forest habitat types on the Gunnison National Forest. Woodland habitat types comprised two series with a total of three habitat types, and forest habitat types included nine series with a total of 34 habitat types. A Key to identify the habitat types is provided, and the management implications associated with each are discussed.

995. **Kramer, Bruce M. 1982. Legal aspects of use and development of wildlife resources on private lands: Colorado, Kansas, New Mexico, Oklahoma, and Texas. Publication 103. Lincoln, NE: Great Plains Agricultural Council. 70 p.**

996. **Kramer, Bruce M.; Fox, Douglas G. 1980. Air quality modeling: judicial, legislative, and administrative reactions. *In:* Second joint conference on applications of air pollution meteorology and second conference on industrial meteorology; 1980 March 24-28; New Orleans, LA. Boston, MA: American Meteorological Society: 683-686.**

Models are an essential tool in the air quality management process. The Clean Air Act establishes goals in the form of national ambient air quality standards, and provides time frames for their achievement. The mechanism for achieving these goals is provided through the state implementation plan process.

997. **Kramp, Betty A.; Patton, David R.; Brady, Ward W. 1983. RUN WILD: wildlife/habitat relationships: the effects of fire on wildlife habitat and species. Wildlife Unit Technical Report. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 29 p.**

This report organized literature on the effects of fire on wildlife into a publication for resource managers, particularly in the Southwest. Fire effects on wildlife habitat, wildlife fire response classifications, and detailed fire effects for classes and species of vertebrates are given.

998. Krueger, Henry O.; Anderson, Stanley H. 1985. The use of cattle as a management tool for wildlife in shrub-willow riparian systems. *In:* Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, Robert H., technical coordinators. Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the first North American riparian conference; 1985 April 16-18; Tucson, AZ. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 300-304. 523 p.

999. Kurtz, William B.; Alig, Ralph J.; Mills, Thomas J. 1980. Retention and condition of agricultural conservation program conifer plantings. Journal of Forestry. 78(5): 273-276.

Of 312 conifer plantings examined 10 to 15 years after establishment under the agricultural conservation program, 95 percent were being retained for timber production, at least to some degree. The plantations were in five eastern states. Eleven percent did not warrant further retention for timber growing. Forty-three percent needed silvicultural work, chiefly thinning of conifers. The other 41 percent required no immediate attention.

1000. Kurtz, William B.; Mills, Thomas J.; Alig, Ralph J. 1980. Development of classes for evaluating the condition of Agricultural Conservation Program conifer plantings. Research Note RM-388. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Five classes were developed to categorize 10- to 15-year-old conifer stands by silvicultural condition. Sample stands, whose planting was cost-shared under the Agricultural Conservation Program, were selected from broad regions of the eastern one-half of the United States. Screening criteria were age, site index, conifer and hardwood basal area, and density.

1001. Laacke, Robert James; Weatherspoon, C. Phillip; Tinus, Richard W. 1986. Monitoring cold hardiness of tree seedlings by infrared thermography. *In:* Proceedings: Combined Western Forest Nursery Council and Intermountain Nursery Association Meeting; 1986 August 15-16; Tumwater, WA. General Technical Report RM-137. Fort Collins, CO: U.S.Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 97-102. 164 p.

1002. Labau, Vernon J.; Schreuder, Hans T. 1983. A multiphase, multiresource inventory procedure for assessing renewable natural resources and monitoring change. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference, renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 456-459.

1003. Laird, Jeffrey R.; Harvey, Michael D. 1987. Complex-response of a chaparral drainage basin to fire. *In:* IAHS International Commission on Continental Erosion; 1986 August 4-8; Albuquerque, NM. Albuquerque, NM: University of New Mexico: 165-183.

1004. Lamb, D.; Blumenstein, R. 1987. Measurement of the entrapment of sulfur dioxide by rime ice. Atmospheric Environment. 21(8): 1765-1772.

1005. Lampkin, Andrew J., III; Sommerfeld, Milton R. 1982. Impact of reclamation on drainage from the Sheldon Mine Complex, Yavapai County, Arizona. Journal of the Arizona-Nevada Academy of Science. 16(3): 65-68.

1006. Landis, Thomas D. 1987. Meeting the challenge of the nineties: proceedings, Intermountain Forest Nursery Association; 1987 August 10-14; Oklahoma City, OK. General Technical Report RM-151. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 138 p.

This proceedings is a compilation of 27 articles on various phases of forest nursery management. Specific topics include: seed treatments, soil manage-

ment, cultural practices, seedling quality, and nursery pests. Results of a discussion on the nursery competition issue are also presented.

1007. **Landis, Thomas D. 1986. Proceedings: Combined Western Forest Nursery Council and Intermountain Nursery Association meeting. General Technical Report RM-137. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 164 p.**

This proceedings is a compilation of over 30 technical articles on various phases of container and bare-root nursery management. Specific areas addressed include: seed production, cultural practices, seedling quality, nursery pests, seedling storage, and computers.

1008. **Landis, Thomas D. 1989. Proceedings, combined meeting of the Western Forest Nursery Associations; 1988 August 8-11; Vernon, BC, Canada. General Technical Report RM-167. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest Forest and Range Experiment Station. 227 p.**

Specific topics include: seed, bareroot seedling culture, container seedling culture, nursery management, seedling quality, nursery pests, nursery equipment, and outplanting performance. of particular note are articles on the new nursery technology of container-bareroot transplants.

1009. **Landis, Thomas D., technical coordinator. 1989. Proceedings, Intermountain Forest Nursery Association; 1989 August 14-18; Bismarck, ND. General Technical Report RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 150 p.**

This proceedings is a compilation of 23 articles on various aspects of forest nursery management in western North America. In addition to general nursery technical reports, special sections are devoted to fumigation in forest nurseries and articles pertaining to Great Plains nurseries. A summary of past meetings and content of proceedings for the years 1960-1988 is included.

1010. **Landis, Thomas D.; Fischer, James W. 1986. Proceedings: Intermountain Nurserymen's Association meeting; 1985 August 13-15; Fort Collins, CO. General Technical Report RM-125. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 111 p.**

Twelve invited papers were presented on a variety of topics of interest to nursery managers growing bareroot and/or containerized seedlings. Nine additional papers were presented in the form of small group workshops on weed control, seeding quality, and bareroot seedling fertilization.

1011. **Landis, Thomas D.; Tinus, Richard W.; McDonald, Stephen E.; Barnett, J. P. 1989. Seedling nurtition and irrigation. *In:* The container tree nursery manual. Washington, DC: U.S. Department of Agriculture, Forest Service: 1-119.**

1012. **Lang, Theodore E.; Brown, R. L. 1980. Numerical simulation of snow avalanche impact on structures. Research Paper RM-216. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 21 p.**

A computer model to predict snow avalanche impact on rigid wall structures is developed based on hydrodynamic equations for viscous flow, and admitting frictional slip-plane lower boundary. Slope normal and vertical wall configurations which extend higher than the height of avalanche flow are evaluated for normal and shear force and overturning moment from avalanche impact. Impact forces and moment time depend upon avalanche leading edge shape.

1013. **Lang, Theodore E.; Dent, J. D. 1983. Basal surface-layer properties in flowing snow. *In:* Proceedings of the second symposium on applied glaciology; 1982 August 23-27; Hanover, NH. Annals of Glaciology (4). Cambridge, England: International Glaciological Society: 158-162.**

1014. **Lang, Theodore E.; Dent, J. D. 1982. Review of surface friction, surface resistance, and flow of snow. Review of Geophysics and Space Physics. 20(1): 21-37.**

1015. **Lang, Theodore E.; Dent, J. D. 1980. Scale modeling of snow-avalanche impact on structures. Journal of Glaciology. 26(94): 189-196.**

1016. Larson, Diane L.; Bock, Carl E. 1986. Determining avian habitat preference by bird-centered vegetation sampling. *In:* Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: University of Wisconsin Press: 37-43.

1017. Larson, Frederic R. 1980. Pinyon-juniper. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 116-117.

1018. Larson, Frederic R.; Ffolliott, Peter F.; Clary, Warren P. 1986. Managing wildlife habitat in southwestern ponderosa pine forests, diverse treatments are the key. Journal of Forestry. 84(3): 40-41.

University and government researchers cooperated on studies of six ponderosa pine watersheds, on the Coconino National Forest, in Arizona. The study sites were examined for changes in wildlife habitat resulting from removing various proportions of the ponderosa pine overstory. Practical guidelines were developed to enhance wildlife habitat while managing forest stands to meet silviculture, range or other objectives.

1019. Lawson, H. Randy; Yost, Larry A.; Jennings, Daniel T. 1983. Southwestern pine tip moth: notes on larval descent behavior, predators and associated shoot borer in northern Arizona. The Southwestern Naturalist. 28(1): 95-123.

Larvae of the southwestern pine tip moth, *Rhyacionia neomexicana* (Dyar), descend tree boles of ponderosa pine during early morning hours, at Chevelon, Ariz. Such behavior may have survival value by avoidance of natural enemies and dessication. Ants and a crab spider were observed feeding on larvae, ants and snakeflies accepted larvae as prey in feeding tests. The western pine-shoot borer, *Eucosma sonomana* Kearfott, infested 34 percent of the trees that were infested by the tip moth. The shoot borer prefers large trees, the tip moth prefers small trees.

1020. Leatherman, David A.; Brewer, J. Wayne; Stevens, Robert E. 1983. Western spruce budworms. Service in Action Leaflet 5.543. Fort Collins, CO: Colorado State University, Extension Service. 2 p.

1021. Lee, Martha E.; Brown, Perry J.; Manfredo, Michael J. 1984. User validation of planning criteria for inventorying and monitoring recreation resources. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference, renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 318-322.

1022. Lee, Raymond M.; Rinne, John N. 1980. Critical thermal maxima of five trout species in the southwestern United States. Transactions of the American Fisheries Society. 109: 632-635.

Critical thermal maxima (CTM) and responses to fluctuating thermal regimes indicate that adult rainbow *(Salmo gairdneri)*, brown *(Salmo trutta)*, and brook *(Salvelinus fontinalis)* trout species introduced into the southwestern United States are as well adapted to elevated water temperature as adult gila *(Salmo gilae)* and Arizona *(Salmo apache)* trout, which are native to that region.

1023. Lehmkuhl, John F.; Patton, David R. 1982. RUN WILD wildlife/habitat relationships: user's manual for the RUN WILD III data storage and retrieval system. Wildlife Unit Technical Series. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 68 p.

RUN WILD III is the expanded and updated version of previous Runwild Wildlife data base. The System 2000 data management system is used. Taxonomy, distribution and status, habitat relationships, management, and reference information is given for 875 vertebrate species and subspecies in the Southwest. This manual describes the structure and data elements of the data base.

1024. Lehmkuhl, John F.; Patton, David R. 1984. User's manual for the RUN WILD III data storage and retrieval system. RUN WILD wildlife/habitat relationships. Wildlife Unit Technical Report. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 69 p.

1025. Lemaster, Richard L.; Troxell, Harry E.; Sampson, George R. 1983. Wood utilization potential of beetle-killed lodgepole pine for solid wood products. Forest Products Journal. 33(9): 64-68.

1026. Lewis, Gordon D. 1980. The Eisenhower Consortium for Western Environmental Forestry Research: research highlights, 1972-1980. Eisenhower Consortium Bulletin 8. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 31 p.

Presents brief summaries of final reports submitted upon completion of research agreements with the nine consortium universities. Research emphasizes relationships between human recreational activities and natural environments. Summaries are organized under topics of air quality, water quality, watershed management, wildlife, social and economic effects, management activities, and fire.

1027. Lewis, William M., Jr.; Grant, Michael C. 1980. Acid precipitation in the western United States. Science. 207(4427): 176-177.

Precipitation chemistry data from a rural area, at an elevation of 2,900 meters, near the Continental Divide, in Colorado, show unexpectedly low pH values for bulk precipitation. A significant downward trend in pH over the last 3 years is associated with increasing amounts of nitric acid in precipitation.

1028. Lewis, William M., Jr.; Grant, Michael C. 1980. Relationships between snow cover and winter losses of dissolved substances from a mountain watershed. Arctic and Alpine Research. 12(1): 11-17.

Substances which differed in yield significantly between years always showed a strong tendency for yield to be negatively correlated to the amount of snow cover. The differences between years must be largely explained by factors related to snow cover, of which soil frost is the most obvious. Results indicate that soil frost increases the yield of substances from the watershed by interfering with biological sequestering mechanisms which would ordinarily trap these substances in the terrestrial system.

1029. Li, H. G.; Schreuder, Hans T. 1985. Adjusting estimates in large two-way tables in surveys. Forest Science. 31(2): 366-372.

An iterative fitting procedure is proposed to adjust two-way table estimates under marginal constraints. Adjustment is inversely proportional to the variances of the cell estimates. The procedure guarantees nonnegative estimates and is compared to a standard nonlinear adjustment procedure for sample data. The proposed procedure is easier to implement in forest survey where large tables frequently occur.

1030. Li, H. G.; Schreuder, Hans T.; Bowden, D. C. 1984. Four-phase sampling estimation for the Alaska survey. *In:* International conference on inventory, forest, and other vegetation of the high latitude and high altitude regions; 1984 July 23-26; Fairbanks, AK. 61-67.

Four-phase sampling with ration and regression estimators will be used in the Alaska forest survey. Information from LANDSAT and high- and low-altitude photography is combined with ground sampling information to yield three double sampling (with ratio or regression) estimators. Different weights, combining the three double sampling estimates, are examined in a simulation study using hypothetical data. Weights based on the variance-covariance matrix are superior to simpler weights based only on the variance for both ratio and regression estimates. Classical variance estimates were more reliable than jackknife variance estimators for the sample sizes considered. Bootstrap variance estimates may be better for computing coverage probabilities but such estimates require a vast amount of computer processing.

1031. Lin, Yann-jou; Peterson, George L.; Rogerson, Peter A. 1987. A nested urban recreation site choice model. Leisure Sciences. 10: 1-5.

1032. Lindeborg, Richard A. 1980. Preparing manuscripts for the Rocky Mountain Forest and Range Experiment Station. Fort Collins CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 36 p. (Unnumbered publication).

Manuscripts prepared for the Station must be in the proper format and follow the prescribed review process. There are differences between Station style, Washington Office style, Government Printing Office style, and journal style. Scientists, typists, and editors benefit when the style is right the first time a manuscript is typed.

1033. Lindemann, William C.; Fresquez, Philip R.; Cardenas, M. 1989. Nitrogen mineralization in coal mine spoil and topsoil. Biology and Fertility of Soils. 7: 318-324.

N mineralization was compared in fresh topsoil, stockpiled topsoil, coal-mine spoil, and in various mixtures of soil and mine spoil, with and without sludge amendment.

1034. Lindemann, William C.; Lindsey, Donald L.; Fresquez, Philip R. 1984. Amendment of mine spoil to increase the number and activity of micro-organisms. Soil Science Society of America Journal. 48(3): 574-578.

Amendments had no or little effect on percentage mycorrhizal roots. Covering the spoil with 30 cm of topsoil provided the greatest amount of mycorrhizal infection.

1035. Lindsey, Donald L. 1984. The role of vesicular-arbuscular mycorrhizae in shrub establishment. *In:* Williams, Stephen E.; Allen, Michael F., editors. VA mycorrhizae and reclamation of arid and semi-arid lands; 1982 August 17-19; Dubois, WY. Scientic Report SA 1261. Laramie, WY: University of Wyoming: 53-68.

1036. Lindsey, Donald L.; Williams, Stephen E.; Beavis, William D.; Aldon, Earl F. 1984. Vesicular-arbuscular mycorrhizae associations in *Atriplex canescens* (Pursh) Nutt. and *Ceratoides lanata* (Pursh) J. T. Howell. *In:* Tiedemann, Arthur R.; McArthur, E. Durant; Stutz, Howard C.; Stevens, Richard; Johnson, Kendall L., editors. Proceedings: symposium on the biology of Atriplex and related chenopods; 1983 May 2-6; Provo, UT. General Technical Report INT-172. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 75-79.

1037. Linhart, Y. B. 1989. Interactions between genetic and ecological patchiness in forest trees and their dependent species. *In:* Bock, J. E.; Linhart, Y. B., compilers, editors. Evolutionary ecology of plants. 393-430.

1038. Linhart, Y. B.; Snyder, M. A.; Habeck, S. A. 1989. The influence of animals on genetic variability within ponderosa pine stands, illustrated by the effects of Abert's squirrel and porcupine. *In:* Tecle, Aregai; Covington, W. Wallace; Hamre, Robert H., technical coordinators. Multiresource management of ponderosa pine forests; 1989 November 14-16; Flagstaff, AZ. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station: 141-148. 282 p.

1039. Linkhart, Brian D.; Reynolds, Richard T. 1987. Brood division and postnesting behavior of flammulated owls. Wilson Bulletin. 99(2): 240-243.

The flammulated owl is widely distributed in the montane forests of western North America. The owl is insectivorous and is presumed to be migratory in the northern part of its range. Little is known of the nesting behavior of this species, especially during the postfledging period. Here, we present the postfledging behavior of adults and young and describe the occurrence of brood division in flammulated owls.

1040. Litten, Sharon M. 1980. Publications of the Rocky Mountain Forest and Range Experiment Station, 1974-1979. Fort Collins CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Lists alphabetically by author all publications of the Rocky Mountain Station for 1974 through 1979. This publication continues the data shown in U.S. Department of Agriculture, Forest Service, General Technical Report RM-6 and Superseses USDA Forest Service General Technical Report RM-31.

1041. Little, Elbert L., Jr. 1987. Pinyon trees *(Pinus edulis)* remeasured after 47 years. *In:* Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 65-68.

1042. Livingston, William H.; Davidson, Ross W. 1987. *Ophiostoma subannulatum*, a new fungal species pathogenic to grand fir roots. Mycologia. 79(1): 144-147.

1043. Logan, J. A.; Schmid, John M.; Mehl, Mel S. 1980. A computer program to calculate the susceptibililty of spruce-fir stands to spruce beetle outbreaks. Research Note RM-393. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

The computer program shows spruce beetle hazard ratings directly from data collected for stage 2 timber inventories.

1044. Loomis, John B.; Donnelly, Dennis M.; Swanson, Cindy Sorg. 1989. Comparing the economic value of forage on public lands for wildlife and livestock. Journal of Range Management. 42(2): 134-138.

1045. Loomis, John B.; Donnelly, Dennis M.; Sorg, Cindy F. 1988. Estimation of marginal values of wildlife and forage using the Travel Cost Method. *In:* Interim report—benefits and costs in natural resources planning. Western Regional Research Publications W-133. Davis, CA: University of California: 157-174.

Marginal values of wildlife and net values of forage (AUM's) to wildlife are estimated within the context of responding to previous criticism of Travel Cost (TC) Method applications for allocating forage between cattle and wildlife. Two-stage least squares is applied to estimate the TC demand equation when site quality is endogenously determined in a bioeconomic system. In the Challis, Idaho, area, the marginal values of an elk and deer were $502 and $155, respectively, for a 25% increase in harvestable animals. Associated forage values for elk and deer were $6.65 and $6.33 per AUM, respectively. These wildlife forage values are similar in magnitude to livestock forage values in the study area.

1046. Loomis, John B.; Donnelly, Dennis M.; Sorg, Cindy F.; Oldenburg, Lloyd. 1985. Net economic value of hunting unique species in Idaho: bighorn sheep, mountain goat, moose, and antelope. Resource Bulletin RM-10. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

The net economic value of hunting unique species in Idaho was estimated using the Travel Cost Method. The new willingness to pay per hunting permit was $239 for bighorn sheep, $360 for mountain goat, $113 for moose, and $73 for antelope.

1047. Loomis, John B.; Donnelly, Dennis M.; Sorg, Cindy F. 1985. Quantifying the economic effects of hydropower development on recreational fisheries: a case study of Idaho. *In:* Olson, Forrest W.; White, Robert G.; Hamre, Robert H., technical editors. Proceedings of the symposium on small hydropower and fisheries; 1985 May 1-3; Aurora, CO. Bethesda, MD: American Fisheries Society: 139-144. 497 p.

1048. Loomis, John B.; Hof, John G. 1985. Comparability of market and nonmarket valuations of forest and rangeland outputs. Research Note RM-457. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

This note discusses the comparability of market prices that measure marginal willingness to pay, and nonmarket evaluations that often measure average willingness to pay. It is concluded that the two are often directly comparable. The Travel Cost Model for evaluation recreation use is discussed as a case in point, and some implications regarding the application of this model are noted. The conclusions drawn support the use of fixed marginal benefit coefficients in forest planning models (in particular, linear programs).

1049. Loomis, John B.; Peterson, George L. 1986. Economic information in river recreation management. *In:* Proceedings 1984 national river recreation symposium; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 260-271.

1050. Loomis, John B.; Peterson, George L.; Sorg, Cindy F. 1984. A field guide to wildlife economic analyses. *In:* Transactions, 49th North American wildlife and natural resources conference; 1984 March 23-28; Boston, MA. Washington, DC: Wildlife Management Institute: 315-324.

1051. Loomis, John B.; Sorg, Cindy F.; Donnelly, Dennis M. 1986. Economic losses to recreational fisheries due to small-head hydro-power development: a case study. Journal of Environmental Management. 22: 85-94.

1052. Loomis, John B.; Sorg, Cindy F.; Donnelly, Dennis M. 1986. Evaluating regional demand models for estimating recreation use and economic benefits: a case study. Water Resources Research. 22(4): 431-438.

1053. Loopstra, Elaine M.; Shaw, Charles G., III; Sidle, Roy C. 1988. Ectomycorrhizal inoculation fails to improve performance of Sitka spruce seedlings on clearcuts in southeastern Alaska. Western Journal of Applied Forestry. 3(4): 110-112.

Hebeloma crustuliniforme Quel., *Laccaria laccata* Berk and Br., and *Cenococcum geophilum* Pers. ex Hooker were established as ectomycorrhizae on container-grown Sitka spruce seedlings that were planted in rotten wood, exposed mineral soil, and undisturbed duff on a recently clearcut site in southeastern Alaska. At planting, seedling heights differed significantly among all fungal treatments. Seedlings planted in rotten wood, regardless of fungal treatment, has the smallest increase in height after 4 years (136%); those planted in undisturbed duff had the largest (162%).

1054. Lopushinsky, William; Kaufmann, Merrill R. 1984. Effects of cold soil on water relations and spring growth of Douglas-fir seedlings. Forest Science. 30: 228-234.

1055. Loudenslager, Eric J.; Rinne, John N.; Gall, G. A. E.; David, Robert E. 1986. Biochemical genetic studies of native Arizona and New Mexico trout. The Southwestern Naturalist. 31(2): 221-234.

Populations of gila trout, *Salmo gilae*, and Apache trout, *S. apache*, from New Mexico and Arizona, respectively, as well as a trout, *Salmo* sp., population from the Rio Mayo, Mexico, were analyzed for protein polymorphisms at 36 presumptive genetic loci using starch gel electrophoresis. *Salmo gilae* and *S. apache* were more similar to each other than either was to *S. gairdneri*, *S. clarki*, or *Rio Mayo salmo*.

1056. Louderbough, Ellen T.; Potter, Loren D. 1982. Mancos shale: some physical and chemical properties which affect vegetative communities on shale outcrops. *In:* Graves, Donald H.; Devore, R. W., editors. Proceedings, symposium on surface mining, hydrology, sedimentology, and reclamation; 1982 December 6-10; Lexington, KY. Lexington, KY: University of Kentucky, Office of Engineering Services: 547-550.

1057. Lund, H. Gyde. 1982. Mapping + sampling + measurements = in-place resource inventories. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 3-9. 1101 p.

Most natural resource inventories are in-place and are a combination of mapping, sampling, and measuring. The mix of the three varies by inventory objectives, size of area, complexities within the inventory unit, restrictions imposed by management, available resources, and by information available on parameters of interest. Uniform standards and definitions, and probability sampling can be used to strengthen the utility of in-place inventories.

1058. Lund, H. Gyde. 1982. Point sampling—the role in in-place resource inventories. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 371-374. 1101 p.

Point sampling is quite frequently used as a means of obtaining area estimates and/or as a procedure for defining plot locations. The role point sampling plays in in-place resource inventories is not always fully understood, acknowledged, or appreciated.

1059. Lund, H. Gyde; Allison, Ray P.; Honing, Frederick W. 1982. Cooperation with Poland on research in remote sensing. Journal of Forestry. 80(6): 369-370.

Poland is evaluating various forms of remote sensing to monitor insect infestation and air pollution damage and to classify and map land-use patterns. A cooperative proposal, previously under development with the United States, may intensify current remote sensing research and may be expanded to include scientific exchange in sampling strategies and computer analysis techniques.

1060. Lund, H. Gyde; Deloya, Miguel Caballero. 1981. Arid land resource inventories: developing cost-efficient methods. Journal of Forestry. 79(6): 387-388.

An international workshop held at Lapaz, Mexico, in late 1980, concentrated on developing cost-efficient inventories for the arid regions of the world.

1061. Lund, H. Gyde; Deloya, Miguel Caballero. 1981. Inventario De Recursos De Tierras Aridas. Bosques Y Fauna. 4(2): 22-26.

1062. Lund, H. Gyde; Myers, Charles C. 1982. Integrating inventories. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 79-82. 1101 p.

Assessments require inventories that are integrated among organizations, purposes or uses, across resources and over time. Uniform definitions and statistically valid sample designs are common means of achieving integratable data. In addition, multiorganization inventories require definite assignment of responsibilities; multipurpose inventories require planning coordination; multiresource inventories require adequately describing the environment for all anticipated uses; and integration over time requires measuring the same variable at the same location at two different points in time.

1063. Lyon, L. Jack; Ward, A. Lorin. 1982. Elk and land management. *In:* Thomas, J. W.; Toweill, D. E., editors. Elk of North America: ecology and management. Wildlife Management Institute. Stackpole Books: 443-447.

1064. MacCracken, James G.; Alexander, Lynn E.; Uresk, Daniel W. 1983. An important lichen of southeastern Montana rangelands. Journal of Range Management. 36(1): 35-37.

The lichen was most abundant in sagebrush and grassland vegetation associations, less so in the pine, and absent in riparian types. It was significantly associated with drier sites and bare ground. Lichens appear to have value in reducing erosion, as indicators of intensive grazing, and in contributing to the nutrient quality of soils.

1065. MacCracken, James G.; Hansen, Richard M. 1982. Herbaceous vegetation of habitat used by blacktail jackrabbits and nuttall cottontails in southeastern Idaho. American Midland Naturalist. 107(1): 180-184.

1066. MacCracken, James G.; Hansen, Richard M. 1982. Seasonal foods of coyotes in southeastern Idaho: a multivariate analysis. Great Basin Naturalist. 42(1): 45-49.

1067. MacCracken, James G.; Uresk, Daniel W. 1984. Big game habitat use in southeastern Montana. The Prairie Naturalist. 16(3): 135-139.

Vegetation mapping indicated that sagebrush-grass occupied 74% of the study area. Hardwood forest occurred along stream bottoms and occupied about 14% of the study area. Pine forest grew on 8% of the study area. The sagebrush-grass community had the most bare ground. Litter cover was greatest in both forest types. Tree density was greatest in the hardwood forest community. Both hardwood and pine forest communities were important to mule deer in southeastern Montana. However, hardwood forests supported more mule deer than pine forests.

1068. MacCracken, James G.; Uresk, Daniel W.; Hansen, Richard M. 1985. Burrowing owl foods in Conata Basin, South Dakota. Great Basin Naturalist. 45(2): 287-290.

1069. MacCracken, James G.; Uresk, Daniel W. 1984. Coyote foods in the Black Hills, South Dakota. Journal of Wildlife Management. 48(4): 1420-1423. (Short communication).

There were no differences among seasons in coyote food habitats. Overall, mammals made up approximately 93% of the diet, birds 4%, insects 1%, and vegetation 2%. The number of different food items in a seasonal diet was greatest for fall and least for winter.

1070. MacCracken, James G.; Uresk, Daniel W.; Hansen, Richard M. 1985. Habitat used by shrews in southeastern Montana. Northwest Science. 59(1): 24-27.

Dwarf shrews, masked shrews, and Merriam shrews were most abundant in riparian and sagebrush grass habitat types in southeastern Montana. Litter cover was greater in areas occupied by shrews than in areas without shrews. Microhabitat humidity, as related to litter cover and vegetation structure, appears to affect shrew distribution in southeastern Montana.

1071. MacCracken, James G.; Uresk, Daniel W.; Hansen, Richard M. 1983. Plant community variability on a small area in southeastern Montana. Great Basin Naturalist. 43(4): 660-668.

Canopy cover, frequency of occurrence, and standing crop were determined for understory plants in a prairie grassland-forest ecotone in southeastern Montana. Caution must be exercised when prescribing management practices for these areas, because desired results may not be realized, as a result of the variability inherent within these plant communities.

1072. MacCracken, James G.; Uresk, Daniel W.; Hansen, Richard M. 1985. Rodent-vegetation relationships in southeastern Montana. Northwest Science. 59(4): 272-278.

Plant communities of southeastern Montana were surveyed for rodents over a two-year period. Grassland, riparian, and sagebrush communities showed the greatest rodent abundance and species diversity. There was a significant positive relationship between rodent abundance and the cover provided by some understory plant species and tree density on the study area.

1073. MacCracken, James G.; Uresk, Daniel W.; Hansen, Richard M. 1985. Vegetation and soils of burrowing owl nest sites in Conata Basin, South Dakota. The Condor. 87: 152-154.

Burrowing owls nested in vacant prairie dog burrows that were in early stages of plant successions, and in soils with a higher sand content when compared to burrows not used. Owl consumption of small mammals decreased in late summer-early fall, while insect consumption increased.

1074. MacLean, Douglas; Mills, Claudia. 1988. Norms and behavior in philosophy and social science. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 117-126.

1075. Maffei, Helen M. 1984. Control of dwarf mistletoe at the Grand Canyon: results after a third of a century. *In:* Hunt, R. S., compiler. Proceedings, 32nd western international forest disease work conference; 1984 September 25-28; Taos, NM. Victoria, BC, Canada: British Columbia Forest Service, Pacific Forest Research Center: 59-60.

1076. Maffei, Helen M. 1989. Southwestern dwarf mistletoe damage to multi-aged ponderosa pine stands of the Colorado Front Range. Fort Collins, CO: Colorado State University. 112 p. Ph.D. dissertation.

1077. Maffei, Helen M.; Beatty, J. S. 1989. Changes in the incidence of dwarf mistletoe over 30 years in the Southwest. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 88-90.

1078. Maffei, Helen M.; Hawksworth, Frank G.; Jacobi, William R. 1985. Incidence and severity of dwarf mistletoe in relation to tree size and stand DMR in irregular, uneven-aged, ponderosa pine stands along the Colorado Front Range. *In:* Proceedings 33rd annual western international forest disease work conference; 1985 September 24-27; Olympia, WA. Corvallis, OR: Oregon State University: 80-81.

1079. Maffei, Helen M.; Jacobi, William R. 1987. Effect of dwarf mistletoe infection on growth and mortality rates of ponderosa pine growing in uneven-aged, irregular stands in Colorado. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 47.

1080. Manfredo, Michael J. 1984. Comparability of onsite and offsite measures of recreation needs. Journal of Leisure Research. 16(3): 245-249.

1081. Manfredo, Michael J.; Brown, Perry J. 1981. Use of recreation opportunity planning to inventory arid lands in eastern Oregon—a demonstration. *In:* Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods. Proceedings of the workshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 331-337. 620 p.

1082. Manfredo, Michael J.; Driver, B. L.; Brown, Perry J. 1983. A test of concepts inherent in experience based setting management for outdoor recreation areas. Journal of Leisure Research. 15(3): 263-283.

This study examines assumptions of the concepts which form the basis for experience based setting management of outdoor recreation areas. Directions for future research are given, and recommendations concerning the usefulness of experienced based information to recreation planning are discussed.

1083. Manfredo, Michael J.; Sneegas, Jan; Driver, B. L.; Bright, Alan. 1989. Hunters with disabilities: a survey of wildlife agencies and a case study of Illinois deer hunters. Wildlife Society Bulletin. 17(4): 487-493.

1084. Manzanares, Daniel. 1986. Botanical compositon of cattle diets on riparian and adjacent upland range in southwestern New Mexico. Las Cruces, NM: New Mexico State University. 61 p. M.S. thesis.

1085. Manzanares, Daniel; Holchek, Jerry L.; Neel, James P. 1987. Cattle diet botanical composition on riparian and upland ranges. *In:* Livestock research briefs and cattle growers' short course; 1987 April 2; Las Cruces, NM. Las Cruces, NM: New Mexico State University: 57.

1086. Mark, Walter R.; Hawksworth, Frank G. 1981. Taxonomic implications of branching patterns in the dwarf mistletoes (*Arceuthobium*). Phytologia. 47: 441-444.

Arceuthobium has been separated into two subgenera, based primarily on branching patterns. Presence of flabellate branching, rather than absence of verticillate branching, is a better criterion for distinguishing *Subgenus vaginatum*. Subgenus *Arceuthobium* seems to be exclusively verticillate.

1087. Markstrom, Donald C. 1984. Service life of treated and untreated Rocky Mountain area fenceposts: a progress report. Research Note RM-436. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Preliminary service-life tests indicate that ponderosa pine, Engelmann spruce, lodgepole pine, and Douglas-fir fenceposts treated with preservative are performing favorably after field exposures of 15 to 22 years.

1088. Markstrom, Donald C.; Alexander, Robert R. 1984. Engelmann spruce—an american wood. FS-264. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.

Engelmann spruce, one of the lightest of all the important commercial woods in the United States, is soft, machines well, and has low shrinkage and uniform color. The wood closely resembles that of the eastern spruces in appearance and properties and, like them, has excellent pulping properties. The principal uses are in home construction—framing, sheathing, interior paneling, and exterior trim, etc.—and for plywood manufacture, food containers, specialty items, and pulp and paper.

1089. Markstrom, Donald C.; Donnelly, Dennis M. 1988. Christmas tree cutting: demand and value as determined by the Travel Cost Method. Western Journal of Applied Forestry. 3(3): 83-86.

The Travel Cost Method was used to determine the value of trips to cut Christmas trees in northern Colorado. The analysis indicated an average value of $9.37 to the Christmas tree collectors for an uncut christmas tree at the collection site. This value includes a $5.00 cutting fee and an average consumer surplus of $4.37 per tree.

1090. Markstrom, Donald C.; Donnelly, Dennis M.; Van Glarik, Janet L.; Woodfin, Richard O., Jr.; Worth, Harold E. 1982. Cord, volume, and weight relationships for small ponderosa pine trees in the Balck Hills. Research Paper RM-234. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p. (0120/0805).

1091. Markstrom, Donald C.; McElderry, Sue E. 1984. White fir-an American wood. FS-237. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p.

Six species and two varieties of true fir in western North America are commercially important and are generally classified as "white fir" by the wood industry. Their wood is light in weight, and is manufactured primarily into lumber, plywood for construction and industrial use, and wood pulp for paper manufacture. Construction uses include framing, sheathing, concrete forms, roof decking, and siding. Industrial uses include industrial crating and shook, pallet stock, furniture parts, and laminated wood products.

1092. Markstrom, Donald C.; Rosenthal, Donald H. 1987. Demand and value of firewood permits as determined by the Travel Cost Model. Western Journal of Applied Forestry. 2(2): 48-50.

The Travel Cost Method is used to determine the value of trips to collect weekend firewood near the Denver-Boulder Metropolitan Area. The analysis indicated an average willingness to pay of $21.42 per cord for small live lodgepole pine stumpage. This value, including a $10 per cord permit fee, is directly comparable to values commonly assigned to other goods and services, such as sawlogs or recreation, for resource allocation. In particular, values obtained through the residual value timber appraisal system are analogous to this figure.

1093. Markstrom, Donald C.; Shuler, Craig E.; King, Rudy M. 1984. Warpage of studs from young growth ponderosa pine from northern New Mexico. Research Paper RM-257. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

Lumber grade recovery and warp of studs from young ponderosa pine trees are affected by tree diameter, but not by a difference in site index from 55 to 100 or log position in the tree. Trees 9 inches d.b.h. yielded lower grade studs with more warp than 10- through 14-inch d.b.h. trees. Logs 5-7 inches d.i.b.

yielded lower grade lumber with more warp than 8-12-inch logs after drying to 6% moisture content. Subsequent drying simulating on-site storage indicated that kiln drying to 15% moisture content instead of 19% would not lessen warpage problems. Logs smaller than 8 inches d.i.b. from trees ranging from 9 to 14 inches d.b.h. produced lumber of similar grade and warpage.

1094. **Markstrom, Donald C.; Troxell, Harry E.; Boldt, Charles E. 1983. Wood properties of immature ponderosa pine after thinning. Forest Products Journal. 33(4): 33-36.**

Differences in growth during the 10-year period after thinning were not accompanied by significant differences in wood specific gravity, latewood percentage, tracheid length, nor microfibril angle.

1095. **Markstrom, Donald C.; Windsor, John C. 1986. Feasibility of collecting firewood blocks with a small skyline. Research Note RM-468. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Firewood collection from the nation's forests has been increasing rapidly. Additional areas are needed for firewood collections in the future. Areas above and adjacent to roads but having slopes too steep for collectors to either hand-carry or drag wood have potential if an easier method of moving wood were available. A single-span skyline made from no. 9 wire and other materials from a farm and ranch store has potential for moving firewood down slopes by gravity. A mathematical model was used initially to calculate maximum spans that would not exceed tension and deflection limits. Subsequent field testing showed that the predicted spans were quite conservative.

1096. **Markstrom, Donald C.; Worth, Harold E. 1981. Economic potentials for particleboard production in the Black Hills. Resource Bulletin RM-5. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 30 p.**

A Black Hills plant producing 100 million square feet of ponderosa pine particleboard per year should produce attractive financial returns and be economically viable in soft markets. The north central region of the United States, together with Wyoming and Colorado, seems to be the prime marketing area, because of the substantial freight cost advantage.

1097. **Marlatt, William E.; Beach, J. D.; Fox, Douglas G. 1981. The shape of air temperature inversion surfaces of mountain valleys. *In:* Proceedings of the second conference on mountain meteorology; Steamboat Springs, CO. Boston, MA: American Meteorological Society: 173-178.**

Characteristics of the temperature regime in the vicinity of the Gunnison Valley in Colorado are described based upon a 3-day field experiment conducted in February 1979. Instrumented aircraft, sodar, and automobiles were combined with surface measurements to define the inversion shape and surface temperature. Results imply that the presence of warm water resulting from the construction of Blue Mesa Reservoir has influenced the cold air pooling in the valley.

1098. **Marose, Robin K.; Tuazon, Raul; Davis, Lawrence S. 1989. Implementing an ownership-behavior simulation of private sector timber supplies. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 114-122. 278 p.**

1099. **Martin, S. Clark. 1980. Mesquite. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 181-182.**

1100. **Martin, S. Clark. 1983. Responses of semidesert grasses and shrubs to fall burning. Journal of Range Management. 36(5): 604-610.**

Results of this study suggest that periodic burning can maintain a grassland aspect if the intensity and frequency of grazing allow enough dry herbage for an effective fire to accumulate between burns.

1101. **Martin, S. Clark. 1986. Values and uses for mesquite. *In:* Management and utilization of arid land plants: symposium proceedings; 1985 February 18-22; Saltillo, Mexico. General Technical Report RM-135. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 91-96. 113 p.**

1102. **Martin, S. Clark; Morton, Howard L. 1980. Responses of falsemesquite, native grasses and forbs, and lehmann lovegrass after spraying with piclorам. Journal of Range Management. 33(2): 104-106.**

Aqueous sprays of picloram, at the rate of 0.56 kg/ha (941/ha total volume) were applied to five plots each, in May 1973 and August 1976, to control falsemesquite *(Calliandra eriophylla)* in southern Arizona. Falsemesquite was effectively controlled on both spraying dates. The greatest vegetation change, on sprayed and unsprayed plots alike, was the overwhelming natural increase in density and yield of lehmann lovegrass, an introduced species. Perennial forbs were almost completely eliminated, and densities of native perennial grasses were greatly reduced, both on treated and untreated plots.

1103. Martin, S. Clark; Patton, David R. 1981. Characteristics, resources, and uses of the hot deserts of the United States. *In:* Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods. Proceedings of the workshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 21-28. 620 p.

1104. Martin, S. Clark; Severson, Kieth E. 1988. Vegetation response to the Santa Rita Grazing System. Journal of Range Management. 41(4): 291-295.

Changes in vegetation under year-long grazing were compared with those under the Santa Rita Grazing System, a rotation system designed for southwestern U.S. rangelands where 90% of the forage is produced in mid- to late summer. Results support the observation that rotation grazing may not improve ranges that are in good condition, but may accelerate recovery of ranges in poor condition.

1105. Martinelli, M. Jr. 1983. Avalanche. *In:* Yearbook of science and technology, 1974. New York, NY: McGraw-Hill: 101-103. 507 p.

The two major problems being studied are the development of models to predict avalanches, and the velocity, runout distance, and impact force of long-running avalanches.

1106. Martinelli, M. Jr. 1984. The Goat Lick Bridge avalanches of 1979 and 1982. *In:* Proceedings of the international snow science workshop; 1984 October 24-27; Aspen, CO. P.O. Box 4446, Aspen, CO: ISSW Workshop Committee: 198-207. 218 p.

The avalanche of February 13, 1979, that destroyed a bridge on U.S. Highway 2 in Montana is described; then, the avalanches of February 15 and 20, 1982, that threatened the new bridge at this site are discussed. These demonstrate the erratic flow pattern of wet avalanches and the cumulative effect of a series of avalanches down the same path.

1107. Martinelli, M. Jr. 1983. An instrument to index snow surface hardness for predicting snow drifting. Cold Regions Science and Technology. 8: 79-82.

A motor-driven, spherical probe attached to a load cell was used to measure the external force needed to fracture the uppermost elements of several natural snow surfaces. These initial failures took place with a probe travel distance that averaged less than 3 mm. The force needed to cause failure varied from less than 1 to more than 200 newtons per square meter. This type of surface hardness index should be useful in predicting the onset, intensity, and duration of snow drifting.

1108. Martinelli, M. Jr. 1986. A test of the avalanche runout equations developed by the Norwegian Geotechnical Institute. Cold Regions Science and Technology. 13: 19-33.

Equations developed in Norway to predict average gradient (runout distance) from terrain parameters were tested against a sample of North American and Swiss avalanches. Average gradient was predicted within + 2° for about 70% of the cases. Runout distances were generally underestimated for paths with a unique longitudinal profile. A new equation that can handle both the normal and the troublesome profiles was developed from the test data.

1109. Martinelli, M. Jr; Lang, Theodore E.; Mears, Arthur I. 1980. Calculations of avalanche friction coefficients from field data. Journal of Glaciology. 26(94): 109-119.

The friction coefficients needed to solve Voellemy's avalanche-dynamics equations and as input to the numerical finite-difference computer program AVALANCH are calculated from case studies.

1110. Martinelli, M. Jr; Ozment, Arnold D. 1984. Controlling snow surface strength measurements with a hand-held calculator. Cold Regions Science and Technology. 9: 277-281.

As a step in developing a field instrument to index snow surface strength, a hand-held calculator and microprocessor have been programmed to control loading rate and measure maximum force required to break surface crystals or bonds. The system prints measurements in engineering units, and records data on magnetic tape.

1111. Martinelli, M. Jr; Ozment, Arnold D. 1985. Laboratory tests of a motorized snow surface hardness gage. Cold Regions Science and Technology. 10: 133-140.

A motor-driven, spherical probe controlled by a handheld calculator and a micro-processor developed to measure the force and probe travel distance needed to break individual snow surface elements was tested for consistency and reliability. Consistency tests were run on automatic pencil leads; reliability tests on ice rods. Both proved satisfactory.

1112. Martinelli, M. Jr; Ozment, Arnold D. 1985. Some strength features of natural snow surfaces that affect snow drifting. Cold Regions Science and Technology. 11: 267-283.

The load, travel distance, and work index needed to break surface elements on 21 natural snow surfaces were measured with a motor-driven, spherical probe. The strongest and least brittle surfaces were fresh deposits of wind transported snow. The weakest surface was a new surface formed during snowfall with no sun and no wind. The strenth of snow surface elements as measured with the current hardness gage corresponded closely to the forces generalted by saltating snow particles.

1113. Martinelli, M. Jr; Schmidt, Ralph A.; Tabler, Ronald D. 1981. Research application helps solve blowing snow problems. *In:* **Division 1. 17th International Union of Forest Research Organizations, World Congress; 1981 September 6-12; Kyoto, Japan. Vienna, Austria: IUFRO Secretariat: 345-356. 615 p.**

The design and construction of a complex snow fence system, the development and implementation of a visual range monitoring system, and the development and use of a snow profile prediction model for highway design, are used as examples of successful technology transfer.

1114. Martinelli, M. Jr; Schmidt, Ralph A.; Tabler, Ronald D. 1982. Technology transfer in snow control engineering. The Journal of Technology Transfer. 6(2): 27-37.

The design and construction of a complex snow fence system, the development and implementation of a visual range monitoring system, and the development and use of a snow profile prediction model for highway design, are used as examples of successful technology transfer.

1115. Marx, D. H.; Cordell, C. E.; Kenney, D. S.; Mexal, J. G.; Artman, J. D.; Riffle, Jerry W.; Molina, Randy J. 1984. Commercial vegetation inoculum of *Pisolithus tinctorius* and inoculation techniques for development of ectomycorrhizae on bare-root tree seedlings. Forest Science Monograph 25. Washington, DC: The Society of American Foresters. 101 p.

Vegetative inoculum of *Pisolithus tinctorius* (PT) produced by research procedures at the Institute for Mycorrhizal Research and Development was compared with that produced in various commercial solid substrate fermentors by Abbott Laboratories. Effectiveness of inocula was examined during 1977 through 1980 in 54 discrete experiments undertaken at the IMRD Microplot Nursery and in 33 conventional bare-root nurseries located in 25 states. Results of these tests showed that viable vegetation inoculum of PT can be effectively produced by industrial fermentation procedures and used to form ectomycorrhizae in bare-root seedlings of a variety of forest tree species for practical use in forestry.

1116. Marx, D. H.; Ruehle, D. S.; Kenney, D. S. 1982. Commercial vegetative inoculum of *Pisolithus tinctorius* and inoculation techniques for development of ectomycorrhizae on container-grown tree seedlings. Forest Science. 28(2): 373-400.

Results of the tests showed that viable vegetative inoculum of *P. tinctorius* in a substrate of vermiculite, peat moss, and nutrient can be produced by industrial fermentation procedures and used to form abundant *P. tinctorius* ectomycorrhizae on container-grown seedlings for practical use in forest regeneration.

1117. Massman, William J. 1987. A comparative study of some mathematical models of the mean wind structure and aerodynamic drag of plant canopies. Boundary-Layer Meteorology. 40: 179-197.

1118. Massman, William J. 1987. Heat transfer to and from vegetated surfaces: an analytic method for the bulk exchange coefficients. Boundary-Layer Meteorology. 40: 269-281.

1119. Massman, William J.; Zeller, Karl F. 1988. A rapid method for correcting the non-cosine response errors of the Gill propeller anemometer. Journal of Atmospheric and Oceanic Technology. 5(6): 862-869.

A fast algorithm to correct for the non-cosine response of the three-component Gill propeller anemometer is presented. Its intended use is for real time in-situ

correction of the horizontal and vertical components of the wind velocity for high frequency turbulent flux measurements. Comparisons between this new method and the original horst correction are presented.

1120. **Mathiasen, Robert L. 1984. Comparative susceptibility of corkbark fir and Douglas-fir to Douglas-fir dwarf mistletoe. Forest Science. 30: 842-847.**

1121. **Mathiasen, Robert L. 1984. Improving assessment of dwarf mistletoe infection in southwestern ponderosa pine stands. Arizona Forestry Notes 21. Flagstaff, AZ: Northern Arizona University. 8 p.**

1122. **Mathiasen, Robert L. 1989. Improving of dwarf mistletoe infection in southwestern ponderosa pine stands. *In:* 9th World Forestry Congress.; 2: 145-150.**

1123. **Mathiasen, Robert L. 1987. Infection of young Douglas-firs and spruces by dwarf mistletoes in the Southwest. Great Basin Naturalist. 46: 528-534.**

1124. **Mathiasen, Robert L. 1982. Taxonomic studies of dwarf mistletoes (*Arceuthobium* spp.) parasitizing *Pinus strobiformis*. Great Basin Naturalist. 42: 120-126.**

1125. **Mathiasen, Robert L.; Blake, Elizabeth A.; Edminster, Carleton B. 1987. Estimates of site potential for Douglas-fir based on site index for several southwestern habitat types. Great Basin Naturalist. 46: 277-280.**

1126. **Mathiasen, Robert L.; Blake, Elizabeth A. 1984. Relationships between dwarf mistletoes and habitat types in western coniferous forests. *In:* Hawksworth, Frank G.; Scharpf, Robert F., technical coordinators. Biology of dwarf mistletoes: proceedings of the symposium; 1984 August 8; Fort Collins, CO. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 111-116. 131 p.**

1127. **Mathiasen, Robert L.; Hawksworth, Frank G. 1983. Dwarf mistletoes on true firs in the Southwest. Arizona Forestry Notes 18. Flagstaff, AZ: Northern Arizona University, School of Forestry. 12 p.**

Three dwarf mistletoes are presently known to parasitize true firs in the southwestern United States: *Arceuthobium abietinum*, *A. douglasii*, and *A. microcarpum*. Symptoms of these true fir diseases are described and a key is provided to help identify them.

1128. **Mathiasen, Robert L.; Hawksworth, Frank G. 1988. Dwarf mistletoes on western white pine and whitebark pine in northern California and southern Oregon. Forest Science. 34(2): 429-440.**

Western white pine is a principal host of *Arceuthobium californicum* in the Siskiyou Mountains of northern California and southern Oregon, and suffers extensive mortality in some stands. Whitebark pine is a principal host and western white pine is a secondary host for *A. cyanocarpum* in northern California. Mortality of whitebark pine caused by this dwarf mistletoe on Mount Shasta, California, is as high as 58%. Western white pine is occasionally infected in *A. tsugense*-infested mountain hemlock stands in California and southern Oregon. However, no infection of western white pine occurred in *A. tsugense*-infested western hemlock stands in southern Oregon.

1129. **Mathiasen, Robert L.; Hawksworth, Frank G.; Edminster, Carleton B. 1986. Effects of dwarf mistletoe on spruce in the White Mountains, Arizona. Great Basin Naturalist. 46: 685-689.**

1130. **Mathiasen, Robert L.; Hawksworth, Frank G. 1980. Taxonomy and effects of dwarf mistletoe on bristlecone pine on the San Francisco Peaks, Arizona. Research Paper RM-224. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.**

The dwarf mistletoe parisitizing bristlecone pine on the San Francisco Peaks, Arizona, is shown to be *Arceuthobium microcarpum*, instead of *A. cyanocarpum*, as reported previously. The dwarf mistletoe causes serious, localized damage, but it is not considered to be a serious threat to the bristlecone pine population.

1131. **Mathiasen, Robert L.; Loftis, L. 1987. Douglas-fir dwarf mistletoe parasitizing Pacific silver fir in northern California. Great Basin Naturalist. 47: 161-162.**

1132. **Maurer, Brian A. 1986. Predicting habitat quality for grassland birds using density-habitat correlations. Journal of Wildlife Management. 50(4): 556-566.**

1133. McAda, Douglas P.; Ffolliott, Peter F. 1987. Predicting solar radiation from cloud cover for snowmelt modeling. *In:* **Hydrology and water resources in Arizona and the Southwest: proceedings of the 1987 meetings of the Arizona Section—American Water Resources Association, Hydrology Section—Arizona-Nevada Academy of Science and the Arizona Hydrological Society; 1987 April 18; Flagstaff, AZ. Flagstaff, AZ: Northern Arizona University: 29-34.**

As part of a study to relate solar radiation to cloud cover in ponderosa pine forests (Mcada 1978), empirical equations relating solar radiation to opaque and transparent clouds were developed for incorporation into a computer subroutine for predicting solar radiation in program SNOWMELT. Development of these equations is described here.

1134. McCambridge, William F. 1981. Duration of effectiveness of carbaryl in protecting ponderosa pines from attack by mountain pine beetle. Research Note RM-408. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Two percent carbaryl spray provided minimally acceptable protection of ponderosa pines from mountain pine beetle attacks 13 months after application. At 4-percent strength, protection was satisfactory for 15 months, as tested by laboratory bioassay.

1135. McCambridge, William F. 1982. Field tests of insecticides to protect ponderosa pine from the mountain pine beetle (Coleoptera: Scolytidae). Journal of Economic Entomology. 75(6): 1080-1082.

Individual ponderosa pines, *Pinus ponderosa* Lawson, can be protected from *Dendroctonus ponderosae* Hopkins attacks by spraying the boles with 2 percent carbaryl-water suspension. Although lindane emulsion at 2 percent gives equal protection, numerous pitch tubes leave trees cosmetically inferior. Other dose rates and materials are considered inferior. Insecticides tested kill a broad spectrum of insects, including predators of the mountain pine beetle. Predators may have been attracted to certain insecticide formulations.

1136. McCambridge, William F. 1980. Some mountain pine beetle infestation characteristics in dwarf mistletoe-infected and uninfected ponderosa pine. Research Note RM-391. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.

There were no significant differences in attacks or brood production between heavily infected and uninfected trees. Total egg gallery length per unit of bark area was greater in uninfected trees.

1137. McCambridge, William F. 1980. What's that chewing in my woodpile? Colorado Outdoors. 29(5): 34-35.

Mountain pine beetle-killed ponderosa pine that has been cut for firewood may produce some large woodborers after being brought indoors. These borers are harmless and will not infest your house.

1138. McCambridge, William F.; Hawksworth, Frank G.; Edminster, Carleton B.; Laut, John G. 1982. Ponderosa pine mortality resulting from a mountain pine beetle outbreak. Research Paper RM-235. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

From 1965 to 1978 mountain pine beetles killed 25 percent of the pines taller than 4.5 feet in a study area in north-central Colorado. Mortality was directly related to number of trees per acre and presence of dwarf mistletoe, but not to site index, elevation, or percent of Douglas-fir in the stand.

1139. McCambridge, William F.; Morris, Meredith J.; Edminster, Carleton B. 1982. Herbage production under ponderosa pine killed by mountain pine beetle in Colorado. Research Note RM-416. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Herbage growth increased steadily over 4 years, beginning the year after beetle attack. Rapid herbage growth and the mulch provided by fallen dead pine needles appeared to help prevent soil erosion.

1140. McCambridge, William F.; Stevens, Robert E. 1982. Effectiveness of thinning ponderosa pine stands in reducing mountain pine beetle-caused tree losses in the Black Hills: preliminary observations. Research Note RM-414. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Three ponderosa pine stands thinned to less than 90 square feet stem basal area per acre sustained little tree mortality from mountain pine beetle attacks, while adjacent, unthinned stands continued to be affected. These results are consistent with subjective observations that thinning dense, second-growth ponderosa pine is effective in preventing unacceptable levels of beetle-caused tree mortality in the Black Hills.

1141. McClure, Joe P.; Czaplewski, Raymond L. 1987. Compatible taper equation for loblolly pine. Canadian Journal of Forest Research. 16: 1272-1277.

Cao's compatible, segmented polynomial taper equation is fitted to a large loblolly pine data set from the southeastern United States. Equations are presented that predict at a given height, height to a given top diameter, and volume below a given position on the main stem. All estimates are inside bark. A condition is given that forces the cao model to be exactly compatible with any total main stem volume equation. An exact volume estimation formula is derived. Twelve benchmarks, which represent realistic utilization criteria, are used to describe expected errors in actually applying the taper equation rather than the more common fit statistics that describe errors encountered when estimating model parameters. Errors in using the fitted model are very similar to errors using Cao's estimates.

1142. McClure, Joe P.; Czaplewski, Raymond L. 1987. High order regression models for regional volume equations. *In:* Estimating tree biomass egressions and their error. Proceedings of the workshop on tree biomass regression functions and their contribution to the error of forest inventory estimates. General Technical Report NE-117. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 295-303.

Four regression models were compared in estimating total or merchantable volume using diameter, and total or merchantable height for loblolly pine and white oak. No model was consistently best for unbiased predictions. However, the higher order weighted quadratic and segmented models were more reliable than the simple weighted and unweighted models.

1143. McCollum, Daniel W.; Peterson, George L.; Arnold, J. Ross; Markstrom, Donald C.; Hellerstein, Daniel M. 1989. Recreation values in nine Forest Service regions for twelve types of primary activity trips. *In:* Western Regional Research Project W-133: Benefits and costs in natural resources planning. Interim Report 2. Orono, ME: Maine Agriculture Experiment Station: 199-253.

1144. McCool, Patrick M.; Musselman, Robert C.; Younglove, Theodore; Teso, R. R. 1988. Response of kidney bean to sequential ozone exposures. Environmental and Experimental Botany. 28(4): 307-313.

1145. McCutchan, Morris H. 1983. Comparing temperature and relative humidity on a mountain slope and in the free-air nearby. Monthly Weather Review. 111(4): 836-845.

Regression models developed to diagnose and predict surface temperature and mixing ratio on the mountain slope from values of these variables in the free air nearby may be applicable in other areas of the western United States under similar, carefully delimited conditions.

1146. McCutchan, Morris H. 1982. Second conference on mountain meteorology AMS, 9-12 November 1981, Steamboat Springs, Colorado. Bulletin of the American Meteorological Society. 63(7): 768-772.

The conference was sponsored by the American Meteorological Society and the USDA Forest Service. An invited paper, "Where we are and where we are going in mountain meteorology," plus overviews of the Ascot and Alpex programs and 79 technical papers were presented at eight well-attended sessions. There were 155 registrants at the conference.

1147. McCutchan, Morris H. 1980. Use of cluster analysis and discriminant analysis to classify synoptic weather types in southern California. *In:* Eighth conference on weather forecasting and analysis; 1980 June 10-13; Denver, CO. Boston, MA: American Meteorological Society: 310-315.

The classification model can automatically predict the synoptic weather type 12 hours in advance, in southern California. When the clustered data analysis was verified by discriminant analysis, 96 percent of the cases were classified the same.

1148. McCutchan, Morris H.; Fox, Douglas G.; Furman, R. William. 1981. The conical mountain study—determining the effect of elevational aspect. *In:* Proceedings of the second conference on mountain meteorology; Steamboat Springs, CO. Boston, MA: American Meteorological Society: 75-81.

To study the effect of elevation and aspect on temperature, relative humidity, wind, and precipitation, nine automatic weather stations will be located on four aspects and three elevations on San Antonio Mountain. San Antonio, in north-central New Mexico, is an isolated, conical mountain providing all aspects, nearly uniform slopes, elevations ranging from 2,743 m to 3,324 m, and grass, brush, and forest vegetation.

1149. McCutchan, Morris H.; Fox, Douglas G. 1986. Effect of elevation and aspect on wind, temperature, and humidity. Journal of Climate and Applied Meteorology. 25(12): 1996-2013.

Meteorological patterns around an isolated, conical mountain were analyzed for 2 consecutive years, July through October. Nine remote automatic weather stations were deployed on nearly uniform slopes, all four aspects, and over an elevational range of from 2700 to 3300 m. The data were sorted according to light and strong winds, both night and day, in order to highlight influences due to airflow, surface heating and topography. Wind speeds greater than 5 m s-1 negate any slope, elevation or aspect differences present at low wind speeds. Detailed statistical analysis illustrated that the effects of aspect were much more pronounced than the effects of elevation on the wind components and, to a lesser degree, on temperature.

1150. McCutchan, Morris H.; Fox, Douglas G.; Furman, R. William. 1982. San Antonio Mountain Experiment (SAMEX). Bulletin of the American Meteorological Society. 63(10): 1123-1131.

The San Antonio Mountain Experiment (SAMEX) involves a 3325 m, conically shaped, isolated mountain in north-central New Mexico where hourly observations of temperature, relative humidity, wind speed, wind direction, and precipitation are being taken at nine locations over a three- to five-year period that began in 1980. The unique set of meteorological data collected in the experiment will be used to determine the effect of elevation and aspect on the meteorological variables, compare the temperature, humidity, and wind components, and validate temperature, humidity, and wind models in complex terrain.

1151. McDonald, Stephen E.; Tinus, Richard W.; Reid, C. P. P.; Grossnickle, S. C. 1984. Effect of $CUCO_3$ container wall treatment and mycorrhizae fungi inoculation of growing medium on pine seedling growth and root development. Journal of Environmental Horticulture. 2(1): 5-8.

1152. McDonald, Stephen E.; Tinus, Richard W.; Reid, C. P. P. 1984. Modification of ponderosa pine root systems in containers. Journal of Environmental Horticulture. 2(1): 1-5.

Coating the inside surfaces of containers with cupric carbonate caused roots of ponderosa pine to stop growth when they contacted the container wall. Indolebutyric acid caused a similar but not as dramatic effect.

1153. McDonald, Stephen E.; Tinus, Richard W.; Reid, C. P. P. 1980. Root morphology control in forest tree seedling containers. *In:* Proceedings of the Intermountain Nurserymen's Association and Western Forest Nursery Association combined meeting; 1980 August 12-14; Boise, ID. General Technical Report INT-109. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 40-45.

1154. McKean, John R.; Hof, John G.; Bartlett, E. T.; Taylor, R. G. 1986. Contingent value estimates for existing federal grazing. Technical Bulletin TB86-1. Fort Collins, CO: Colorado State University. 24 p.

1155. Mears, Arthur I. 1981. Design criteria for avalanche structures in the runout zone. General Technical Report RM-84. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 28 p.

Guidelines are given for the design and location of deflecting, catching, retarding, and direct protection structures. Terrain, snow conditions, and type and frequency of avalanches are among the most important Criteria for planning structural control of avalanches in the lower track and runout zone.

1156. Medcraft, J. Richard; Clark, William R. 1986. Big game habitat use and diets on a surface mine in northeastern Wyoming. Journal of Wildlife Management. 50(1): 135-142.

1157. Medina, Alvin L. 1988. Diets of scaled quail in southern Arizona. Journal of Wildlife Management. 52(4): 753-757.

Diets of scaled quail were examined from 1982 to 1984 in southern Arizona. Seeds of forbs and woody plants composed 57% of the volume of quail diets. Forbs were staple foods and composed 39% of diets. Green herbage composed 16% of diets during February-June. Grass seeds were eaten in large amounts from September through November. Insects were consumed primarily from March through August. Lehmann's lovegrass stands produced comparatively low amounts of forbs and high perennial grass cover. Quail were most abundant in area with low perennial grass cover and high forb cover.

1158. Medina, Alvin L. 1988. An English-Spanish glossary of terminology used in forestry, range, wildlife, fishery, soils, and botany. General Technical Report RM-152. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 54 p.

The English-Spanish/Spanish-English equivalent translations of scientific and management terms (jargon) commonly used in the field of natural resource management are presented. The glossary is useful in improving communications and fostering understanding between Spanish- and English-speaking persons.

1159. Medina, Alvin L. 1983. La Investigacion en El Campo y El Manejo de Recursos en El Sur de Arizona. *In:* Patton, David R. [and others], technical coordinators. Reunion Sobre "La Fauna Y Su Medio Ambiente" Noreste De Mexico Suroeste Estados Unidos De America. Workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36S. Washington, DC: U.S. Department of Agriculture, Forest Service: 104-108. 120 p.

1160. Medina, Alvin L. 1984. A profile meter for obtaining surface relief and substrate measurements in streams. Research Note RM-437. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

The design and details for construction are presented. A potential exists for its use in fish microhabitat assessment and in vegetation sampling.

1161. Medina, Alvin L. 1983. Range research and resource management in southern Arizona. *In:* Patton, David R. [and others], technical coordinators. Wildlife and range research needs in northern Mexico and southwestern United States: workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36. Washington, DC: U.S. Department of Agriculture, Forest Service: 104-108. 108 p.

Summarizes five field-day presentations given by various authorities on range research, resource management, and range management in southern Arizona. Emphasis is given to range research on the Santa Rita Experimental Range and resource management on the Coronado National Forest.

1162. Medina, Alvin L. 1986. Riparian plant communities and soils of the Fort Bayard Watershed in southwestern New Mexico. The Southwestern Naturalist. 31(3): 345-359.

Cluster analysis was used to classify the riparian vegetation of the Fort Bayard Watershed into eight plant communities. Communities identified represent residual vegetation after a severe grazing and deforestation impact. *Populus* and *Juglans* communities persisted on mostly shallow, recently deposited ustifluvents of lower elevations. At higher elevations, *Acer* and *Alnus* communities occurred on moderate to very deep ustifluvents of haplustolls. *Populus* and *Salix* showed poor reproduction under dense canopies which suggested they were pioneer species. Soils were found to be mollic ustifluvents, aquic ustifluvents, aquic haplustolls, and cumulic haplustolls.

1163. Medina, Alvin L. 1989. Trends in residential development and water usage below the Mogollon rim of central Arizona. *In:* Tecle, Aregai; Covington, W. Wallace; Hamre, Robert H., technical coordinators. Multiresource management of ponderosa pine forests; 1989 November 14-16; Flagstaff, AZ. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station: 213-219. 282 p.

1164. Medina, Alvin L. 1987. Woodland communities and soils of Fort Bayard, southwestern New Mexico. Journal of Arizona-Nevada Academy of Science. 21: 99-112.

Species composition of woodland communities of Fort Bayard, New Mexico, represents an amalgamation of components from the Great Basin conifer woodlands and Madrean Evergreen Woodlands. Characteristics of 74 woodland stands were analyzed to determine their vegetation and soil similarities. Cluster analysis identified six community types: *Quercus emory-Pinus discolor, Juniperus monosperma-Pinus edulis, Pinus edulis-Juniperus deppeana, Quercus grisea, Quercus gambelii,* and *Pinus ponderosa/Pinus edulis-Quercus grisea.* Soils, landforms, and geologic substrata were associated with community differences. Analysis of stand composition revealed evidence with past disturbance. Accelerated erosion was continuous despite 40 plus years of nongrazing.

1165. Medina, Alvin L.; Betancourt, Jorge Sepulveda. 1987. Strategies for enhanced production of beef and jojoba on northern Baja California rangelands. *In:* Aldon, Earl F.; Gonzales Vicente, Carlos E.; Moir, William H., technical coordinators. Strategies for classification and management of native vegetation for food production in arid zones: symposium proceedings; 1987 October 12-16; Tucson, AZ. General Technical Report RM-150. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 190-195. 257 p.

An economic assessment of grazed vs. nongrazed jojoba stands revealed cattle grazing significantly reduced jojoba seed than grazed areas. Vegetation removal and water catchment treatments enhanced seed production by 2 to 2.7 times over nontreated grazed areas. Total exclusion of cattle resulted in a loss of forage and beef production. Strategies for grazing stands of jojoba, based on height and canopy attributes, are proposed for the enhancement of beef, jojoba, and other rangeland resources.

1166. Medina, Alvin L.; Martin, S. Clark. 1988. Stream channel and vegetation changes in sections of McKnight Creek, New Mexico. Great Basin Naturalist. 48(3): 373-381.

Measurements taken in 3-year intervals between 1977 and 1985 of channel morphology and vegetation cover between sections inside and outside a cattle exclosure showed that channels increased in depth and width on all plots. Tree canopy cover decreased significantly between 1977 and 1985, but changes in density of trees and shrubs and herbaceous cover were small. Exclusion of cattle use did not prevent channel erosion or deterioration of vegetation; rather, changes were attributed to a wildfire in the headwaters and subsequent storm events that temporarily upset the dynamic equilibrium of the stream.

1167. Medina, Alvin L.; Smith, H. Dwain. 1986. Designs for an antenna boom and masts for telemetry applications. Wildlife Society Bulletin. 14: 291-297.

Antenna and mast designs for wildlife telemetry studies, although commercially available, often lack specific information regarding installation, adaptations to the tracting systems, and procedural details of construction. We present detailed construction designs for installing a precision-antenna array and mast assemblies for mobile, portable-fixed, and permanent (fixed) stations.

1168. Meffe, Gary K.; Hendrickson, Dean A.; Rinne, John N. 1982. Description of a new topminnow population in Arizona, with observations on topminnow/mosquitofish co-occurrence. Southwestern Naturalist. 27(2): 226-228.

1169. Meffe, Gary K.; Hendrickson, Dean A.; Minckley, W. L.; Rinne, John N. 1983. Factors resulting in decline of the endangered sonoran topminnow *Poeciliopsis occidentalis* (Atheriniformes: Poeciliidae) in the United States. Biological Conservation. 25: 135-159.

The endangered sonoran topminnow *Poeciliopsis occidentalis* has steadily declined in distribution and abundance in the past several decades, and currently survives in the United States only in several isolated localities in southern Arizona. This reduction is correlated with, and primarily attributed to, habitat destruction, and introduction and establishment of mosquitofish *Gambusia affinis* and other exotic fishes. Topminnows have characteristically been reduced in number or replaced within a year or two of introduction of non-native fishes.

1170. Meiman, James R. 1987. Influence of forest on snowpack accumulation. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 61-67. 253 p.

1171. Melichar, Michael; Hetrick, Barbara Daniels; Hensley, David; Geyer, Wayne. 1985. Ectomycorrhizae—common associates of ponderosa pine in the central Plains. *In:* Conzelmann, Janet; Paparozzi, Ellen T., technical editors. Trees for your community: 8th annual trees for Nebraska conference; 1985 February 15-16; Lincoln, NE. Lincoln, NE: University of Nebraska: 53-56.

1172. Melichar, Michael; Hetrick, Barbara Daniels; Geyer, Wayne. 1985. Endemic ectomycorrhizal fungi of ponderosa pine in the central Plains. *In:* Molina, Randy J., editor. Proceedings of the 6th North American conference on mycorrhizae; 1984 June 25-29; Bend, OR. Corvallis, OR: Oregon State University: 278.

1173. Mendelsohn, Robert; Markstrom, Donald C. 1988. The use of travel cost and hedonic methods in assessing environmental benefits. *In:* **Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 159-166.**

1174. Mendelsohn, Robert; Peterson, George L. 1988. The definition, measurement, and policy use of monetary values. *In:* **Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 53-64.**

This paper defines monetary valuation, examines its use as a public policy tool, and contrasts the economist's approach to valuation with value concepts from other disciplines. Common misunderstandings about monetary valuation are identified and clarified, along with constraints on practical application. This paper also examines ethical and social issues.

1175. Mendelsohn, Robert; Peterson, George L. 1989. Welfare measurement with expenditure-constrained demand models. Review of Economics and Statistics. 71(1): 164-167.

1176. Merkel, Daniel L. 1981. The USA National Site (Land) Classification System. *In:* **Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods. Proceedings of the workshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 177-179. 620 p.**

1177. Merkel, Daniel L.; Driscoll, Richard S.; Hagihara, James S.; Radloff, David L. 1982. A component land classification for the United States. *In:* **Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 612-616. 1101 p.**

This guide to a component land classification will help agencies and classify land into a uniform framework. A four-component (soil, vegetation, landform, and water) classification framework is described with procedures for integrating the components to describe land units in more detail.

1178. Merkel, Daniel L.; Driscoll, Richard S. 1982. An ecological land classification for the United States. Canada Committee on Ecological (Biophysical) Land Classification Newsletter. 11: 5-9.

1179. Merrill, Laura M.; Hawksworth, Frank G.; Jacobi, William R. 1984. Evaluation of a dwarf mistletoe roadside survey procedure. *In:* **Proceedings, 31st annual western international forest disease work conference; 1983 August 22-26; Coeur d'Alene, ID. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region: 56-57.**

1180. Merrill, Laura M.; Hawksworth, Frank G.; Johnson, David W. 1985. Evaluation of a roadside survey procedure for dwarf mistletoe on ponderosa pine in Colorado. Plant Disease. 69(7): 572-573.

A survey of dwarf mistletoe intensity on ponderosa pine was conducted along roadsides and on adjacent plots in the Roosevelt, Pike, and San Juan National Forests in Colorado. The roadside survey procedure can be reliable for estimating the proportion of ponderosa pine stands with dwarf mistletoe if the road network provides a representative sample of the stands being surveyed.

1181. Merrill, Laura M.; Hawksworth, Frank G.; Jacobi, William R. 1987. Frequency and severity of ponderosa pine dwarf mistletoe in relation to habitat type and topography in Colorado. Plant Disease. 71(4): 342-344.

Relationships between forest habitat types, topographical and stand factors, and the frequency and severity of ponderosa pine dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) were assessed in Colorado. *A. vaginatum* occurred most frequently and was most severe on the driest ponderosa pine sites, which are typically the *P. ponderosa/Muhlenbergia montana* habitat type. Severity of dwarf mistletoe was least in the wetter *P. ponderosa/Quercus gambelli* habitat types common in southwestern Colorado.

1182. Merrill, Laura M.; Hawksworth, Frank G.; Jacobi, William R. 1984. Relationship of ponderosa pine dwarf mistletoe with habitat types and other ecological factors. *In:* **Proceedings, 31st annual western international forest disease work conference; 1983 August 22-26; Coeur d'Alene, ID. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region: 58-59.**

1183. Miller, David R.; Thistle, H. W.; Wang, Y. S.; Anderson, D. E. 1989. Microscale turbulence in the cold air drainage from the forest edge during project WIND, Phase IV. *In:* 19th conference on agriculture and forest meteorology; 1989 March 7-10; Charleston, SC. Boston, MA: American Meteological Society.

1184. Miller, Stephen A. 1984. Estimation of animal production numbers for national assessments and appraisals. General Technical Report RM-105. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.

Population inventory methods and associated data are best applied in national assessments of wildlife and fish in conjunction with analytical approaches which utilize estimates of the production capability of the supporting habitat. Current knowledge of estimating animal populations is contrasted with current practice. Problems in using available population data as input for national assessments are reviewed.

1185. Miller, Stephen A. 1982. Problems in standardizing animal production capability. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 607-610. 1101 p.

1186. Mills, Allan S.; Bond, Mark A.; Couturier, Hermel. 1982. Benefits sought by Lake Tahoe area downhill skiers. California Parks and Recreation. 38(5): 7, 8, 26, 27.

1187. Minckley, W. L.; Mihalick, Paula. 1982. Effects of chemical treatment for fish eradication on stream-dwelling invertebrates. Journal of the Arizona-Nevada Academy of Science. 16(3): 78-82.

1188. Minckley, W. L.; Rinne, John N. 1985. Large woody debris in hot-desert streams: an historical review. Desert Plants. 7(3): 142-153.

1189. Mitchell, John E. 1983. Analysis of forage production for assessments and appraisals. General Technical Report RM-98. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p.

This report is an overview of the biotic and abiotic ecological factors, including human activities, that affect forage production on forest and rangeland ecosystems. Also discussed are forage production models and how forage quantity and quality can control animal production.

1190. Mitchell, John E. 1988. Impacts of the Conservation Reserve Program in the Great Plains: proceedings of the symposium; 1987 September 16-18; Denver, CO. General Technical Report RM-158. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 134 p.

The Conservation Reserve Program, created in the Food Security Act of 1985, will place up to 45 million acres of cropland under permanent cover for 10 years. At some cost, it provides opportunities to reduce soil erosion, enhance wildlife habitat, stimulate components of the farm economy, and reduce commodity surpluses.

1191. Mitchell, John E. 1983. Overstory-understory relationships: Douglas-fir forests. *In:* Overstory-understory relationships in western forests. Western Regional Research Publication 1. Fort Collins, CO: Colorado State University Experiment Station: 27-34. 37 p.

Douglas-fir indisputably ranks as the premier commercial tree species of the western coniferous forests. Because of its long life, however, Douglas-fir retains dominant stature in old-growth stands below the mountain hemlock zone.

1192. Mitchell, John E.; Bartling, P. N. S.; O'Brien, R. 1988. Comparing cover-class macroplot data with direct estimates from small plots. American Midland Naturalist. 120(1): 70-78.

Recording canopy cover by class has been justified on the basis that it saves time and is less biased than direct percentage estimates. Overestimation of low cover and underestimation of high cover took place three or four times as often as the reverse situation. Results from Monte Carlo simulations of changing canopy cover (20% and 30% decrease of a dominant; 20% and 30% increase of a subdominant) showed that cover-class estimates can usually detect qualitative changes in mean cover, but provide biased quantitative estimates of changes in cover.

1193. Mitchell, John E.; Bartling, P. N. S.; O'Brien, R. 1987. Understory cover/biomass relationships in the Front Range ponderosa pine zone. Research Note RM-471. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Generalized relationships between cover and biomass for three understory plant groups were examined across 30 ponderosa pine sites along the Front Range of Colorado and Wyoming. Sixteen sites were dominated by grass/forbs and 14 by shrubs. For each plant group a linear regression estimator forced through the origin provided a prediction comparable to one with a y-intercept. These analyses show that regional-level forest survey data can be useful to forest and range resource planners and others needing to translate understory cover into biomass over large-scale areas of the ponderosa pine zone.

1194. Mitchell, John E.; Eissenstat, David M.; Irby, Alex J. 1982. Forest grazing—an opportunity for diplomacy. Rangelands. 4(4): 172-174.

Problems associated with managing grazing programs on forested lands owned by private timber companies,including attitudes of foresters, damage caused by livestock, and uncertainties over the ecological and economic consequences of managing for range animals on commercial forest land, are discussed, and possible solutions suggested.

1195. Mitchell, John E.; Evans, Gary R. 1988. A prospectus for research needs created by passage of the Conservation Reserve Program. *In:* **Mitchell, John E., editor. Impacts of the Conservation Reserve Program in the Great Plains: proceedings of the symposium; 1987 September 16-18; Denver, CO. General Technical Report RM-158. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 128-132. 134 p.**

The CRP will result in the payment of billions vegetative cover. For the program to succeed, changes in land use must remain in place after the 10-year payment period ends. This paper outlines research needs to aid in reaching toward such a goal.

1196. Mitchell, John E.; Forero, L. 1989. A cow-calf vs. yearling substitution ratio for shortgrass steppe. Journal of Range Management. 42: 343-345.

1197. Mitchell, John E.; Hart, Richard H. 1987. Winter of 1886-87: the death knell of open range. Rangelands. 8(5): 3-8.

Events and conditions causing the decline and eventual extinction of the open range cattlemen can be tied to factors both outside their control and within it. By the end of the 19th century range management had begun to become a part of western ranching operations. The winter of 1886-87 changed a way of life. The conditions that came together 100 years ago to precipitate such a clamitous event, however, are still present; these are the uncertanties of bad weather and low livestock prices.

1198. Mitchell, John E.; Hatch, Charles R. 1981. Use of polar coordinates in random sampling. Northwest Science. 55: 168-173.

1199. Mitchell, John E.; Joyce, Linda A. 1986. Use of a generalized linear model to evaluate range forage production estimates. Environmental Management. 10(3): 403-411.

Interdisciplinary teams have been used in federal land planning and in the private sector to reach consensus on the environmental impact of management. When a large data base is constructed, verifiability of the accuracy of the coded estimates and the underlying assumptions becomes a problem. A mechanism is provided by the use of a linear statistical model to evaluate production coefficients in terms of errors in coding and underlying assumptions. The technique can be used to evaluate other intuitive models depicting natural resource production in relation to prescribed variables, such as site factors or secondary succession.

1200. Mitchell, John E.; Pickens, James B. 1985. An evaluation of the herbage and browse production estimators used in the 1980 RPA Assessment. Research Paper RM-259. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.

Interdisciplinary team estimates of herbage/browse production used in the 1980 RPA Assessment were evaluated using three approaches. Estimates for nontimbered areas were mostly accurate; however, intrinsic relationships between forage production and productivity/condition classes were inconsistent. Production estimates for forested areas were more difficult to interpret, in part because of insufficient independent data. Intrinsic relationships also were inconsistent.

1201. Mitchell, John E.; Pickens, James B. 1986. An evaluation of procedures used to predict timber growth and harvest in the range and multiple resource interactions sections of the 1980 RPA Assessment. General Technical Report RM-124. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.

Interdisciplinary (ID) team estimates of wood growth and harvest used in the range and multiple resource interactions sections of the 1980 RPA Assessment were evaluated by checking for the presence of joint resource production estimates, examining data set documentation, and searching for logical and procedural errors. Apparent deficiencies in ID-team training and procedural documentation were found to limit the usefulness of the wood growth and harvest estimates.

1202. Mitchell, John E.; Rodgers, Richard T. 1985. Food habitats and distribution of cattle on a forest and pasture range in northern Idaho. Journal of Range Management. 38(3): 214-219.

Land managers of forested rangelands in the northern Rocky Mountains should consider tall and mid browse species as a forage source for cattle when determining carrying capacity. Parameters defining the degree of expected use will have to be somewhat site-specific. Cattle behavior and food habits on ranges containing both forest and pasture land are complex functions, responding interactively to food supply, climate, and perhaps other factors.

1203. Mitchell, John E.; Snyder, Dale E.; Drawe, D. Lynn; French, Norman R.; Capinera, John L. 1986. Chapter 2. Assessment of habitat factors. *In:* Cook, C. Wayne; Stubbendieck, James, editors. Range research: basic problems and techniques. Denver, CO: Society of Range Management: 19-50.

Natural ecosystems vary both in time and space. They are complex, multifaceted mosaics of landscapes, affected by soil, water, climatic, fire, and biotic factors. In range research, it often is necessary to control or isolate habitat factors, especially when hypotheses involve the testing of ecological principles. This chapter examines concepts for classifying, evaluating, and controlling habitat factors that will help to design experiments and interpret and apply results.

1204. Mitchell, Robert C.; Carson, Richard T. 1988. Evaluating the validity of contingent valuation studies. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 187-200.

1205. Mitchell, Thomas R. 1989. General analysis and project identification in national forest planning: a discussion. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 173-186. 278 p.

1206. Mitton, J. B.; Raphael, Martin G. 1989. Genetic variation in the marten *(Martes americana)*. Journal of Mammalogy. 71(2): 195-197.

1207. Modde, Timothy; Drewes, Henry G.; Rumble, Mark A. 1986. Effects of watershed alteration on the brook trout population of a small Black Hills stream. Great Basin Naturalist. 46(1): 39-45.

The impacts of adjacent landscaping activity and livestock presence on the brook trout population of a small Black Hills stream were evaluated. Moderate changes in temperature, turbidity, and fecal coliform numbers did not influence brook trout densities. Stream morphometry, particularly factors affecting stream cover, appeared to have the greatest impact on numbers of trout. Brook trout were poor indicators of moderate changes in water quality, but they were adequate indicators of the physical perturbations within the stream.

1208. Moir, William H. 1989. History of development of site and condition criteria for range condition within the U.S. Forest Service. *In:* Lauenroth, W. K.; Laycock, W. A., compilers, editors. Secondary succession and the evaluation of rangeland condition. 49-76.

1209. Molles, Manuel C. 1980. Effects of road salting on aquatic invertebrate communities. Eisenhower Consortium Bulletin 10. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.

Salting and sanding of roads affects stream invertebrates, mainly through increased input of fine sediments, and can impair trout condition and reproduction. Salting and sanding favored production of

oligochaetes over other invertebrates, but had no pronounced effect on Ephemeroptera, Plecoptera, Trichoptera, or Coleoptera.

1210. Monson, R. K. 1989. Screening alpine flora for potential sensitivity to atmospheric deposition. Final report. Boulder, CO: University of Colorado. 61 p.

1211. Moore, Richard L.; Simpson, C. David. 1981. Disease mortality of waterfowl on Texas Playa Lakes. Southwestern Naturalist. 25: 566-568.

1212. Morizot, Donald C.; Anthony, Robert G.; Grubb, Teryl G.; Hoffman, Stephen W.; Schmidt, Maureen E.; Ferrell, Robert E. 1985. Clinal genetic variation at enzyme loci in bald eagles *(Haliaeetus leucocephalus)* from the western United States. Biochemical Genetics. 23(3-4): 337-345.

1213. Morris, Meredith J. 1982. Plot configuration for multiresource purposes in the West. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 375-378. 1101 p.

Size and shape of plots, number of plots, and optimization of plot configuration are discussed for univariate and multivariate natural resource inventories.

1214. Morrison, Michael L.; Dedon, Mark F.; Yoder-Williams, Michael P.; Raphael, Martin G. 1986. Distribution and abundance of snags in the Sagehen Creek Basin, California. Research Note PSW-389. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 4 p.

The distribution of snags by tree species in the eastern Sierra Nevada of California generally reflects the associated timber type. Where present, however, lodgepole pine forms a large proportion of the snags present. Few snags of any species were present in the Jeffrey pine timber type in a study at Sagehen Creek Basin in Nevada County. The results indicate that most snags in the study area were formed by the action of water (i.e., meadows, creeks) and fire. aerial photography should be useful in locating areas of highest snag density; regression analysis appears to be of marginal usefulness.

1215. Morrison, Michael L.; Dedon, Mark F.; Raphael, Martin G.; Yoder-Williams, Michael P. 1986. Snag requirements of cavity-nesting birds: are U.S. Department of Agriculture, Forest Service guidelines being met? Western Journal of Applied Forestry. 1(2): 38-40.

U.S. Department of Agriculture, Forest Service guidelines for retention of standing dead trees were analyzed in the eastern Sierra Nevada by surveying snags and recording the use of snags for nesting by birds. Surveys showed the density of large, hard snags to be only about 25% of that required by the guidelines. Birds tended to nest in snags 30 to 40 cm or more d.b.h. The majority of snags, however, were less than 40 cm d.b.h. Results indicate that current guidelines for retention of large snags are appropriate. However, because these guidelines are not being met, the practice of removing snags for fuelwood of other purposes is questioned.

1216. Mowrer, H. Todd. 1986. ASPNORM: a normal diameter distribution growth and yield model for aspen in the central Rocky Mountains. Research Paper RM-264. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

Development of a normal diameter distribution growth and yield model for pure, even-aged, unthinned clones of aspen in the central Rocky Mountains is described, including testing for normality of diameter distributions, development of regression estimators for stand parameters, model validation, and model application.

1217. Mowrer, H. Todd. 1989. The effect of forest simulation model complexity of estimate precision. *In:* Artificial intelligence and growth models for forest management decisions; 1989 September 18-22; Vienna, Australia. Publication No. FWS-1-89. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forest and Wildlife Research: 100-109.

1218. Mowrer, H. Todd. 1987. Growth and yield of aspen in the central Rocky Mountains. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 41-44. 253 p.

This paper provides an overview of the mensurational procedures available for aspen management in the central Rocky Mountains, and compares the relative precision of two aspen growth and yield models using a Monte Carlo technique.

1219. Mowrer, H. Todd. 1988. Is managing aspen density worthwhile? *In:* Schmidt, Wyman C., compiler. Proceedings—Future forests of the Mountain West: a stand culture symposium; 1986 September 29-October 3; Missoula, MT. General Technical Report INT-243. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 201-209.

Clonal growth, combined with extreme shade intolerance and apical dominance, enable naturally occurring aspen stands to successfully regulate their density. Aspen stems are easily wounded mechanically during thinning and often are infected subsequently by fungal pathogens. Artificial thinning also may create new layers of reproduction that hamper redistribution of growth to the desired stems. However, growth simulations indicate that sawlog volume may be produced more quickly by thinning. For longer rotations, total cubic foot volume and sawlog volume are maximized over all site qualities in stands receiving no intermediate thinning.

1220. Mowrer, H. Todd. 1988. A Monte Carlo comparison of propagated error for two types of growth models. *In:* Ek, Alan R.; Shifley, Stephen R.; Burk, Thomas E., editors. Forest growth modelling and prediction: proceedings of the IUFRO conference; 1987 August 23-27; Minneapolis, MN. General Technical Report NC-120. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 2: 778-785.

A Monte Carlo technique is used to simulate errors in input variables at intensity. These errors are propagated through five 10-year projections by two growth and yield models. Comparison of the response surfaces indicates that the more complex diameter distribution model estimates the same stand average values with less precision than the whole stand model. Similarities in silvicultural assumptions, calibration, and predictive technique allow differences to be attributed to model resolution.

1221. Mowrer, H. Todd. 1986. Site productivity estimates for aspen in the central Rocky Mountains. Western Journal of Applied Research. 3: 89-91.

1222. Mowrer, H. Todd; Edminster, Carleton B. 1985. Estimating past breast height diameters and bark thickness of aspen in the central Rocky Mountains. Research Note RM-456. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.

Diameter inside or outside bark and past diameter may be estimated using the presented equations. Past and present outside bark diameters are tabulated for radial wood growth increments from 0.05 to 2 inches.

1223. Mowrer, H. Todd; Frayer, Warren E. 1987. Variance propagation in growth and yield projections. Canadian Journal of Forest Research:. 16: 1196-1200.

This paper reports the results of a study on the propagated variance associated with stand estimates in a forest growth and yield model. A cumulative variance as a result of input measurement and regression estimation errors is propagated in a growth and yield model using the method of statistical differentials. To provide an assessment of relative performance, these variance estimates are compared with a Monte Carlo simulation estimate of propagated variance through five 10-year growth projections. The results indicate growth projection estimates may have substantial error components that are not readily apparent from model calibration statistics or bias assessment procedures.

1224. Mowrer, H. Todd; Shepperd, Wayne D. 1987. Field measurement of age in quaking aspen in the central Rocky Mountains. Research Note RM-476. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Aspen rings can be reliably counted without resorting to laboratory procedures by using a low-power microscope and simple field preparation of cores.

1225. Mpoame, Mbida; Rinne, John N. 1984. Helminths of Apache *(Salmo apache)*, gila *(S. gilae)*, and brown *(S. trutta)* trouts. The Southwestern Naturalist. 29(4): 505-506.

1226. Mpoame, Mbida; Rinne, John N. 1983. Parasites of some fishes native to Arizona and New Mexico. Southwestern Naturalist. 28: 399-405.

1227. Murphy, Dennis J.; Buchan, R. M.; Fox, Douglas G. 1981. Ambient particulate and benzo (A) pyrene concentrations from residential wood combustion in a mountain resort community. *In:* Cooper, J. A.; Malek, D., editors. Proceedings, international conference on residential solid fuel combustion: environmental impacts and solutions; 1981 June 1-4; Portland, OR. Beaverton, OR: Oregon Graduate Center: 495-505.

1228. Murphy, Dennis J.; Buchan, R. M.; Fox, Douglas G. 1984. Ambient total suspended particulate matter and benzo (A) pyrene concentrations from residential wood combustion in a mountain resort community. American Industrial Hygiene Association Journal. 45(7): 431-435.

The mean BAP level of 7.4 Ng/m^3 appears to be several times greater than what is expected in a major metropolitan area. Residential wood combustion is suspected as the primary source of bap in this community.

1229. Musselman, Robert C. 1988. Acid neutralizing capacity of leaves exposed to acidic fog. Environmental and Experimental Botany. 28(1): 27-32.

1230. Musselman, Robert C.; McCool, Patrick M.; Sterrett, Jerry L. 1988. Acid fog injures California crops. California Agriculture. 42(4): 6-7.

1231. Musselman, Robert C.; McCool, Patrick M. 1989. Effects of acidic fog on productivity of celery and lettuce and impact on incidence and severity of diseases. Annals of Applied Biology. 114: 559-565.

1232. Musselman, Robert C.; McCool, Patrick M. 1989. Effects of acidic fog on productivity of celergy and lettuce and impact on incidence and severity of diseases. Annals of Applied Biology. 114: 559-565.

1233. Musselman, Robert C.; McCool, Patrick M.; Younglove, Theodore. 1988. Selecting ozone exposure statistics for determining crop yield loss from air pollutants. Environmental Pollution. 53: 63-78.

1234. Musselman, Robert C.; Sterrett, Jerry L.; Voth, Victor. 1988. Effects of simulated acidic fog on strawberry productivity. HortScience. 23(31): 128-130.

1235. Musselman, Robert C.; Sterrett, Jerry L. 1988. Sensitivity of plants to acidic fog. Journal of Environmental Quality. 17(2): 329-333.

1236. Myhre, Richard J. 1982. Photo mission logistics and feasibility testing. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 255-265. 1101 p.

The inventory specialist should have a general knowledge of principles of aerial photography, such as: resolution, scale, film, cameras, navigation aids, ground marking, and photo mission planning. The logistics phase will be reflected in the quality of resource data extracted from the final photo product. Prior to designing an inventory utilizing aerial photography, a feasibility test should be conducted.

1237. Myhre, Richard J. 1982. The role of aerial photography in multiresource inventories—techniques and tests in applications research. *In:* Technical papers, American Society of Photogrammetry. ASCM-ACP Convention; 1982 March 14-20; Denver, CO. Falls Church, VA: American Society of Photogrammetry: 585-594.

1238. Myhre, Richard J. 1982. Satellite photos can aid navigation on aerial photo missions. Photogrammetric Engineering and Remote Sensing. 48(2): 275-279.

LANDSAT photos can be an aid when maps are too old, lack proper information, are the wrong scale, or are not available. They also can be used to resolve problems when aerial photos are used as maps. It is important to select the best available spectral band and landsat photographic products. Methods for scaling the satellite image and producing black and white photo prints are also described.

1239. Nabhan, Gary P. [and others]. 1982. Papago influences on habitat and biotic diversity: quitovac oasis ethnoecology. Journal of Ethnobiology. 2(2): 124-143.

1240. Nappo, C. J. [and others]. 1982. *In:* The workshop on the representativeness of meteorological observations; 1981 June; Boulder, CO. Bulletin of the American Meteorological Society; 63: 761-764.

1241. Neel, James P. 1986. Nutritive quality of riparian and upland forage diets for cattle grazing pinyon-juniper woodland in southwestern New Mexico. Las Cruces, NM: New Mexico State University. 47 p. M.S. thesis.

1242. Neel, James P.; Kiesling, Herman E.; Donart, Gary B.; Holchek, Jerry L.; Goodman, Tim D.; Manzanares, Daniel. 1986. Nutritive value of forage collected by esophageal fistulated cows in riparian and upland areas on forest land. *In:* Proceedings, Western Section, American Society of Animal Science; 1985 July 17-19; Moscow, ID. Moscow, ID: American Society of Animal Science: 304-306.

1243. Nelson, David L.; Sturges, David L. 1986. A snowmold disease of mountain big sagebrush. Phytopathology. 76(9): 946-951.

A sagebrush snowmold disease, induced by an unidentified fungus, results in extensive death of mountain big sagebrush in areas of heavy snow deposition in Wyoming, Utah, and Colorado. A fungus with deptate, hyaline hyphae with unique knobby wall projections has been isolated that reproduces field symptoms of snowmold in coldroom inoculation tests. It has not been induced to sporulate in culture. In temperature growth studies, the isolate grew from -4°C to 24°C, with an optimum near 8-12°C. In southern Wyoming, snowpack temperatures in the sagebrush zone ranged from -4° to -16°C in early winter; in late winter the snowpack warms and becomes isothermal at 0° C.

1244. Nelson, Kurt J. 1980. Sterilization of dominant males will not limit feral horse populations. Research Paper RM-226. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Evidence does not support the premise that reproductive units are stable, with one male and many females. Individual horses, including productively active females, move between bands during the breeding season.

1245. Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, Robert H. 1987. Biology and conservation of northern forest owls. Symposium proceedings; 1987 February 3-7; Winnipeg, Manitoba. General Technical Report RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 309 p.

Proceedings of this first international symposium consist of 47 presented papers covering 15 owl species and 4 workshops dealing with capture, telemetry, census, and management techniques. Basic information on habitat preferences, home range size, detecting lesser known owls, etc., will be invaluable to managers of wildlife and of forested lands; techniques information will be invaluable to researchers.

1246. Newell, Jay A.; Toepfer, John E.; Rumble, Mark A. 1988. Summer brood-rearing ecology of the greater prairie chicken on the Sheyenne National Grasslands. *In:* Bjugstad, Ardell J., technical coordinator. Prairie chickens on the Sheyenne National Grasslands: proceedings of the symposium; 1987 September 18; Crookston, MN. General Technical Report RM-159. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 24-31. 73 p.

Twenty-two radio-tagged high, especially in the first 24 days, with only 28.4% surviving to the end of summer. Brood ranges varied from 22 to 2,248 ha, with an average of 488.6 ha for 15 broods that had at least one chick alive on 10 August. Broods were relocated in native vegetation 70.1% of the time. Broods seldom night roosted in upland vegetation, the community most heavily grazed by cattle, and were seldom relocated in pastures with cattle and usually left areas once they were mowed. Population declines in recent years might be due in part to the poor brood survival.

1247. Nicholls, Thomas H. 1989. Ethephon tests for lodgepole pine dwarf mistletoe in Colorado. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 34-36.

1248. Nicholls, Thomas H.; Egeland, Leanne; Hawksworth, Frank G. 1989. Birds of the Fraser Experimental Forest and their role in the dissemination of lodgepole pine dwarf mistletoe. Colorado Field Ornithologists Journal. 23: 3-12.

1249. Nicholls, Thomas H.; Egeland, Leanne; Hawksworth, Frank G. 1987. Control of dwarf mistletoe with ethephon. *In:* The 34th annual western international forest disease work conference; 1986 September 9-12; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 78-85.

1250. Nicholls, Thomas H.; Egeland, Leanne; Hawksworth, Frank G.; Johnson, David W.; Robbins, M. Kathryn. 1987. Control of dwarf mistletoes with a plant growth regulator. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 154-156. 253 p.

This paper summarizes test results of ethephon, an ethylene-releasing plant growth regulator, as a control for two dwarf mistletoes: *Arceuthobium americanum* on *Pinus contorta* and *A. vaginatum* subsp. *cryptopodium* on *P. ponderosa* in Colorado. Ethephon at 2,500 ppm with a surfactant was tested using three application methods: a bottle sprayer, a backpack mistblower, and a hydraulic sprayer. Dwarf mistletoe shoot abscission rates of 74% to 100% were consistently achieved using these ground application methods. Mistletoe seed dispersal the year after ethephon application was much less in the treated plots than in the nontreated control plots. An evaluation of aerial application methods is in progress.

1251. Nicholls, Thomas H.; Hawksworth, Frank G.; Merrill, Laura M. 1984. Animal vectors of dwarf mistletoe, with special reference to *Arceuthobium americanum* on lodgepole pine. *In:* Hawksworth, Frank G.; Scharpf, Robert F., technical coordinators. Biology of dwarf mistletoe: proceedings of the symposium; 1984 August 8; Fort Collins, CO. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 102-110. 131 p.

This paper summarizes studies of animal vectors of dwarf mistletoes with special reference to *Arceuthobium americanum* on lodgepole pine in Colorado. A total of 23 vectors has been identified. Results show birds can inoculate susceptible trees and that establishment of dwarf mistletoes beyond the range of their explosive fruits can be explained by vector dissemination of seed.

1252. Nicholls, Thomas H.; Hawksworth, Frank G.; Egeland, Leanne. 1987. Animal vectors of *Arceuthobium americanum* on lodgepole pine. *In:* The 34th annual western international forest disease work conference; 1986 September 9-1; Juneau, AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 96.

1253. Nicholls, Thomas H.; Hawksworth, Frank G.; Merrill, Laura M. 1984. A preliminary look at animal vectors of lodgepole pine dwarf mistletoe. *In:* Proceedings, 31st annual western international forest disease work conference; 1983 August 22-26; Coeur d'Alene, ID. Missoula, MT: Department of Agriculture, Forest Service, Northern Region: 54-55.

1254. Nielsen, D. G.; Hart, E. R.; Dix, Mary Ellen; Linit, M. J.; Appleby, J. E.; Ascerno, M.; Mahr, D. L.; Potter, D. A.; Jones, J. A. 1985. Common street trees and their pest problems in the north central United States. Journal of Arboriculture. 11: 225-232.

1255. Noble, Daniel L. 1980. Leafy spurge—evaluation and education needs. *In:* In Proceedings: Northern regional leafy spurge conference; 1979 December 17-18; Billings, MT. Helena, and Billings, MT: Montana Department of Agriculture, and Montana Experiment Station, Montana CRD Leafy Spurge Committee; and Montana Cooperative Extension Service. 3 p.

Recommendations for an accelerated research and application program include establishment of: demonstration areas, economic studies, joint U.S.-Canadian programs, standardized inventory techniques, educational tools, funding studies, and support of biological control programs,

1256. Noble, Daniel L.; Howe, Marmion. 1983. Cyanide in riparian vegetation. *In:* Fuerstenau, Maurice C.; Palmer, Bruce R., editors. Proceedings of gold, silver, uranium, and coal geology, mining, extraction and the environment; 1980 September 18-20; Rapid City, SD. New York, N.Y. The American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. 498-505. 526 p.

Gold ore processing has introduced industrial cyanide into the Black Hills of South Dakota. T shows amounts of cyanide in various areas and components of riparian habitat.

1257. Noble, Daniel L.; Winokur, Robert P. 1984. Wooded draws: characteristics and values for the northern Great Plains: symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication 111. South Dakota School of Mines and Technology. 52 p.

1258. Noel, Lynn E.; Marcus, Michael D.; Young, Michael K. 1989. Results from a regional survey ranking research needs for salmonid habitats in the central Rocky Mountains. *In:* Annual Meeting of the Colorado-Wyoming Chapter of the American Fisheries Society; 1989 March 1-2; Laramie, WY. 24: 70-80.

1259. Norman, J. M.; Jarvis, P. G.; Berry, Joseph K.; Kaufmann, Merrill R.; Raschke, K.; Haldin, S.; Lynn, B. 1989. Parameterizations of leaf stomatal conductance response functions. *In:* Workshop on stomatal resistance formulation and its application to modeling of transpiration; 1989 April 10-13; University Park, PA. University Park, PA: Pennsylvania State University: 81-90.

1260. Nowakowski, Nancy A.; Ffolliott, Peter F.; Patton, David R. 1982. RUN WILD: wildlife/habitat relationships: livestock-wildlife interactions in the Southwest. Wildlife Unit Technical Report. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 10 p.

This paper presents information for the RUN WILD III database concerning the effects of grazing on wildlife on southwestern rangelands. Information was compiled from the published literature specifically pertaining to Arizona and New Mexico. Livestock-wildlife interactions are first discussed in general, and then specific impacts and management suggestions are given for 31 vertebrate species.

1261. Oliver, William W.; Edminster, Carleton B. 1988. Growth of ponderosa pine thinned to different stocking levels in the western United States. *In:* Schmidt, Wyman C., compiler. Future forests of the Mountain West: a stand culture symposium; 1986 September 29-October 3; Missoula, MT. General Technical Report INT-243. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 155-159.

1262. Olson, Forrest W.; White, Robert G.; Hamre, Robert H. 1985. Proceedings of the symposium on small hydropower and fisheries; 1985 May 1-3; Aurora, CO. Bethesda, MD: American Fisheries Society. 497 p.

1263. Olson, Richard A. 1981. Wetland vegetation, environmental factors, and their interaction in site mine ponds, stockdams, and natural wetlands. General Technical Report RM-85. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 p.

Water regime, chemical features, temperature factors, light penetration, substrate properties, and physical characteristics are described for northern Great Plains strip mine ponds and stockdams, followed by a discussion of how their interaction determines wetland plant community composition and resulting wildlife habitat quality for consumptive and nonconsumptive resource utilization.

1264. Omi, Philip N.; Laven, Richard D. 1982. Prescribed fire impacts on recreational wildlands: a status review and assessment of research needs. Eisenhower Consortium Bulletin 11. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 18 p.

1265. Orland, B. O. 1989. Digital image processing aids for visual simulation of forest management practices. *In:* Conference on integrating research on hazards in fire-prone forest environments; Geelong, Victoria, Australia.

1266. Ostrofsky, Andrea; Peterson, Glenn W. 1981. Etiological and Cultural Studies of *Kabatina juniperi*. Plant Disease. 65(11): 908-910.

Kabatina juniperi is reported for the first time in the United States. The fungus causes a dieback of *Juniperus virginiana* and *J. scopulorum*. Fruiting bodies are present in February but are not rampant until March. Initial symptoms are first evident in spring, when junipers lose winter coloration. The fungus enters foliage through wounds, and only wounded foliage becomes infected.

1267. Ostrofsky, Andrea; Peterson, Glenn W. 1986. Kabatina tip blight of junipers. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 116-117. 149 p.

1268. Parker, Lawrence W.; Elkins, Ned Z.; Aldon, Earl F. [and others]. 1987. Decompositon and soil biota after reclamation of coal mine spoils in an arid region. Biology and Fertility of Soils. 4(12): 129-135.

1269. Pase, Charles P. 1983. Alpine tundra. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 27-33. (Biotic communities of the American Southwest-United States and Mexico).

1270. Pase, Charles P. 1983. Californian (coastal) chaparral. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 91-94. (Biotic communities of the American Southwest-United States and Mexico).

1271. Pase, Charles P. 1981. Community structural analysis—a rapid, effective range condition estimator for semi-arid ranges. *In:* Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods. Proceedings of the workshop; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 425-430. 620 p.

1272. Pase, Charles P. 1983. Sierran montane conifer forest. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 49-51. (Biotic communities of the American Southwest-United States and Mexico).

1273. Pase, Charles P. 1983. Sierran subalpine conifer forest. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 40-41. (Biotic communities of the American Southwest-United States and Mexico).

1274. Pase, Charles P.; Brown, David E. 1983. Californian coastalscrub. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 86-89. (Biotic communities of the American Southwest-United States and Mexico).

1275. Pase, Charles P.; Brown, David E. 1983. Interior chaparral. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 95-99. (Biotic communities of the American Southwest-United States and Mexico).

1276. Pase, Charles P.; Brown, David E. 1983. Rocky Mountain (Petran) and Madrean montane conifer forests. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 43-47. (Biotic communities of the American Southwest-United States and Mexico).

1277. Pase, Charles P.; Brown, David E. 1983. Rocky Mountain (Petran) subalpine conifer forest. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 37-39. (Biotic communities of the American Southwest-United States and Mexico).

1278. Pasek, Judith E. 1988. Influence of wind and windbreaks on local dispersal of insects. Agriculture, Ecosystems and Environment. 22/23: 539-554.

Small, wingless insects disperse downwind; however, flying insects may control the direction of travel within their boundary layer, where windspeed is lower than flight speed. Insects accumulated leeward of windbreaks. The distribution pattern is affected by wind parameters, windbreak structure, source of insects, and insect species.

1279. Pasek, Judith E.; Dix, Mary Ellen. 1988. Insect damage to conelets, second-year cones, and seeds of ponderosa pine in southeastern Nebraska. Journal of Economic Entomology. 81(6): 1681-1690.

Rhyacionia spp. and *Retinia metallica* caused annual average conelet losses in ponderosa pine of 8.2 • 3.0% and 5.4 • 4.9%, respectively. Abortion and disappearance of conelets caused by *Leptoglossus occidentalis*

Heidemann average 65.7 •8.2% and were reduced by 13% when conelets were protected with screen cages. *Dioryctria* spp. annually damaged an average of 14.2 • 7.2% of the second-year cones. Mean annual seed potentials ranged from 77.4 to 127.1 seeds per cone, but mean annual seed yields ranged from only 0.4 to 8.1 filled seeds per cone. For 1985, an estimated 41% of initial ovules were damaged by *L. occidentalis*.

1280. Pasek, Judith E.; Dix, Mary Ellen. 1989. Life history of a ponderosa pine coneworm, *Dioryctria auranticella* (Lepidoptera: Pyralidae). Journal of Economic Entomology. 82(3): 879-885.

First instars apparently overwinter in hibernaculae. Second and third instars feed in flowers during early May. Between mid-May and mid-June, fourth and fifth instars tunnel in second-year cones. Larvae pupate within cones during June, and moths are active from mid-June through July. Eggs hatch in 6 to 9 days.

1281. Pasek, Judith E.; Kearby, W. H. 1984. Larval parasitism of *Psilocorsis* spp. (Lepidoptera: Oecophoridae) leaftiers of central Missouri oaks. Journal of the Kansas Entomological Society. 57(1): 84-91.

Twenty-three species of larval parasites were reared. The most abundant were the braconids *Apanteles* N. sp., *Agathis calcarata*, *A. cincta*, the eulophid *Elachertus proteoteratis*, and the icheumonid *Diadegma pisilocorsis*. Larval parasitism averaged 22 percent.

1282. Patton, David R. 1986. Administration of research. *In:* Cole, Richard A.; Zeedyk, William D., editors. Proceedings, workshop on fish and wildlife research needs in New Mexico; 1984 October 3-4; Las Cruces, NM. Special Report 67. Las Cruces, NM: New Mexico State University: 118-121.

1283. Patton, David R. 1981. Chapter VIII: managing the habitat for mule deer in southwestern United States. *In:* Ffolliott, Peter F.; Gallina, Sonia, editors. Deer biology, habitat requirements, and management in western North America. A.C., Mexico, D.F. Instituto De Ecologia: 168-180. 238 p.

To manage deer in the southwestern United States is to manage habitat. Animals do not exist alone, but are always a part of some communal organization. Management of a wildlife species is concerned with the manipulation of a population either by controlling animals directly or indirectly through its habitat.

1284. Patton, David R. 1983. The Forest Service program of range and wildlife habitat research in the Southwest. *In:* Patton, David R. [and others], technical coordinators. Wildlife and range research needs in northern Mexico and southwestern United States: workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36. Washington, DC: U.S. Department of Agriculture, Forest Service: 67-70. 108 p.

Within the Rocky Mountain Forest and Range Experiment Station there are 9 field locations work units. Research includes determining the effects of livestock grazing on wildlife habitats, habitat requirements of fish and wildlife, and developing habitat management systems.

1285. Patton, David R. 1987. Is the use of "management indicator species" feasible? Western Journal of Applied Forestry. 2(1): 33-34.

Indicators were first used by plant ecologists who worked with soil productivity and agricultural crops. In the 1930s, vegetation condition and trend techniques, using plant indicators, were developed for range management. Modified forms of these techniques are still in use today. Recently, indicators were introduced to the wildlife profession as management indicator species by the National Forest Management Act. Management indicator species probably was meant to be a unifying concept to put wildlife on an equal basis with other resources when competing in the planning process, but the lack of a scientific definition in the regulations, a lack of data, and a lack of field experience detracts, at least for now, from its credibility as a planning tool.

1286. Patton, David R. 1983. Management applications of biotic community data. *In:* Brown, David E., editor. Desert Plants. 4(1-4): 7. (Biotic communities of the American Southwest-United States and Mexico).

1287. Patton, David R. 1984. A model to evaluate Abert squirrel habitat in uneven-aged ponderosa pine. Wildlife Society Bulletin. 12(4): 408-414.

Tree size, density, and sociability were used to develop a model for evaluating Abert squirrel habitat quality. Habitat capability (squirrels per acre) was determined for 5 quality classes (poor to optimum) by using an exponential regression model.

1288. Patton, David R. 1982. Wildlife habitat in land management planning: some ideas and principles. *In:* Ffolliott, Peter F.; Sowls, Lyle K.; Tash, Jerry C., technical coordinators. Proceedings of the workshop on the effects of land management practices on fish and wildlife in southwestern conifer forests; 1982 February 16-17; Tucson, AZ. Tucson, AZ: University of Arizona: 33-38. 40 p.

New federal laws require that wildlife habitat be part of the land management planni some of the specific requirements of these laws there is a need to develop new concepts and techniques and to standardize terminology. This paper suggests ways to integrate wildlife habitat into resource management plans.

1289. Patton, David R.; De La Puente-E, Jose M.; Ffolliott, Peter F.; Gallina, Sonia; Bartlett, E. T. 1983. Wildlife and range research needs in northern Mexico and southwestern United States: workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36. Washington, DC: U.S. Department of Agriculture, Forest Service. 108 p.

This seminar brought together participants from the United States, Mexico, and several Central American nations. Twenty invited and volunteer papers on a variety of topics relating to natural resources policies formed the basis for discussion among the participants.

1290. Patton, David R.; Ertl, Mary G. 1982. RUN WILD wildlife/habitat relationships: wildlife food plants in the Southwest. Wildlife Unit Technical Series. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 49 p.

Manipulation of food plants is one of the best techniques a biologist has to increase wildlife populations. This information is part of a file for the RUN WILD data base management system for Arizona and New Mexico. The system contains information on species habitat associations, distribution, protection status, references, cover requirements, and general food habits.

1291. Patton, David R.; Gonzales Vicente, Carlos E.; Medina, Alvin L.; Segura, Luis A.; Hamre, Robert H. 1986. Management and utilization of arid land plants. Symposium proceedings; 1985 February 18-22; Saltillo, Mexico. General Technical Report RM-135. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 113 p.

These proceedings contain 19 papers presented as part of a continuing cooperative effort in forestry and related resources between Mexico and the U.S. Primary species discussed include jojoba, guayule, palms, prickly pear, candelilla, mesquite, buffalo grind, creosotebush, indian ricegrass, and yerba del manso. Papers in the language of the author (Spanish or English) with an abstract in the other language.

1292. Patton, David R.; Severson, Kieth E. 1989. WILDHARE: a wildlife habitat relationships data model for southwestern ponderosa pine. *In:* Tecle, Aregai; Covington, W. Wallace; Hamre, Robert H., technical coordinators. Multiresource management of ponderosa pine forests: proceedings of the symposium; 1989 November 14-16; Flagstaff, AZ. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 268-276. 282 p.

Wildlife habitat can be described completely by a system of attributes and relations in a relational data base. A habitat relationships data model has been developed for ponderosa pine that includes four basic relations and 33 attributes for 250 wildlife species.

1293. Patton, David R.; Vahle, J. Robert. 1986. Red squirrel use in a mixed conifer forest in Arizona. Western Journal of Applied Forestry. 1(2): 48-51.

The red squirrel is closely associated with mature-to old-growth forest conditions of large coniferous trees, dense canopy closure, and a structure of all-aged trees. In Arizona, mixed-conifer forests with these stand conditions provide red squirrels with suitable opportunities for food gathering sites for food caching, and trees for nesting. Douglas-fir, white fir, and blue spruce are the most important species in red squirrel habitat. Red Squirrels contribute to the functioning of the forest ecosystem by spreading the spores of mycorrhizal underground, which may be necessary for the survival of coniferous trees.

1294. Patton, David R.; Wadleigh, Richard L. 1985. The effects of timber harvesting on the Kaibab Squirrel. Journal of Wildlife Management. 49(1): 14-19.

Kaibab squirrel density in southwestern ponderosa pine was less on treatment plots (cut) when compared to controls. The degree of influence of timber harvesting on squirrel density is related to the density and diameter of trees remaining for food and cover, the amount of tree patchiness, and to the size of cut area. The home range of five squirrels increased from pre- to posttreatment conditions. Mitigation procedures

such as leaving small groups of trees aroung nest trees, feed trees, and water sources can reduce the effects of a timber harvest on squirrel habitat.

1295. **Paulson, Deborah D.; Sieg, Carolyn Hull. 1984. Long-eared owls nesting in Badlands National Park. South Dakota Bird Notes. 36(4): 72-75.**

1296. **Paulson, Deborah D.; Sieg, Carolyn Hull. 1984. Long-eared owls nesting in Badlands National Park. South Dakota Bird Notes. 36(4): 72-75.**

Long-eared owls, reported as rare to uncommon in South Dakota, nested at high densities in Rocky Mountain juniper stands in Badlands National Park during 1982 and 1983. The abundance of long-eared owls in South Dakota may be underestimated due to the species' low detectability.

1297. **Perla, Ronald I.; Sommerfeld, Richard A. 1986. On the metamorphism, morphology, and microstructure of snow.** ***In:*** **International snow science workshop—a merging of theory and practice; 1986 October 22-25; Lake Tahoe, NV. Homewood, CA: ISSW Workshop Committee: 98-102.**

The tendency for snow microstructure to reduce surface energy via sintering and crystal growth (ET-metamorphism) is discussed using solutions to a simple rate equation. ET-metamorphism is contrasted with temperature gradient (TG-) metamorphism where by the microstructure attempts to remove the gradient via a positive feedback mechanism which causes exaggerated growth. Metamorphism in the presence of the liquid phase (melt-freeze metamorphism) is discussed briefly.

1298. **Perry, Hazel M.; Aldon, Earl F.; Brock, John H. 1987. Reclamation of an asbestos mill waste site in the Southwest. Reclamation and Revegetation Research. 6(1987): 187-196.**

Surface treatments with differing rates of mulch and surface modifications were implemented on an abandoned asbestos mill site near Globe, Arizona. Treatment areas were seeded and interplanted with woody species in the summer of 1981. Surface modification and mulching enhanced successful plant establishment. "cochise" lovegrass (*Eragrostis antherstonii* Stapf.) was the most successfully establishing species. Of the three interplanted woody species, velvet mesquite (*Prosopis velutina* Woot.) and catclaw acacia (*Acacia greggii* Gray.) showed excellent survival.

1299. **Peterson, George L. 1985. Economic growth from forest-based recreation, wildlife and tourism.** ***In:*** **Proceedings of the fifteenth forestry forum. Forest resources in regional economic development; 1985 April 11-12; Blacksburg, VA. Blacksburg, VA: Virginia Cooperative Extension Service: 55-73. 109 p.**

This paper summarizes several studies that have measured willingness to pay for forest-based recreation. These figures demonstrate substantial wealth flowing to the public through recreation, much of which is not captured as revenue. A summary of trends in camping fees on federal lands suggest that fees are tending to increase in real dollars, but that considerable surplus continues to remain with the public.

1300. **Peterson, George L. 1989. Estimating recreation values over time. Outdoor recreation benchmark.** ***In:*** **National outdoor recreation forum; 1988; Asheville, NC. General Technical Report SE-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest and Range Experiment Station: 209-221.**

1301. **Peterson, George L. 1988. Invited review of measuring recreation supply by Winston Harrington (RFF, 1987). Journal of Leisure Research. 19: 4.**

1302. **Peterson, George L. 1983. Rationing and redistribution of recreation use of scarce resources with limited carrying capacity.** ***In:*** **Lieber, Stanley R.; Fesenmaier, Daniel R., editors. Recreation planning and management. State College, PA: Venture Publishing: 286-302.**

1303. **Peterson, George L.; Anderson, Dorothy H.; Lime, David W. 1982. Multiple-use site demand analysis: an application to the boundary waters canoe are wilderness. Journal of Leisure Research. First Quarter 1982: 27-36.**

1304. **Peterson, George L.; Arnold, J. Ross. 1987. The economic benefits of mountain running: the Pikes Peak Marathon. Journal of Leisure Research. 19(2): 84-100.**

This paper reports willingness to pay for a trip to participate in the Pikes Peak Marathon as estimated by travel cost analysis of published 1981 to 1984 race results. Stratification of the demand function by gender, ascent vs. round trip race, and Colorado residency produces significant differences. According to the results, value is higher for Colorado nonresidents

than for residents, and for the round trip race than for the ascent race. Overall, the estimated average net willingness to pay is about $50.00 per person, and varies from about $20.00 for resident participants in the ascent race to $130.00 for nonresident participants in the round trip race.

1305. Peterson, George L.; Brown, Thomas C. 1986. The economic benefits of outdoor recreation. *In:* Driver, B. L.; Peterson, George L., compilers, editors. A literature review, the President's Commission on American Outdoors. Washington, DC: Government Printing Office: 11-18.

1306. Peterson, George L.; Brown, Thomas C. 1986. The economic benefits of recreation: common disagreements and informed replies. *In:* Southeastern recreation research conference; 1985 February 8-March 1; Myrtle Beach, SC. Statesboro, CA: Department of Recreation and Leisure Sciences: 17-33.

1307. Peterson, George L.; Brown, Thomas C. 1989. Forest resource economics needs: Production and economic valuation of forest and wildland recreation. *In:* Risbrudt, C. D.; Kaiser, H. Fred; Ellefson, P. V., compilers, editors. Forest economics and policy research: A research agenda for the next decade. 209-227.

1308. Peterson, George L.; Brown, Thomas C.; Rosenthal, Donald H. 1987. An improved framework for estimating RPA values. General Technical Report RM-138. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p.

An RPA value is defined in terms of the philosophical basis for valuation, the objectives and accounts to be served, alternative planning models and pricing policies, the reference for change, and the assumed efficiency of past and future decisions. Guidelines for estimating reporting RPA values are provided.

1309. Peterson, George L.; Brown, Thomas C. 1986. Visual impact assessment in benefit cost analysis. Journal of Urban Planning and Development. 112(1): 1-14.

Civil engineering projects generally change the visual environment. Complete benefit cost analysis (BCA) should include the visual costs and benefits, which tend to be nonpriced. Methods are available for estimating the monetary value of those impacts for BCA. This paper reviews the visual impact problem and methods for measuring and valuing visual impact. Limitations and biases of BCA are also reviewed.

1310. Peterson, George L.; Driver, B. L.; Gregory, Robin. 1988. Amenity resource valuation: integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 260 p.

This book attacks the walls that separate economics from other behavioral science disciplines by bringing together scientists from different fields in joint authorship of papers on amenity resource valuation. Topics range from policy need for amenity resource valuation to theoretical debates and critical evaluation of alternative valuation methods.

1311. Peterson, George L.; Driver, B. L.; Gregory, Robin. 1988. Let us hear the conclusion of the matter. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 255-260.

1312. Peterson, George L.; Driver, B. L. 1989. Managing forests for outdoor recreation and aesthetics: Concepts and principles. *In:* Society of American Foresters. Bethesda, MD: Society of American Foresters; 88: 79-94.

1313. Peterson, George L.; Dwyer, John F.; Darragh, Alexander J. 1983. A behavioral urban recreation site choice model. Leisure Sciences. 6(1): 61-81.

A multinomial logit site choice model (MNL) derived by utility maximization and based on reported travel distance and perceived site attributes was estimated for 21 forest-related urban recreation sites in Chicago. When estimated for subsets of the 21 sites, the coefficient for travel distance remained stable in sign, magnitude, and significance, while coefficients for "quiet" and "forested" changed in sign and significance.

1314. Peterson, George L.; Lime, David W. 1983. A research-management partnership grows in Minnesota's canoe country. Naturalist. 34(3): 5-11.

Research and management have enjoyed a productive partnership in the boundary waters canoe area wilderness. In a new program of research, wilderness permit data are being used to help explain recreation behavior to measure the value of wilderness recreation, to evaluate the potential for value capture, and to explore price rationing.

1315. **Peterson, George L.; Loomis, John B.; Sorg, Cindy F. 1985. Trends in the value of outdoor recreation.** *In:* **Proceedings, 1985 outdoor recreation trends symposium 2; 1985 February 25-27; Myrtle Beach, SC. Atlanta, GA: Southeastern Forest Experiment Station, Forestry Sciences Laboratory; and Department of Interior, National Park Service, Southeast Regional Office: 243-256.**

1316. **Peterson, George L.; Randall, Alan. 1984. Valuation of wildland resource benefits. Boulder, CO and London: Westview Press. 258 p.**

This collection of essays provides a comprehensive review of the most advanced techniques in the valuation of wildland benefits, a field within natural resources economics that is gaining widespread attention as pressures on U.S. wildlands reach critical levels and debate over their proposed uses and costs grows. Included in the book is a sophisticated, yet realistic review of the proper role of information in the evaluation of the economic costs and benefits of wildland management plans.

1317. **Peterson, George L.; Sorg, Cindy F. 1987. Introduction. Toward the measurement of total economic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-2. 44 p.**

1318. **Peterson, George L.; Sorg, Cindy F. 1987. Toward the measurement of total economic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.**

Considerable progress has been made in recent years in the valuation of nonpriced goods. however, Emphasis has been on those things most readily measurable. Valuation of wildlife benefits, for example, has aimed at consumptive, on-site recreation use (i.e., hunting and fishing). The danger in these partial estimates of value is that measuring only the on-site consumptive use of wildlife may presume to measure total value. This report examined the task of measuring off-site nonconsumptive wildlife values by considering values that include: total value, option value, existence value, quasi-option value, and bequest value. Discrepancies in definitions, measurement problems, and research needs are addressed in this collection of papers.

1319. **Peterson, George L.; Stynes, Daniel J. 1986. Evaluating goodness of fit in nonlinear recreation demand models. Leisure Sciences. 8(2): 131-147.**

Translation bias, rotation bias, and dispersion components of mean-square error are used to construct standardized measures of agreement between predictions and observations for any model. They are simple but useful measures for evaluating goodness of fit in recreation demand models that violate the restrictive assumptions of linear regression.

1320. **Peterson, George L.; Stynes, Daniel J.; Arnold, J. Ross. 1985. The stability of a recreation demand model over time. Journal of Leisure Research. 17(2): 121-132.**

Temporal stability of a simple recreation demand model specified in terms of distance and population is tested using a census of paddle canoe-camping trips to the Boundary Waters Canoe Area Wilderness for 1974-77, 1980, and 1981. Increases In the overall level of participation cannot be explained by the model or by changes in its exogenous variables. Plausible causes of change, including specification error, are discussed and directions for future research are recommended.

1321. **Peterson, George L.; Stynes, Daniel J.; Rosenthal, Donald H.; Dwyer, John F. 1984. Substitution in recreation choice behavior.** *In:* **Proceedings, 1984 Northwestern Science Association meeting; 1984 March 22-23; Missoula, MT. General Technical Report INT-184. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 19-30.**

1322. **Peterson, Glenn W. 1981. Control of *Diplodia* and *Dothistroma* blights of pines in the urban environment. Journal of Arboriculture. 7(1): 1-5.**

Diplodia tip blight and *Dothistroma* needle blight are two of the most common diseases afflicting pines in urban areas of the central United States. Extensive research has led to the development of effective and economical methods for control of these two diseases.

1323. **Peterson, Glenn W. 1981. *Diplodia* blight of pines. Forest Insect and Disease Leaflet 161. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.**

The fungus *Diplodia pinea* is most damaging to plantings of both exotic and native pine species in the United States. The effects of this disease are most severe in landscape, windbreak, and park plantings in the central and eastern United States.

1324. Peterson, Glenn W. 1988. Disease management in windbreaks. Agriculture, Ecosystems and Environment. 22/23: 501-511.

Diseases affecting trees in windbreaks are considered, with emphasis on methods of reducing disease impact; e.g., use of resistant species or varieties of trees, use of alternative species, chemical control, and timing management activities to coincide with periods when disease threat is low. Included are diseases contracted in the nursery, which reduce production of planting stock or which affect trees in windbreaks, and diseases of roots, stems, and foliage and twigs of trees in windbreaks.

1325. Peterson, Glenn W. 1982. *Dothistroma* needle blight of pines. Forest Insect and Disease Leaflet 143. Washington, DC: U.S. Department of Agriculture, Forest Service. 5 p.

Dothistroma needle blight of pines is a devastating foliar disease of a wide range of pine species. Procedures for control of the disease in the western United States will differ from those that are effective in the central United States because of differences in the life cycle of the fungus, hosts, growth, and weather. The use of genetic resistance looks promising for preventing or reducing damage by this fungus.

1326. Peterson, Glenn W. 1989. Dothistroma needle blight. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 34-35. 184 p.

Dothistroma needle blight, caused by the fungus Dothistroma septospora (syn. D. pini), affects 20 pine species and hybrids in the United States. The most frequent hosts are Austrian, mugo, and ponderosa pines in the Central and Eastern States and lodgepole, Monterey, and ponderosa pines in the West.

1327. Peterson, Glenn W. 1986. *Phomopsis* blight of junipers. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 112-113. 149 p.

1328. Peterson, Glenn W. 1981. Pine and juniper diseases of the Great Plains. General Technical Report RM-86. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 46 p.

The results of research on diseases of pines and junipers in the Great Plains are presented; diagnosis, biology, damage, and control are emphasized.

1329. Peterson, Glenn W. 1986. Recent research on conifer needle diseases: proceedings of the International Union of Forestry Research Organizations working party on needle diseases conference; 1984 October 14-18; Gulfport, MS. General Technical Report WO-50. Washington, DC: U.S. Department of Agriculture, Forest Service. 106 p.

Results of current research on foliage diseases of conifers in several countries were presented in 15 papers. The results included aspects of infection, genetic resistance, ecology, epidemiology, taxonomy, and control.

1330. Peterson, Glenn W. 1981. Research in the United States in *Dothistroma* blight of pines. *In:* Millar, C. S., editor. Proceedings of a conference of the International Union of Forest Research Organizations; 1980 September 15-19; Sarajevo, Bosnia, Yugoslavia. Aberdeen, Scotland: Aberdeen University Central Printing Service: 25-36. 113 p.

The author briefly reviews research on *Dothistroma pini* conducted in the United States, presenting information on geographic distribution and hosts infected in the United States; describing current research and results on genetic resistance to *D. pini* within *Pinus nigra* and *P. ponderosa*; and giving some suggestions for additional research on *D. pini*.

1331. Peterson, Glenn W. 1984. Resistance to *Dothistroma pini* within geographic seed sources of *Pinus ponderosa*. Phytopathology. 74(8): 956-960.

Resistance to *Dothistroma pini* was investigated in 78 geographic sources of ponderosa pine, in plantings established in 1968, in Nebraska, Oklahoma, and Missouri. There was high resistance to this fungus in 6 of the sources, 4 from New Mexico, 1 from Arizona, and 1 from Nebraska. Most of these sources were above plantation averages in height growth at 10 years. Thus, there are a number of areas where seed can be collected for production of seedlings which are to be planted where *D. pini* is a threat.

1332. Peterson, Glenn W. 1986. Resistance to *Phomopsis juniperovora* in geographic seed sources of *Juniperus virginiana*. *In:* Recent research on conifer needle diseases; 1984 October 14-18; Gulfport, MS. General Technical Report WO-50. Washington, DC: U.S. Department of Agriculture, Forest Service: 65-69. 106 p.

Progenies from 86 select *J. virginiana* trees in the Great Plains were inoculated with *P. juniperovora* and infection was evaluated to determine the degree of resistance to this fungus. The field growth and survival of 15 of the 20 resistant progenies after years were above plantation averages.

1333. Peterson, Glenn W. 1984. Spread and damage of western x-disease of chokeberry in eastern Nebraska plantings. Plant Disease. 68(2): 103-104.

The western x-disease pathogen spread rapidly from artificially inoculated chokecherry to healthy chokecherry; 60 percent of trees showed symptoms Within 3 years, and 80 percent showed symptoms within 5 years. Mortality was 50 percent within 8 years. American plums planted adjacent to infected chokecherry were not killed or damaged by the western x-disease pathogen.

1334. Peterson, Glenn W.; Hodges, Charles S., Jr. 1982. *Phomopsis* blight of junipers. Forest Insect and Disease Leaflet 154. Washington, DC: U.S. Department of Agriculture Forest Service. 7 p.

Phomopsis blight has been a serious problem for more than 75 years in nurseries producing juniper seedlings and grafts. The fungus causing this disease, is widespread in the United States.

1335. Peterson, Glenn W.; Hodges, Charles S., Jr. 1989. Phomopsis blight. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 56-57. 184 p.

Phomopsis blight, caused by the fungus Phomopsis juniperovora, occurs on several species of conifers in the cypress family such as juniper, cypress, whitecedar, and arborvitae. In the United States, the most frequent hosts are eastern redcedar, Rocky Mountain juniper, and Arizona cypress.

1336. Peterson, Glenn W.; Johnson, David W. 1986. *Diplodia* blight of pines. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 128-129. 149 p.

1337. Peterson, Glenn W.; Johnson, David W. 1986. Western x-disease of chokecherry. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 24-25. 149 p.

1338. Peterson, Glenn W.; Maier, Charles. 1986. *Phymatotrichum* rootrot. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 106-107. 149 p.

1339. Peterson, Glenn W.; Merrill, William; Skilling, Darroll D. 1989. Eastern and western gall rusts. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 36-37. 184 p.

Eastern gall rust, caused by the fungus Cronartium quercuum, affects jack, Scotch, shortleaf, Virginia, and other hard pines. Primary alternate hosts, which are needed to complete its life cycle, are red and black oaks. Western gall rust, caused by the fungus *Endocronartium harknessii* (syn. *Peridermium harknessii*), affects many native hard pines. It also affects exotic Scotch, Swiss Mountain, Aleppo, and Canary Island pines. It needs no alternate host to complete its life cycle.

1340. Peterson, Glenn W.; Morton, Harrison L. 1986. *Botryodiplodia* disease of Russian-olive. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 42-43. 149 p.

1341. Peterson, Glenn W.; Nicholls, Thomas H. 1989. Diplodia blight. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 31-33. 184 p.

Diplodia blight, caused by the fungus Sphaeropsis sapinea (syn. Diplodia pinea), affects more than 20 pine species in the United States. Most commonly affected are Austrian, red, ponderosa, Scotch, Monterey, and mugo pines.

1342. Peterson, Glenn W.; Riffle, Jerry W. 1986. *Cylindrosporium* leaf spot of buffaloberry and skunkbush sumac. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 32. 149 p.

1343. Peterson, Glenn W.; Riffle, Jerry W. 1984. Disease resistance investigations in relationship to tree improvement research in Nebraska. *In:* 36th annual meeting of the forestry committee. Tree improvement in the Great Plains proceedings; 1984 June 26-28; Watertown, SD. Great Plains Agricultural Council Publication 112. Lincoln, NE: University of Nebraska: 130-136. 230 p.

This paper relates the importance of general tree improvement research in Nebraska to disease re investigations. It reviews progress on investigations of resistance to fungi causing major diseases of pines (*Dothistroma* needle blight, western gall rust, *Diplodia* tip blight) and junipers (*Phomopsis* blight, *Cercospora* blight).

1344. Peterson, Glenn W.; Riffle, Jerry W. 1986. Root lesion nematodes in junipers and pines. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 140-141. 149 p.

1345. Peterson, Glenn W.; Stack, Robert W. 1986. Melampsora leaf rust of cottonwood and willow. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 4-5. 149 p.

1346. Peterson, Glenn W.; Walla, James A. 1986. *Naemacyclus (Cyclaneusma)* needle cast of pines. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 122-123. 149 p.

1347. Peterson, Glenn W.; Walla, James A. 1986. Western gall rust of pines. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 126-127. 149 p.

1348. Peterson, Glenn W.; Wysong, David S. 1986. *Cercospora* blight of junipers. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 114-115. 149 p.

1349. Peterson, Glenn W.; Wysong, David S. 1986. *Dothistroma* blight of pines. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 120-121. 149 p.

1350. Peterson, Roger S. 1982. Rust fungi (Uredinales) on *Cypressaceae* I. Micologia. 74(6): 903-910.

Gymnosporangium sabinae, the pear-juniper rust, occasionally infects *Cypressus sempervirens* in southern Europe, *G. minus* is a synonym. In the United States, Mexico, and Guatemala, *G. cupressi* is indistinguishable from the earlier-described Himalayan *G. cunninghamianum*, of which *G. meridissimum* and *Roestelia guatemaliana* are also synonyms. *Gymnosporangium clavipes* F. sp. *cupressi* in Mexico and Guatemala, and *Uredo cupressicola* in all three countries, also infect cypress. *Symnosporangium sabinae* and *G. clavipes* are the first *Gymnosporangium* species reported to infect members of more than one genus of *Cypressaceae*.

1351. Peterson, Roger S.; Rasmussen, Eric. 1986. Research natural areas in New Mexico. General Technical Report RM-136. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 58 p.

New Mexico's 17 research natural areas are described. Included are maps, photographs, and brief accounts of administration, climate, physiography, geology, soils, vegetation, fauna, research uses, and references. Threats and intrusions are noted. This information should be useful to scientists interested in conducting botanical or zoological research in New Mexico.

1352. Peterson, Thomas G.; Schmidt, Ralph A. 1984. Outdoor scale modeling of shrub barriers in drifting snow. Agricultural and Forest Meteorology. 31: 167-181.

The experiments demonstrate the importance of maintaining porous barriers; but gaps, simulating shrub mortality, greatly reduced snow storage, especially during high winds. Results from this investigation suggest that a low density shrub in rows spaced at least 14 times the average barrier height, would provide good snow distribution for forage production between rows.

1353. Pickens, James B.; Hof, John G. 1988. Accounting for stochastic variaton in linear programming technical coefficients. *In:* Kent, Brian M.; Davis, Lawrence S., technical coordinators. The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 54-58. 278 p.

Two recent studies by the authors (and others) dealing with stochastic production coefficients in land allocation linear programs are discussed. One major conclusion, which was reached independently in both studies, is that selection of truly feasible solutions is unlikely if technical coefficients are random.

1354. Plascencia, Douglas J.; Ffolliott, Peter F.; Gottfried, Gerald J. 1984. Effects of mixed conifer openings on snow. *In:* Hydrology and water resources in Arizona and the Southwest. Proceedings, 1984 meetings, Arizona Section American Water Resources Association and Hydrology Section Arizona-Nevada Academy of Science; 1984 April 7; Tucson, AZ. Tucson, AZ: Water Resources Research Center: 57-61.

1355. Platts, William S.; Rinne, John N. 1985. Riparian and stream enhancement management and research in the Rocky Mountains. North American Journal of Fisheries Management. 5: 115-125.

This report reviews past stream enhancement research in the Rocky Mountains, its adequacy, and research that should be done to improve the effectiveness of future stream enhancement projects. Research is lacking on stream improvement in a watershed context on a long-term basis. Not all streams can be enhanced. Enhancement should be attempted only after techniques described in the literature have been carefully considered and judged appropriate for the selected site.

1356. Pomeroy, John Willard. 1988. Evaporation from drifting snow. *In:* Eley, F. J., editor. Evaporation and evapotranspiration processes; 1987 May 20-21; Saskatoon, Saskatchewan, Canada. Saskatoon, Saskatchewan, Canada: Canadian Climate Centre, National Hydrology Research Centre; 88: 50-53.

1357. Pomeroy, John Willard. 1989. A process-based model of snow drifting. Annals of Glaciology. 13: 237-240.

This physics-based two-phase flow model of the mass balance of drifting snow calculated the transport of snow through saltation and suspension, and recognizes the important role of in-transit sublimation on surface-erosion rates.

1358. Pomeroy, John Willard. 1988. Wind transport of snow. Saskatoon, Saskatchewan, Canada: University of Saskatchewan. 226 p. Ph.D. dissertation.

1359. Pomeroy, John Willard; Male, D. H. 1988. Optical properties of blowing snow. Journal of Glaciology. 34(116): 3-10.

1360. Pomeroy, John Willard; Male, D. H. 1987. Wind transport of seasonal snow covers. *In:* Seasonal snow covers: physics, chemistry, hydrology. NATO Advanced Study Institute Series C. Dordrecht, Netherlands: D. Reidel Publishing Co. 211: 119-140.

1361. Potter, Loren D.; Gosz, James R.; Carlson, Clarence A., Jr. 1984. Water resources in the southern Rockies and High Plains. Eisenhower Consortium Institution Series Report 6. Albuquerque, NM: University of New Mexico Press. 331 p.

This publication synthesizes several years of the Eisenhower Consortium-sponsored research dealing with the interrelationships of human recreational activities with the multiple aspects of water quantity and quality in the Rocky Mountain West.

1362. Potter, Loren D.; Reynolds, Robert C., Jr.; Louderbough, Ellen T. 1985. Mancos shale and plant community relationships: analysis of shale, soil, and vegetation transects. Journal of Arid Environments. 9: 147-165.

1363. Potter, Loren D.; Reynolds, Robert C., Jr.; Louderbough, Ellen T. 1985. Mancos shale and plant community relationships: field observations. Journal of Arid Environments. 9: 137-145.

1364. Price, Peter W.; Clancy, Karen M. 1986. Interactions among three trophic levels: gall size and parasitoid attack. Ecology. 67(6): 1593-1600.

1365. Price, Peter W.; Clancy, Karen M. 1986. Multiple effects of precipitation on *Salix lasiolepsis* and populations of the stem-galling sawfly, *Euura lasiolepsis*. Ecological Research, April. 1: 1-14.

1366. Probasco, George E.; Bjugstad, Ardell J. 1980. Influence of fertilizer, aspect, and harvest date on chemical constituents and in vitro digestibility of tall fescue. Journal of Range Management. 31(6): 439-442.

1367. Radloff, David L. 1980. Coping with uncertainty in fuel management decisions. *In:* Proceedings: sixth conference on fire and forest meteorology; 1980 April 22-24; Seattle, WA. Washington, DC: Society of American Foresters: 151-155. 304 p.

A fuel hazard appraisal procedure combining decision analysis, fuel modeling, and fire modeling is described. Alternative fuel treatment effects, fire occurrence rate, levels of fire behavior, and fire suppression effectiveness are incorporated in a decision tree that evaluates the fuel treatments. Two examples are presented.

1368. Radloff, David L. 1983. Fire hazard effects of timber harvesting. *In:* Timber harvesting in the central Rockies: problems and opportunities. SAF regional technical conference; 1983 January 4-6; Fort Collins, CO. Cooperative Extension Service Publication XCM-870. Fort Collins, CO: Colorado State University: 314-325.

1369. Radloff, David L. 1982. National activity fuel appraisal process. *In:* Proceedings, Computer modeling: its application in fire management: symposium of the Intermountain Fire Council; 1981 October 20-22; Salt Lake City, UT. Logan, UT: Utah State University: 142-156.

1370. Radloff, David L.; Freeman, Duane R.; Yancik, Richard F. 1984. FUELBED-EAST: users guide for modeling activity fuels and fire behavior in eastern forests. Unnumbered Publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

In the north-central and northeastern sections of the United States, the computer program FUELBED-EAST can be used as part of the national fuel appraisal process for evaluating the fire hazard aspects of fuel management alternatives. Detailed input instructions, sample runstreams, example inputs, and example outputs are provided.

1371. Radloff, David L.; Schopfer, Walter C.; Yancik, Richard F. 1982. Slash fire hazard analysis on the Siskiyou National Forest. Environmental Management. 6(6): 517-526.

A Decision analysis approach to estimating fire hazard in terms of expected burned area was applied to a watershed in the Siskiyou National Forest (Oregon). Three treatment alternatives were evaluated, and the effects of the treatments were projected over a 90-year period. Initially, the effects of applying a treatment are small. After 50 years of treatment, the most intense alternative can be expected to show almost a 50 percent reduction in burned area compared to no treatment.

1372. Radloff, David L.; Yancik, Richard F. 1983. Decision analysis of prescribed burning. *In:* Proceedings, 7th conference on fire and forest meteorology; 1983 April 25-28; Fort Collins, CO. Boston, MA: American Meteorological Society: 85-93.

1373. Radloff, David L.; Yancik, Richard F.; Walters, Kenneth G. 1982. User's guide to the national fuel appraisal process. Unnumbered Publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 41 p.

The activity fuel appraisal process is a method for evaluating the fire hazard aspects of fuel management alternatives. A fuel appraisal software package is described which provides computer support for the appraisal process. Detailed input instructions, runstreams, example inputs, and example outputs are provided.

1374. Radwan, M. A.; Crouch, Glenn L.; Harrington, C. A.; Ellis, W. D. 1982. Terpenes of ponderosa pine and feeding preferences of pocket gophers. Journal of Chemical Ecology. 8(1): 241-253.

Yield and composition of essential oils were compared in foliage, stems, and roots of ponderosa pine seedlings, and preferences for the trees by pocket gophers were determined. Results of correlation and discriminant analyses showed that some oil constituents could serve as indicators of resistance (or susceptibility) to gopher damage.

1375. Ragenovich, I. R.; Schmid, John M.; Bennett, D. D.; Barry, J. W.; Richmond, Charles E. 1986. Field evaluations of four insecticides against the pandora moth. Insecticide and Acaricide Tests. 11: 426.

Four insecticides were aerially applied by helicopter to blocks, 8 hectares in size, along 2 roads east, of Jacob Lake, Arizona, in October 1982. Two 60-cm branch samples were removed from each of 24 trees systematically distributed within each block to estimate larval numbers. Samples were taken just before treatment and 12 and 213 days after treatment.

1376. Ragenovich, I. R.; Schmid, John M.; Bennett, D. D. 1986. Pine, ponderosa: *Pinus ponderosa* Laws. Pandora moth: *Coloradia pandora* Blake. Ornamentals, forest and shade trees. Insecticide and Acaricide Tests. 16: 426.

1377. Ragotzkie, Kim E. 1988. Desert mule deer ecology and habitat use on cattle-grazed grass-shrub range. Fort Collins, CO: Colorado State University. 102 p. M.S. thesis.

1378. Rahn, Perry H. 1984. Base flow of Slate Creek, central Black Hills. Proceedings of the South Dakota Academy of Science. 62: 80-83.

1379. Randall, Alan. 1988. A camel is a camel is... *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 225-228.

1380. Randall, Alan. 1988. The total value dilemma. *In:* Toward the measurement of total economic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 3-13. 44 p.

1381. Raphael, Martin G. 1987. The Coon Creek Wildlife Project: effects of water yield augmentation on wildlife. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 173-179. 253 p.

The Coon Creek Water Yield Augmentation Pilot Project is a demonstration of timber harvest designed to increase water yield from a treated drainage compared to an untreated control. Of interest here are the effects of this pattern of timber harvest on bird and small mammal community structure, and on the distribution, habitat selection, and reproductive success of selected species. This paper describes preliminary results during the pretreatment phase of a longer-term study.

1382. Raphael, Martin G. 1988. Douglas-fir. *In:* Mayer, K. E.; Laudenslayer, W. F., Jr., editors. A guide to wildlife habitats in California. Sacramento, CA: California Department of Forestry and Fire Protection: 52-53.

This paper describes structure, composition, classification, succession, and wildlife association of Douglas-fir forests in northwestern California. Typical stands are composed of overstory Douglas-fir with a dense subcanopy of tanoak, Pacific madrone, and other hardwoods. Composition varies with soil, moisture, topography, and parent material.

1383. Raphael, Martin G. 1987. Estimating relative abundance of forest birds: simple versus adjusted counts. The Wilson Bulletin. 99(1): 125-131.

In applied studies of avian ecology, one of the more commonly encountered problems is the estimation of a species' abundance across a gradient of habitat types. Recently, much attention has focused on transect or point counts incorporating detection functions derived from the distribution of distances to each detected bird. Detection functions are used to calculate a "basal region" which is that area sampled over which all individuals are believed to be detected. This paper investigates how well simple counts compare to more complex methods of estimating relative abundance.

1384. Raphael, Martin G. 1988. Habitat associations of small mammals in a subalpine forest, southeastern Wyoming. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 359-367. 458 p.

Mammal capture rates were greatest at sites with mature timber and other old-growth attributes. Shrews and southern red-backed voles were much more abundant at sites dominated by spruce or fir compared to drier sites dominated by lodgepole pine. Deer mice, in contrast, were most abundant on drier, pine-dominated sites. The southern red-backed vole, because of its high abundance and strong association with mature forest, is a good ecological indicator of late seral conditions for forest planning purposes.

1385. Raphael, Martin G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in Douglas-fir of northwestern California. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 23-31.

Relative abundance of 55 species of amphibians, reptiles, and mammals was estimated at 166 sites representing early clearcut through old-growth Douglas-fir forest in northwestern California. Nine species were strongly associated with older stands, and 11 species were strongly associated with younger stands. The remaining species were either too rare to analyze statistically or exhibited no clear trends of abundance in relation to stand age. Estimates of relative abundance of each species in each stage, coupled with data on historical, present, and future acreage of timber in each seral stage, were used to approximate the long-term impacts of timber harvest on the fauna of the Douglas-fir region.

1386. Raphael, Martin G. 1987. Nongame wildlife research in subalpine forests of the central Rocky Mountains. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 113-122. 253 p.

Subalpine forests of the central Rocky Mountains provide habitat for 145 species of amphibians, reptiles, birds, and mammals. Perhaps because of extreme seasonal climate and the relatively simple structure and composition of subalpine forests, diversity of wildlife is lowest of any forest type in the region. No species are found only in subalpine habitats but some, e.g., southern red-backed vole, reach their maximum abundance there. Research to date has emphasized community structure; much additional work is needed to understand population dynamics and habitat relationships of species that find optimum habitat conditions in subalpine forests.

1387. Raphael, Martin G. 1985. Orientation of American kestrel nest cavities and nest trees. The Condor. 87: 437-438.

Compass orientation of nest cavities and nest trees used by the American kestrel *(Falco sparverius)* was compared to orientation of available cavities in a Sierra Nevada watershed. Kestrels preferentially selected east-facing slopes and cavities, possibly to reduce exposure to westerly storms.

1388. Raphael, Martin G. 1988. A portable computer-compatible system for collecting bird count data. Journal of Field Ornithology. 59(3): 280-285.

A portable, battery-operated system for recording bird count data is described. All components are commercially available and include a hand-held terminal for recording observations in the field, a battery-operated microcomputer and disk drive for storing daily observations onto a diskette, and a second disk drive and software for data editing and analysis in the laboratory. The system was used by five observers to collect about 20,000 observations during 2,160 10-minute counts using the variable circular plot technique.

1389. Raphael, Martin G. 1988. A portable data-acquisition system for recording wildlife counts. *In:* Buhyoff, Gregory J., editor. Proceedings, Resource technology 88: international symposium on advanced technology in natural resource management; 1988 June 20-23; Fort Collins, CO. Falls Church, VA: American Society for Photogrammetry and Remote Sensing: 234-235.

A battery-operated data logger, laptop microcomputer, and laboratory personal computer were linked to create a system for electronically collecting wildlife counts in the field. The system performed with excellent reliability over a 2-year period.

1390. Raphael, Martin G. 1987. Preliminary suggestions for monitoring marten on the Medicine Bow National Forest. Laramie, WY: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; Report to Medicine Bow National Forest. 7 p. Available from: Forest, Range and Watershed Laboratory, Laramie, WY.

1391. Raphael, Martin G. 1989. There's life in dead trees. Biologue. 3(2): 11-12.

Snags (standing dead trees) provide critical habitat for nearly 100 wildlife species in the Rocky Mountains. Snags are used for nesting, feedings, cover, perching, and communication. Fallen trees also provide important habitat for mammals, reptiles, and amphibians. Dead wood contributes diversity to forest systems.

1392. Raphael, Martin G. 1987. Use of Pacific madrone by cavity-nesting birds. *In:* Plumb, Timothy R.; Pillsbury, Norman H., editors. Multiple-use management of California's hardwood resources: proceedings of the symposium; 1986 November 12-14; San Luis Obispo, CA. General Technical Report PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 198-202.

Cavity-nesting birds preferentially selected Pacific madrone trees for nesting in Douglas-fir forests of California. Most cavity nests were in live madrones >30 cm dbh. To meet habitat requirements of cavity-nesting birds, retention of >1.5 stems/ha is recommended.

1393. Raphael, Martin G. 1984. Wildlife populations in relation to stand age and area in Douglas-fir forests of northwestern California. *In:* Meehan, William R.; Merrell, Theodore R., Jr.; Hanley, Thomas A., editors. Fish and wildlife relationships in old-growth forests. Proceedings of a symposium; 1982 April 12-15; Juneau, AK. American Institute of Fishery Research Biologists: 259-274. (Available from: John W. Reintjes, Morehead City, NC).

Wildlife populations and vegetation characteristics were compared among sawtimber, mature, and old-growth stands, and among five stand area classes. Seventeen species of birds, two salamanders, and ten mammals were most abundant in older stands; numbers of species did not vary among age or area classes after adjusting for sampling effort. Ten wildlife species were more abundant in both older and larger stands.

1394. Raphael, Martin G. 1987. Wildlife-tanoak associations in Douglas-fir forests of northwestern California. *In:* Plumb, Timothy R.; Pillsbury, Norman H., editors. Multiple-use management of California's hardwood resources: proceedings of the symposium; 1986 November 12-14; San Luis Obispo, CA. General Technical Report PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 183-189.

Of 61 species tested, the abundance of 12 bird species, 7 mammal species, and 5 salamander species were correlated with tanoak canopy volume. Management practices that eliminate tanoak are probably detrimental to these and possibly other species of wildlife in Douglas-fir forests.

1395. Raphael, Martin G.; Brink, Glen E. 1988. Bootstrap estimation of home range area: user's guide to program HOMERANG. General Technical Report RM-165. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

Program HOMERANG estimates the home range area of an individual animal and uses bootstrapping to assess the influence of sample size. UTM coordinates of locations of sightings or captures are the "X-Y Cartesian points" used in computing the area of the largest polygon that will enclose all the locations. Sample runs are included.

1396. Raphael, Martin G.; Marcot, Bruce G. 1986. Validation of a wildlife-habitat-relationships model: vertebrates in a Douglas-fir sere. *In:* Verner, Jared; Morrison, Michael L.; Ralph, John C., editors. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: University of Wisconsin Press; 2: 129-138.

1397. Raphael, Martin G.; Morrison, Michael L.; Yoder-Williams, Michael P. 1987. Breeding bird populations during twenty-five years of postfire succession in the Sierra Nevada. The Condor. 89: 614-626.

A summary of breeding bird censuses done from 1966-1985 on two Sierra Nevada forest plots; one burned in 1960, the other, an adjacent unburned control. Total density of birds was nearly equal on the two plots but species richness increased on the burned plot compared with the unburned plot.

1398. Raphael, Martin G.; Morrison, Michael L. 1987. Decay and dynamics of snags in the Sierra Nevada, California. Forest Science. 33(3): 774-783.

A study on the rates of decay, falling, and recruitment in a population of snags (standing dead trees) in the Sierra Nevada during 1975-83 showed that large-diameter snags fell slower than small-diameter snags, and firs fell at a lower rate than pines.

1399. Raphael, Martin G.; Rosenberg, Kenneth V. 1983. An integrated approach to wildlife inventories in forested habitats. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 219-222. 737 p.

The cost-effectiveness of six data collection techniques are assessed. The techniques determine presence, relative abundance, and habitat associations of terrestrial vertebrates on 136 forest sites in northwestern California. Year-to-year and seasonal variation in vertebrate abundance can ne great, confounding interpretation of habitat relationships.

1400. Raphael, Martin G.; Rosenberg, Kenneth V.; Marcot, Bruce G. 1989. Large-scale changes in bird populations of Douglas-fir forests, northwestern California. *In:* Jackson, Jerome A., editor. Bird conservation. Madison, WI: The University of Wisconsin Press: 63-68.

Comparisons of estimates of historical composition of the bird community with present populations of 60 species and with numbers expected in the future as more mature forest is harvested indicate that no species will likely be eliminated but that there will be major shifts in abundance. Among the birds studied, 14 species will likely decline by greater than 50% and 10 will decrease by greater than 50% as more forest is harvested and replaced by younger stands.

1401. Raphael, Martin G.; Taylor, Cathy A.; Barrett, Reginald H. 1986. Smoked aluminum track stations record flying squirrel occurrence. Research Note PSW-384. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 3 p.

Smoked aluminum track stations are a useful technique for studying patterns of abundance and distribution of northern flying squirrels. They are easily transported to remote field sites, allow permanent preservation of tracks, and yield frequency-of-occurrence information. A study in Douglas-fir forests of northwestern California illustrates the use of the track stations, methods of data analysis, and habitat association of the northern flying squirrel.

1402. Raphael, Martin G.; White, Marshall. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wildlife Monographs No. 86. Washington, DC: The Wildlife Society, Inc. 66 p.

Cavity-nesting birds (CNB) selected large-diameter snags for nesting. Decay and size characteristics of nests differed among bird species but characteristics of feeding sites differed less. Abundance of CNB was limited by snag density below 3 stems 40 cm dbh per ha. Management recommendations stress retaining large-diameter live trees and planning for a diversity of snag size and hardness classes.

1403. Rasmussen, William O.; Ffolliott, Peter F. 1983. A model to predict snag development. Wildlife Society Bulletin. 11(3): 291-292.

1404. Rasmussen, William O.; Weise, Reuben N.; Ffolliott, Peter F.; Carder, D. Ross. 1980. Planning for forest roads—a computer assisted procedure for selection of alternative corridors. Journal of Environmental Management. 11: 93-104.

1405. Read, Ralph A. 1980. Genetic variation in seedling progeny of ponderosa pine provenances. Forest Science Monograph 23. Washington, DC: Society of American Foresters. 59 p.

Twenty-four characteristics were measured on 100 seedlings each of 80 natural stand seed provenances of ponderosa pine, during three growing seasons, in a 10-replicated experiment, at Bessey Nursery, in central Nebraska. Isodata multi-character analysis, using 13 traits, provided a basis for grouping the 80 origins into a pattern of nine geographic clusters.

1406. Read, Ralph A. 1983. Ten-year performance of ponderosa pine provenances in the Great Plains of North America. Research Paper RM-250. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 17 p.

A cluster and discriminant analysis based on nine of the best plantations, partitioned the seed provenance populations into six geographic clusters according to their consistency of perfomance in the plantations. The north-central Nebraska cluster of three provenances performed consistently well above the average in all plantations.

1407. Read, Ralph A.; Sprackling, John A. 1980. Cottonwood-willow. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 113.

1408. Read, Ralph A.; Sprackling, John A. 1983. Flowering in a ponderosa pine provenance plantation in eastern Nebraska. Research Note RM-423. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Nebraska plantation ponderosa pines from 50 provenances exhibited variations in flower sex, northern sources producing predominantly ovulate strobili and southern sources predominantly staminate. Relative proportions of ovulate and staminate strobili produced appear to be influenced by photoperiod length as expressed by differences between latitudes of seed origin and plantation location.

1409. Read, Ralph A.; Sprackling, John A. 1981. Hail damage variation by seed source in a ponderosa pine plantation. Research Note RM-410. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

A Hastings, Nebr., plantation of 13-year-old ponderosa pine, originating from 79 seed sources throughout the species' natural range, was evaluated after a severe hail storm in 1977. Trees sustaining the most damage were progeny of seed sources from the Pacific Northwest, the Bitterroot Valley of Montana, and the southern Rocky Mountains.

1410. Reaves, Jimmy L.; Allen, Thomas C.; Shaw, Charles G., III; Dashek, William V.; Mayfield, John E. 1988. Occurrence of virus-like particles in isolates of *Armillaria*. Journal of Ultrastructure and Molecular Structure Research. 98: 217-221.

1411. Reaves, Jimmy L.; Allen, Thomas C.; Shaw, Charles G., III; Dashek, William V.; Mayfield, John E. 1987. Viruslike particles in *Armillaria*. *In:* The 35th annual western forest disease work conference; 1987 August 18-21; Nanaimo, BC. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Forest Pest Management: 76-83.

1412. Reich, Peter B.; Schoettle, Anna W.; Amundson, Robert G. 1985. Effect of low concentrations of O_3, leaf age and water stress on leaf diffusive conductance and water use efficiency in soybean. Physiologia Plantarum. 63: 58-64.

1413. Reich, Peter B.; Schoettle, Anna W.; Amundson, Robert G. 1985. Effects of O_3 and acidic rain on photosynthesis and growth in sugar maple and northern red oak. Environmental Pollution. 40: 1-16.

1414. Reich, Peter B.; Schoettle, Anna W.; Stroo, Hans F.; Troiano, J.; Amundson, Robert G. 1985. Effects of O_3, SO_2, and acidic rain on mycorrhizal infection in northern red oak seedlings. Canadian Journal of Botany. 63: 2049-2055.

1415. Reich, Peter B.; Schoettle, Anna W.; Stroo, Hans F.; Troiano, J.; Amundson, Robert G. 1987. Effects of ozone and acid rain on white pine *(Pinus strobus)* seedlings grown in five soils. I. Net photosynthesis and growth. Canadian Journal of Botany. 65: 977-987.

1416. Reich, Peter B.; Schoettle, Anna W.; Stroo, Hans F.; Amundson, Robert G. 1988. Effects of ozone and acid rain on white pine *(Pinus strobus)* seedlings grown in five soils. III. Nutrient relations. Canadian Journal of Botany. 66(8): 1517-1531.

1417. Reich, Peter B.; Schoettle, Anna W.; Raba, R. M.; Amundson, Robert G. 1986. Response of soybean to low concentrations of ozone. I. Reductions in leaf and whole plant net photosynthesis and leaf chlorophyl. Journal of Environmental Quality. 15: 31-36.

1418. Reich, Peter B.; Schoettle, Anna W. 1989. Role of phosphorus and nitrogen in photosynthetic and whole plant carbon gain and nutrient use efficiency in Eastern White Pine. Oecologia. 77: 25-33.

1419. Reich, Peter B.; Stroo, Hans F.; Schoettle, Anna W.; Amundson, Robert G. 1986. Acid rain and ozone influence mycorrhizal infection in tree seedlings. Journal of the Air Pollution Control Association. 36: 724-726.

1420. Reuss, J. O. 1989. Soil-solution equilibria in lysimeter leachates under red alder. *In:* 82nd annual meeting of AWMA; 1989 June 25-30; Anaheim, CA. 16 p.

1421. Reynolds, Richard T. 1989. Accipiters. *In:* Western raptor management symposium and workshop. Scientific and Technical Series No. 12. National Wildlife Federation; 12: 92-101.

1422. Reynolds, Richard T. 1987. Census of flammulated owls. *In:* Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, Robert H., editors. Biology and conservation of northern forest owls: symposium proceedings; 1987 February 3-7; Winnipeg, Manitoba, Canada. General Technical Report RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 308-309. 309 p.

1423. Reynolds, Richard T. 1989. The flammulated owl and old-growth forests. Biologue. 3: 13.

1424. Reynolds, Richard T. 1983. Management of western coniferous forest habitat for nesting *Accipiter* hawks. General Technical Report RM-102. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

1425. Reynolds, Richard T. 1982. North American *Accipiter* hawks. *In:* Davis, David E., editor. CRC handbook of census methods for terrestrial vertebrates. Boca Raton, FL: CRC Press, Inc: 288-289. 397 p.

Accipiter populations are highly dispersed and, therefore, difficult to census. This paper reports on the behavior and activity of adults, active and inactive nests, feces and molted feathers, prey remains, and the activity of fledged young.

1426. Reynolds, Richard T. 1989. Small forest owls. *In:* Western raptor management symposium and workshop. Scientific and Technical Series No. 12. National Wildlife Federation; 12: 134-143.

1427. Reynolds, Richard T.; Linkhart, Brian D.; Jeanson, Judy-Jo. 1985. Characteristics of snags and trees containing cavities in a Colorado conifer forest. Research Note RM-455. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

In Colorado a 160-ha forest of mature ponderosa pine-Douglas-fir contained 6.5 snags and spike-top trees per hectare. Of these, 0.9 per hectare had one or more cavities. In addition, there were 0.4 live cavity-trees per hectare. Most snags and spike-tops that contained cavities were in the larger diameter classes. The proportion of snags with cavities was equal among ponderosa pine, Douglas-fir, limber pine, and quaking aspen.

1428. Reynolds, Richard T.; Linkhart, Brian D. 1987. Fidelity to territory and mate in flammulated owls. *In:* Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, Robert H., editors. Biology and conservation of northern forest owls: symposium proceedings; 1987 February 3-7; Winnipeg, Manitoba, Canada. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 34-238. 309 p.

Adult flammulted owls were banded on a 452-ha area in Colorado. Nine adults nested 1 yeaar only, five nested in 2 years, four in 3, one in 4, and one in 5. Males had a lower return rate than females. Once males established breeding territories, they returned to them each year. Females sometimes changed territories,

and their corresponding dispersal distance (474 m) was similar to the mean distance across territories, 424 m.

1429. Reynolds, Richard T.; Linkhart, Brian D. 1984. Methods and materials for finding and monitoring flammulated owls. Great Basin Naturalist. 44(1): 49-51.

Adult flammulated owls responded to imitated territorial song throughout the nest season. Nests were found by noting vocalizations and behaviors associated with courtship-feeding and food transfers between the sexes. Backpack harnesses and tail-mounted transmitters were used on adults and backpacks on fledglings.

1430. Reynolds, Richard T.; Linkhart, Brian D. 1987. The nesting biology of flammulated owls in Colorado. *In:* Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, Robert H., editors. Biology and conservation of northern forest owls: symposium proceedings; 1987 February 3-7; Winnipeg, Manitoba, Canada. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 239-248. 309 p.

Spring arrival of flammulated owls to a 452-ha area in Colorado occurred in early May. Each year, 4-6 territories were occupied by pairs and 2-3 territories by unpaired males. Clutch size was 2-7 eggs, incubation was 22 nights, brood size was 2-4 young, and young were in the nest 23 nights. Owlets dispersed in late August and adults in early October. The affinity of flammulated owls for old yellow pine forests stems from the abundance of nest cavities, the structure of the trees and stands, and the arthropods found in these forests.

1431. Reynolds, Richard T.; Meslow, E. Charles; Wight, Howard M. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. Journal of Wildlife Management. 46(1): 124-138.

1432. Reynolds, Richard T.; Meslow, E. Charles. 1984. Partitioning of food and niche characteristics of coexisting *Accipiter* during breeding. The Auk. 101: 761-779.

Accipiter striatus diets in both areas were composed almost entirely of birds (<5% mammals). The percent occurrence of prey taxa in *A. cooperii* diets, however, varied from 74% birds and 25% mammals in northwestern Oregon to 47% birds and 53% mammals in eastern Oregon. The diet of *A. gentilis* in eastern Oregon consisted of 55% birds and 45% mammals. Both *A. cooperii* and *A. gentlis* foraged primarily in the ground-shrub and shrub-canopy zones, whereas *A. striatus* foraged in the canopy zone.

1433. Reynolds, Richard T.; Scott, J. M.; Nussbaum, R. A. 1980. A variable circular-plot method for estimating bird numbers. Condor. 82: 309-313.

1434. Richardson, Frank; Hamre, Robert H. 1985. Wild Trout III: proceedings of the symposium; 1984 September 24-25; Yellowstone National Park, WY. Vienna, VA: Trout Unlimited: 192. p.

1435. Richardson, Frank; Hamre, Robert H., technical editors. 1989. Wild Trout IV: proceedings of the symposium; 1989 September 18-19; Yellowstone National Park, WY. 233 p.

The Wild Trout symposia, held at 5-year intervals in Yellowstone National Park, have evolved from a relatively narrow management concept to examine a broader range of environmental factors influencing wild salmonids, and social factors affecting those who fish for them. This proceedings consists of 38 technical papers, progress summaries, and keynote addresses.

1436. Richardson, M. L.; Betters, David R.; Sampson, George R. 1981. Productivity equations for forest vegetation treatment projects in the Colorado Front Range. Research Paper RM-230. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Regression equations have been developed which relate labor and equipment hours required for various treatment methods to charateristics of the terrain, size of job, and worker efficiency. The equations can be used for other front range areas. This paper also offers recommendations for improvement of vegetation management programs.

1437. Richards, Merton T.; Daniel, Terry C. 1989. Recreation esthetics management in southwestern ponderosa pine: Assessing research needs. *In:* Mulitresource management of ponderosa pine forests. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 196-207. 282 p.

1438. Richards, Merton T.; King, David A. 1982. An economic measure of nonconsumptive wildlife values. *In:* Lime, David W., technical coordinator. Forest and river recreation: research update; 1981 October 25-27; Minneapolis, MN. Miscellaneous Publication 18-1982. St. Paul, MN: University of Minnesota, Agricultural Experiment Station: 81-84.

1439. Rideout, Doug; Hof, John G. 1987. Allocating joint costs in applied forestry. Western Journal of Applied Forestry. 2(2): 45-48.

1440. Rideout, Doug; Hof, John G. 1987. Cost sharing in multiple use forestry: a game theoretic approach. Forest Science. 33(1): 81-88.

1441. Rideout, Doug; Hof, John G. 1986. A re-evaluation of the site burden concept when forest land value is maximized. Forest Science. 32(2): 511-516.

1442. Riebau, Al R.; Dailey, B.; Fox, Douglas G.; Archer, S. F.; Sestak, M. L. 1988. Simple approach smoke estimation model. Atmospheric Environment. 22(4): 783-788.

1443. Riebau, Al R.; Fox, Douglas G.; Dietrich, David L.; Mussard, Donald E.; Marlatt, William E. 1986. Regional risk identification analysis applicable to resource development of H2S-contaminated natural gas fields in southwest Wyoming. *In:* Proceedings of geographic information systems; 1986 April 1-4; Atlanta, GA. Falls Church, VA: American American Society for Photogrammetry and Remote Sensing: 345-356.

1444. Riebau, Al R.; Fox, Douglas G.; Marlatt, William E. 1987. TAPAS: Topographic Air Pollution Analysis System. Technical Note 375. Denver, CO: USDI Bureau of Land Management Bureau of Land Management. 13 p.

1445. Rietveld, W. J. 1989. Effect of paclobutrazol on conifer seedling morphology and field performance. *In:* Landis, Thomas D., technical coordinator. Proceedings, combined meeting of the Western Forest Nursery Associations; 1988 August 8-11; Vernon, BC. General Technical Report RM-167. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 19-23. 227 p.

Paclobutrazol, an inhibitor of *Gibberellin biosynthesis*, significantly reduced the growth of jack pine, red pine, and eastern larch bareroot nursery seedlings. Application in August prior to the final complete year in the nursery was more effective than application in April Of the final complete year. In many cases, the higher concentrations of paclobutrazol retarded root growth as well as shoot growth, and retarded first-year growth in the field. One treatment resulted in a 20% reduction in seedling height, 33% increase in root dry weight, and 35% reduction in shootroot ratio, without carryover effects to the field. Further work is needed to optimize the shoot and root growth responses to paclobutrazol and to control its persistence in the soil.

1446. Rietveld, W. J. 1989. Evaluating root growth potential of tree seedlings with an automated measuring system. New Forests. March(3): 191-199.

1447. Rietveld, W. J. 1989. Evaluation of three root growth potential techniques with tree seedlings. New Forests. March(3): 181-189.

1448. Rietveld, W. J. 1989. Transplanting stress in bareroot conifer seedlings: its development and progression to establishment. Northern Journal of Applied Forestry. 6(3): 99-107.

Transplanting stress is: (1) a temporary condition of distress from injuries, depletion, and impaired functions; (2) a process of recovery; and (3) a period of adjustment to a new environment. Stress can be minimized by planting stock with high stress resistance, preserving seedling performance potential, preparing a favorable planting site environment, and planting the seedling properly.

1449. Rietveld, W. J. 1989. Variable seed dormancy in Rocky Mountain juniper. *In:* Landis, Thomas D., technical coordinator. Proceedings, Intermountain Forest Nursery Association; 1989 August 14-18; Bismarck, ND. General Technical Report RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 60-64. 150 p.

Rocky Mountain juniper is difficult to grow in the nursery due to variable seed dormancy that spreads germination over time. In two experiments, six seed sources, five seed treatments, and 15 stratification treatments were tested. Although there were some seed source and stratification treatment differences,

none of the treatments effectively enhanced germination amount or timing enough to be useful in nursery culture.

1450. Rietveld, W. J.; Hergenrader, Gary L.; McDonald, Stephen E.; Fudge, Charles W. 1989. The status of future of USDA forestry research in the Great Plains. *In:* Landis, Thomas D., technical coordinator. Proceedings, Intermountain Forest Nursery Association; 1989 August 14-18; Bismarck, ND. General Technical Report RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 8-12. 150 p.

1451. Rietveld, W. J.; McDonald, Stephen E.; Fudge, Charles W.; Hergenrader, Gary L. 1989. The status and future of USDA forestry research on the Great Plains. *In:* Landis, Thomas D., technical coordinator. Proceedings, Intermountain Forest Nursery Association; 1989 August 14-18; Bismarck, ND. General Technical Report RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 8-12. 150 p.

The number of USDA field units actively engaged in tree-related research in the Great Plains has declined from nine to two in recent years, and funding is flat. Despite this decline in overall effort, the USDA Forest Service unit in Lincoln, Nebraska, is developing a novel research program of research on improvement of tree stress and pest resistance. In addition, a research and development initiative is being developed that will emphasize agroforestry systems that integrate tree windbreaks with conservation farming practices.

1452. Rietveld, W. J.; Tinus, Richard W. 1987. Alternative methods to evaluate root growth potential and measure root growth. *In:* Landis, Thomas D., technical coordinators. Meeting the challenge of the nineties: proceedings, Intermountain Forest Nursery Associations; 1987 August 10-14; Oklahoma City, OK. General Technical Report RM-151. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 70-76. 138 p.

This paper reports experiments that compared root growth potential (RGP) testing methods, methods of quantifying root growth, and diagnostic ability of test methods. Factors that affect root growth in RGP tests are discussed. For new applications, it is recommended that preliminary screening tests be run to determine the most suitable testing conditions.

1453. Rietveld, W. J.; Tinus, Richard W. 1988. A new, efficient method for evaluating root growth potential of planting stock using a root area index. *In:* Hartmann, H. T., editor.; 1987; Santa Barbara, CA. Seattle, WA: International Plant Propagators Society; 5: 37.

1454. Rietveld, W. J.; Tinus, Richard W. 1987. A simple method for evaluating whole-plant cold hardiness. Tree Planter's Notes. 38(2): 16-18.

1455. Rietveld, W. J.; Van Sambeek, J. W. 1989. Relating black walnut planting stock quality to field performance. *In:* 7th central hardwood forest conference; 1989 March 5-8; Carbondale, IL. General Technical Report NC-132. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 162-169.

1456. Riffle, Jerry W. 1981. Cankers. *In:* Stipes, Jay R.; Campana, Richard J., editors. Compendium of elm diseases. St. Paul, MN: American Phytopathological Society: 34-42.

Several canker diseases which occur on elm trees throughout the world are discussed. Most cankers are caused by fungi. Cankers are diseases which kill definite and relatively localized areas of bark on the branches or trunk of a tree.

1457. Riffle, Jerry W. 1989. Field performance of ponderosa, Scots, and Austrian pines with *Pisolithus tinctorius* ectomycorrhizae in prairie soils. Forest Science. 35(4): 935-945.

Ectomycorrhizae of *Pisolithus tinctorius*, formed with inoculum produced by research or industrial procedures and tree rootlets, did not improve survival or growth in bare-root or container ponderosa, Scots, and Austrian pines after 5 years' growth in plantings in south-central and southeastern Nebraska, and in central Kansas.

1458. Riffle, Jerry W. 1980. Growth and endomycorrhizal development of broadleaf seedlings in fumigated nursery soil. Forest Science. 26(3): 403-413.

A test with 98- and 67-percent methyl bromide-MB, mylone 50-D, terraclor 75-percent WP on *Lonicera tatarica*, *Elaeagnus angustifolia*, *Shepherdia argentea*, and *Fraxinus pennsylvanica*, resulted in erratic seedling

growth and a significant decrease in production of plantable seedlings (18 percent) over that obtained from untreated soil.

1459. Riffle, Jerry W. 1989. Honeysuckle blight. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 92-94. 184 p.

Most species and varieties of native and introduced honeysuckle are susceptible to honeysuckle blight, caused by the fungus *Isolibasidium deformans*. The disease is widespread in at least 14 Northeastern and North Central States.

1460. Riffle, Jerry W. 1986. Mushroom collecting and mycorrhizae. *In:* Mooter, Dave; Locklear, Jim, technical editors. Conference papers of the 9th annual trees for Nebraska conference; 1986 February 14-15; Lincoln, NE. Lincoln, NE: Deparment of Horticulture, University of Nebraska: 149-153. 159 p.

Some fungi that produce mushrooms also infect roots of trees and form a mutually beneficial association called mycorrhizae. Procedures for collecting and identifying mushrooms, and for determining which fungi form mycorrhizae on a tree species are discussed.

1461. Riffle, Jerry W.; Conway, Kenneth E. 1986. Phellinus stem decays of hardwoods. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 83-85. 149 p.

1462. Riffle, Jerry W.; Crowe, Frederick J. 1986. Pine wilt disease. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 138-139. 149 p.

1463. Riffle, Jerry W.; Krupinsky, Joseph M. 1986. Botryodiplodia canker of elms. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 38-39. 149 p.

1464. Riffle, Jerry W.; Krupinsky, Joseph M. 1986. Nematodes of broadleaf trees. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 110-111. 149 p.

1465. Riffle, Jerry W.; Maronek, Dale M. 1982. Ectomycorrhizal inoculation procedures for greenhouse and nursery studies. *In:* Schenck, N. C., editor. Methods and principles of mycorrhizal research. St. Paul, MN: The American Phytopathological Society: 147-153. 244 p.

A discussion of all facets of ectomycorrhizal inoculations is beyond the scope of this paper. The inoculation procedures presented here should be helpful to investigators involved in improving quantity and quality of tree seedlings for use in forestry and horticultural programs.

1466. Riffle, Jerry W.; Myatt, Al; Davis, Roger L. 1985. Incidence of *Phellinus robineae* in black locust plantings in Oklahoma. Plant Disease. 69(2): 116-118.

Black locust trees with sporocarps of *Phellinus robineae* were found in 64 of 144 plantings in Oklahoma. Incidence of infected trees of age 10 years was less than 1%; incidence increased significantly after age 15.

1467. Riffle, Jerry W.; Ostrofsky, W. D.; James, Robert L. 1981. *Fomes fraxinophilus* on green ash in Nebraska windbreaks. Plant Disease. 65: 667-669.

Visible incidence of *Fomes fraxinophilus* stem decay on 35- to 42-year-old *Fraxinus pennsylvanica* trees in Nebraska Prairie States Forestry Project windbreaks was estimated by using a 2.8 percent random sample of windbreaks (clusters). About 110,000 tress of an estimated 2 million living *Fraxinus pennsylvanica* in Nebraska have *Sporocarps*; an even greater number are infected with *F. Fraxinophilus*.

1468. Riffle, Jerry W.; Peterson, Glenn W. 1986. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 149 p.

Hosts, distribution, symptoms and signs, disease cycle, and control measures are described for 46 hardwood and 15 conifer diseases. Diseases in which abiotic agents are contributory factors also are described. Color and black-and-white illustrations that

stress diagnosis and control are provided. A glossary of technical terms and indexes to hosts, pathogens, and insect vectors also are included.

1469. Riffle, Jerry W.; Peterson, Glenn W. 1986. Thyronectria canker of honeylocust: influence of temperature and wound age on disease development. Phytopathology. 76: 313-316.

The number of days for three isolates of *Thyronectria austro-americana* to girdle stems and wilt foliage of 20-week-old seedlings of *Gleditsia triacanthos* decreased as temperatures increased from 16°to 28°C. Inoculation of freshly made wounds, and 7-, 14-, and 21-day-old wounds with *T. austro-americana* produced cankers on 100, 62, 10, and 6% of the seedlings, respectively. Growth in culture was optimum at 28-32°C for three Nebraska isolates.

1470. Riffle, Jerry W.; Sharon, Edward M.; Harrell, Mark O. 1984. Incidence of *Fomes fraxinophilus* on green ash in Nebraska woodlands. Plant Disease. 68(4): 322-324.

Incidence of sporocarps of *Fomes fraxinophilus* on living green ash was determined by examining 7,066 trees, on 361 sample plots, in 10 multicounty forest inventory units. Infected trees were found on 55 percent of the plots and in 55 of 64 counties sampled. It is estimated that 10 percent of the more than 20 million living green ash trees in Nebraska woodlands have sporocarps.

1471. Riffle, Jerry W.; Tinus, Richard W. 1982. Ectomycorrhizal characteristics, growth, and survival of artificially inoculated ponderosa and Scots pine in a greenhouse and plantation. Forest Science. 28(3): 646-660.

Pinus ponderosa and *P. sylvestris* were inoculated with six ectomycorrhizal fungi and pine duff, grown in a greenhouse for 6 months, and planted on a native grassland site in North Dakota. Observation after 5 years in the planting indicated that fungal symbionts in pine duff inoculum effectively improved survival and growth of seedlings.

1472. Riffle, Jerry W.; Walla, James A. 1986. Perennial woodrotting fungi that cause stem decays of hardwoods. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 80-82. 149 p.

1473. Riffle, Jerry W.; Watkins, John E. 1986. Honeysuckle leaf blight. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 26-29. 149 p.

1474. Riffle, Jerry W.; Wysong, David S.; Boosalis, Michael G. 1980. Canker diseases of elm. Nebguide G80-490. Lincoln, NE: University of Nebraska, Cooperative Extension Service. 4 p.

More than 20 species of fungi caused elm cankers. In the Nebraska Guide, two important canker diseases of elm in Nebraska, diffuse type (bothryodiplodia canker) and a target type (nectria canker) are illustrated and discussed.

1475. Riffle, Jerry W.; Wysong, David S. 1986. Septoria canker of cottonwood and hybrid poplars. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 50-51. 149 p.

1476. Rinne, John N. 1980. Arizona trout. *In:* Lee, David S. [and others], editors. Atlas of North American freshwater fishes. Publication 1980-12. Raleigh, NC: North Carolina Biological Survey, North Carolina State Museum: 104.

1477. Rinne, John N. 1988. Effects of livestock grazing exclosure on aquatic macroinvertebrates in a montane stream, New Mexico. Great Basin Naturalist. 48(2): 146-153.

Aquatic macroinvertebrate populations inhabiting reaches of a stream within areas excluded from livestock grazing for a decade were markedly different from those in grazed areas when density, biomass, biotic condition indices, and mean chi square indices of the two populations were compared. Increased densities and biomasses of more tolerant forms of macroinvertebrates were observed in grazed reaches. Results of this study have implications for the design of future research on the effects of livestock grazing on stream environments and biota.

1478. Rinne, John N. 1986. Endangered and nongame fish programs in the West. Their role in the conservation of native fishes. *In:* Western proceedings: 64th annual conference of the western association of fish and wildlife agencies; 1984 July 16-19; Victoria, BC. Sacramento, CA: California Department of Fish and Game: 456-469.

Nine of 13 western states have nongame/rate-endangered fishery programs. The importance of state nongame programs is illustrated by the fact that 172 taxa of fish are listed under state programs, compared to only 31 that are federally listed.

1479. Rinne, John N. 1980. Gila trout. *In:* Lee, David S. [and others], editors. Atlas of North American freshwater fishes. Publication 1980-12. Raleigh, NC: North Carolina Biological Survey, North Carolina State Museum: 107.

1480. Rinne, John N. 1988. Grazing effects on stream habitat and fishes: research design consideration. North American Jornal of Fisheries Management. 8: 240-247.

A 4-year study of a montane stream from which cattle grazing had been excluded for 10 years indicated that stream bank vegetation and stability were markedly improved and that stream substrate fines were somewhat reduced, but it indicated that fish populations were unaffected. Shortcomings of this case history study are common to past similarly designed studies of grazing effects on fishes and their habitats.

1481. Rinne, John N. 1988. Grazing effects on stream habitat and fishes: Research design consideration. North American Journal of Fisheries Management. 8: 240-247.

1482. Rinne, John N. 1984. Indicator or diversity of species management: the case of native southwestern fishes. *In:* McComb, William C., editor and compiler. Proceedings, workshop on management of nongame species and ecological communities; 1984 June 11-12; Lexington, KY. Lexington, KY: Department of Forestry, College of Agriculture, University of Kentucky: 75-92. 404 p.

This paper considers the concepts of indicators and diversity as applied to conservation of nongame native fishes of the southwestern United States, a region in which 60% of all fish species in the U.S. currently listed as threatened or endangered are endemic. Widespread habitat alteration and concomitant introduction of nonnative species of fishes have resulted in disjunct distribution and reductions in range and numbers of native fishes. Ecosystem management should continue to incorporate land purchases and nongame programs. Management that maintains streamflow, considers fish communities, and excludes nonnative species will far outweigh an individual indicator species management approach.

1483. Rinne, John N. 1985. Livestock grazing effects on southwestern streams: a complex research problem. *In:* Riparian ecosystems and their management: reconciling conflicting uses. proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 295-299. 523 p.

Conducting viable research on the effects of domestic livestock grazing on stream environments and biota in southwestern national forest is problematic. The multiple use concept, spatial temporal factors, inadequate control and replication, and changes in land management objectives and direction render it difficult to effectively study grazing impacts.

1484. Rinne, John N. 1982. Movement, home range, and growth of a rare southwestern trout in improved and unimproved habitats. North American Journal of Fisheries Management. 2: 150-157.

Gila trout, *Salmo gilae* Miller, in three streams in New Mexico, homed, moved greater distances downstream, and moved less upstream in streams with greater population densities and streams with log improvement structures. In recovery efforts, this trout should be introduced in headwaters and habitat improvement (log structures) should be few and low (0.5 m).

1485. Rinne, John N. 1988. Native southwestern (USA) trouts: Status, taxonomy, ecology, and conservation. Polskie Archiwum Hydrobiologii. 35(3-4): 305-320.

1486. Rinne, John N. 1985. Notes on collecting and photographing of fishes in northern Mexico, June 1981. *In:* Proceedings of Desert Fishes Council; 1981 November 19-21; Furnace Creek, CA. Bishop, CA: Desert Fishes Council: 8-15-A22-28.

1487. Rinne, John N. 1985. Physical habitat evaluation of small stream fishes: point or transect, observation vs. capture methodologies. Journal of Freshwater Ecology. 3(1): 121-132.

Physical habitat data (velocity and depth of water, and percentage substrate composition) for several

southwestern fishes collected by point and transect methodologies were similar. Velocity estimates showed less agreement and greatest variation. Choice of direct observation or capture by electrofishing as methods to locate fishes for habitat evaluation is problematic. Fish location techniques may induce more error in measurement of habitat than do different habitat evaluation techniques.

1488. Rinne, John N. 1989. Physical habitat use by loach minnow, *Tiaroga cobitis* (Pices: Cyprinidae), in southwestern desert streams. Southwestern Naturalist. 34(1): 109-117.

1489. Rinne, John N. 1982. Problems associated with habitat evaluation of an endangered fish in headwater environments. *In:* Armantrout, Neil B., editor. Proceedings of acquisition and utilization of aquatic habitat inventory information; 1981 October 28-30; Portland, OR. Bethesda, MD: American Fisheries Society: 202-209. 376 p.

Attempted evaluation of habitat for gila trout, *Salmo gilae* Miller, in three headwater tributaries, in the Gila National Forest, New Mexico, may have been hampered by small sample size, extreme variability in habitat, stream intermittency, and asynchronous sampling. Further developmental testing of methods to evaluate gila trout habitat is recommended to aid in recovery of this endangered species.

1490. Rinne, John N. 1980. Spawning habitat and behavior of gila trout, a rare salmonid of the southwestern United States. Transactions of the American Fisheries Society. 109: 83-91.

Water temperature (about 8° C) and streamflow interacted to induce spawning of *Salmo gilae* in three streams in the Gila National Forest. Spawning fish selected redd sites based on depth of water and substrate more than they did on velocity. Fry (15-20 mm long) emerged in 8 to 10 weeks.

1491. Rinne, John N. 1981. Stream habitat improvement and native southwestern trouts. Research Note RM-409. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Log stream improvement structures in two streams containing gila trout increased physical habitat factors and positively influenced populations of this endangered trout. Results of analyses of habitat improvement for the gila trout may have similar management implications for Arizona trout and for developing quality sport fisheries for these two rare southwestern trouts.

1492. Rinne, John N. 1985. Variation in Apache trout population in the White Mountains, Arizona. North American Journal of Fisheries Management. 5: 146-158.

Six hundred and forty-four trout from 46 streams in the White Mountains of east central Arizona were examined meristically and morphometrically to determine the presence of the native Apache trout. Evidence for a wider range of morphometric characters than given in the type description of the species was substantiated. Patterns of variation were corroborated by stocking histories and probable behavior of stocked, catchable hatchery rainbow trout. Based on combinations of three meristic characters, classifications are given for stream populations of trout in the White Mountains for use in the management of this threatened species of Fish.

1493. Rinne, John N.; Belfit, Scott C. 1985. Notes on collecting and photographing of fishes in Sonora and Chihuahua, Mexico, June 1982. *In:* Proceedings of the Desert Fishes Council; 1982 November 18-20; Tempe, AZ. Bishop, CA: Desert Fishes Council: 8-15-A138-150.

1494. Rinne, John N.; Jakle, Martin D. 1981. The photarium: a device for taking natural photographs. The Progressive Fish Culturist. 43(4): 201-204.

Fabrication of plexiglas tanks connected to a direct-current pump enables quality photographs of live fishes to be made in situ. The device is simple, inexpensive ($5-$10 for the tanks, $30-$50 for the pump and battery), and its use eliminates the stress and distortion of subjects that normally accompany out-of-water photographs of fishes.

1495. Rinne, John N.; Johnson, James E.; Jensen, Buddy L.; Ruger, Alan W.; Sorenson, Roger. 1987. The role of hatcheries in the management and recovery of threatened and endangered fishes. *In:* Stroud, Richard H., editor. Fish culture in fisheries management; 1985 March 31-April 3; Lake Ozark, MO. Bethesda, MD: American Fisheries Society: 271-285.

The role of hatcheries in conservation of threatened and endangered species of fishes has only begun to unfold. Case histories from the West and Southwest (U.S.A.) demonstrate the potential of artificial propagation in management of this rare natural resource.

1496. Rinne, John N.; Kroeger, Erich. Physical habitat used by spikedace, *Medafulgida*, in Aravaipa Creek, Arizona. *In:* Western Proceedings of the 68th Annual Conference of the Western Associations of Fish and Wildlife Agencies; 1988 July 10-13; Albuquerque, NM. 282-290

1497. Rinne, John N.; Medina, Alvin L. 1988. Factors influencing salmonid populations in six headwater streams, central Arizona, USA. Polskie Archiwum Hydrobiologii. 35(3-4): 515-532.

1498. Rinne, John N.; Minckley, W. L.; Hanson, J. N. 1981. Chemical treatment of Ord Creek, Apache County, Arizona, to reestablish Arizona trout. Journal of the Arizona-Nevada Academy of Science. 16: 74-78.

Arizona trout, a threatened species, was being displaced in Ord Creek, Apache County, Arizona, by introduced brown trout and brook trout. The stream was treated with antimycin a after removal of a stock of the native species. Procedures, and effects of the ichthyotoxin, are reviewed. Another treatment in 1978 succeeded in eradicating the nonnative species, and the Arizona trout introduced in October 1980 are surviving in the stream.

1499. Rinne, John N.; Minckley, W. L.; Bersell, P. O. 1981. Factors influencing fish distribution in two desert reservoirs, central Arizona. Hydrobiologia. 80: 31-42.

Fishes introduced into western reservoirs are intrinsically shallow-water, littoral inhabitants and remain so because of inherent limnological factors characteristic of mid-latitude lentic systems. Depth of euphotic zone and thermocline and dissolved oxygen concentrations limited the majority (90 percent) of fish in two desert reservoirs to the upper 10 m of water.

1500. Rinne, John N.; Minckley, W. L. 1985. Patterns of variation and distribution in Apache trout *(Salmo apache)* relative to co-occurrence with introduced salmonids. Copeia. 2: 285-292.

Examination of Apache trout *(Salmo apache)* populations in the White Mountains, Arizona, indicated wider ranges of morphological and meristic variation than in the type descriptions, greater genetic purity of stocks on Fort Apache Indian Reservation than on Apache-Sitgreaves National Forest, and distributional patterns that primarily reflect stocking of nonnative rainbow trout *(S. gairdneri)*.

1501. Rinne, John N.; Rickel, Bryce; Hendrickson, Dean A. 1980. A new gila topminnow locality in southern Arizona. Research Note RM-382. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

A new gila topminnow (Atheriniformes: Poeciliidae) locality discovered in an intermittent stream on the Coronado National Forest should be protected from future mineral and water mining, off-road vehicles, grazing, and the introduction of nonnative fish species if it is to persist in this desert environment.

1502. Rinne, John N.; Robertson, Ben; Major, Ron; Harper, Ken. 1980. Sport fishing for the native Arizona trout, *Salmo apache* Miller, in Christmas Tree Lake: a case study. *In:* Proceedings of Wild Trout Two; 1979 September 24-25; Yellowstone National Park, WY. Trout Unlimited, Federation of Fly Fishermen, and U.S. Department of the Interior: 158-164.

1503. Rinne, John N.; Sorenson, Roger; Belfit, Scott C. 1986. An analysis of F1 hybrids between Apache *(Salmo apache)* and rainbow trout *(Salmo gairdneri)*. Journal of the Arizona-Nevada Academy of Sciences. 20: 63-69.

Analysis of two replicate sets of F1 hybrids (N = 4) between the native Apache and introduced rainbow trouts indicated that overall intermediacy in characters did not occur. Careful case-by-case evaluation of the nature and source of variation in wild trout populations in the West must be given to prevent erroneous taxonomic conclusions and mismanagement of this valuable natural resource.

1504. Rinne, John N.; Tharlson, T. 1987. Effects of domestic livestock grazing on montane streams: aquatic macroinvertebrates. *In:* Proceedings, 66th annual conference, Western Association of Fish and Wldlife Agencies; 1986 July 20-23; Portland, OR. Sacramento, CA: Western Association of Fish and Wildlife Agencies: 91-98.

1505. Rinne, John N.; Wanjala, Bennie. 1983. Maturity, fecundity, and breeding seasons of the major catfishes in Lake Victoria, east Africa. Journal of Fisheries Bulletin. 23: 357-363.

1506. Risser, Paul G.; Mankin, J. B. 1986. Simplified simulation model of the plant producer function in shortgrass steppe. American Midland Naturalist. 115: 348-360.

1507. Rivers, James W.; Martin, S. Clark. 1980. Perennial grass improves with moderate stocking. Rangelands. 2(3): 105-106.

1508. Robbins, K.; Johnson, David W.; Hawksworth, Frank G.; Nicholls, Thomas H. 1989. Aerial application of ethephon is ineffective in controlling lodgepole pine dwarf mistletoe. Western Journal of Applied Forestry. 4: 27-28.

1509. Roberts, Edwin H.; Dana, Robert W. 1982. Comparison of three types of remote sensing data for mapping in Grand County, Colorado. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 801-804. 1101 p.

Digital data from microdensitometer color separation of color infrared aerial photographs and LANDSAT data, both classified for wildland cover mapping using spectral clustering techniques, are compared with mapping from intense photointerpretation utilizing ground reference material. Film response calibration techniques are employed, and normalization techniques for lens falloff, illumination variations, and topographic effects are described.

1510. Rochette, E. A.; Drever, J. I.; Sanders, F. S. 1988. Chemical weathering in the West Glacier Lake drainage basin, Snowy Range Wyoming: implications for future acid deposition. Contributions to Geology, University of Wyoming. 26(1): 29-44.

1511. Rogers, James J.; Prosser, Joseph M.; Garrett, Lawrence D. 1982. ECOSIM: a prototype system for estimating multiresource outputs under alternative forest management regimes. *In:* Proceedings, working party planning and control of forest operations XVII IUFRO World Congress; 1981 September 6-17; Kyoto, Japan. Miscellaneous Report 264. Orono, ME: Life Sciences and Agriculture Experiment Station, University of Maine: 122-127.

1512. Rogers, James J.; Prosser, Joseph M.; Garrett, Lawrence D. 1981. Modeling on-site multiresource effects of silvicultural management prescriptions. *In:* Proceedings of the International Union of Forestry Research Organizations, symposium on forest management planning: present and future decisions; 1981 August 18-20; Blacksburg, VA. Publication FWS-1-81. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Resources: 107-117. 228 p.

Summarizes ECOSIM, a prototype system, presently in the testing stage, which predicts response of individual forest stands to alternative silvicultural management prescriptions. The system simulates treatment effects on forest stand structure, herbage, forest floor and fuel bed, water and sediment, wildlife habitat, and near view scenic quality.

1513. Roggenbuck, J. W. 1981. Wilderness User preferences—eastern and western areas. *In:* Proceedings of the wilderness management symposium; 1980 November 11-13; Knoxville, TN. Knoxville, TN: University of Tennessee: 103-146.

1514. Roggenbuck, J. W.; Watson, A. A.; Stankey, George H. 1982. Wilderness management in the southern Appalachians. Journal of Applied Forestry. 6(3): 114-152.

1515. Rolston, Holmes III. 1986. Beyond recreational value: the greater outdoors preservation-related and environmental benefits. *In:* Driver, B. L.; Peterson, George L., compilers and editors. A literature review, the President's Commission on American Outdoors. Washington, DC: Government Printing Office: 103-113.

1516. Rolston, Holmes III. 1985. Valuing wildlands. Environmental Ethics. 7: 23-48.

Valuing wildlands is complex. In a philosophically oriented analysis, the author distinguishes seven meaning levels of value—individual preference, market price, individual good, social preference, social good, organismic, and ecosystemic—and itemizes twelve types of value carried by wildlands—economic, life support, recreational, scientific, genetic diversity, aesthetic, cultural symbolization, historical, character building, therapeutic, religious, and intrinsic. He criticizes contingent valuation efforts to price these values. He then proposes an axiological

model, which interrelates the multiple levels and types of value, and some principles for wildland management policy.

1517. **Rominger, James M.; Paulik, Laurie A. 1983. A floristic inventory of the plant communities of the San Francisco Peaks Research Natural Area. General Technical Report RM-96. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.**

In this study area, covering 1,024 acres of alpine and subalpine vegetation on the west slopes of Humphreys Peak in Coconino County, Arizona, 129 species of vascular plants were found within nine plant communities or habitat types, as classified by Moir and Ludwig.

1518. **Ronco, Frank Jr. 1987. Stand structure and function of pinyon-juniper woodlands.** *In:* **Proceedings of the pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 114-22. 581 p.**

A keynote address, with broad coverage, on pinyon-juniper woodlands discusses factors influencing stand structure. Productivity of woodlands with regard to the overstory undergrowth, and animal life, and tree and undergrowth relationships are covered, especially with regard to management implications. Productivity is correlated in general terms with stand dynamics and succession.

1519. **Ronco, Frank Jr. 1984. Succession.** *In:* **Wenger, Karl F., editor. Handbook of forestry, 2nd edition. New York: John Wiley and Sons: 16-20.**

1520. **Ronco, Frank Jr; Edminster, Carleton B.; Trujillo, David P. 1985. Growth of ponderosa pine thinned to different stocking levels in northern Arizona. Research Paper RM-262. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.**

A dense, immature ponderosa pine stand was thinned in 1962, 1972, and 1982 to six growing stock levels. Except for height, average tree growth characteristics (diameter, crown length, and width) were negatively correlated with residual stand density. Stand basal area and volume increment were positively related to stand density.

1521. **Ronco, Frank Jr; Gottfried, Gerald J.; Alexander, Robert R. 1984. Silviculture of mixed conifer forests. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 71 p.**

1522. **Ronco, Frank Jr; Ready, Kenneth L. 1983. Southwestern ponderosa pine.** *In:* **Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture: 70-72. 191 p.**

1523. **Ronco, Frank Jr; Shaffer, Richard; Gottfried, Gerald J. 1983. Southwestern mixed conifers.** *In:* **Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture: 73-76. 191 p.**

1524. **Rosenberg, Kenneth V.; Raphael, Martin G. 1986. Effects of forest fragmentation on vertebrates in Douglas-fir forests.** *In:* **Verner, Jared; Morrison, Michael L.; Ralph, John C., editors. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: University of Wisconsin Press: 263-272.**

1525. **Rosenthal, Donald H. 1987. The necessity for substitute prices in recreation demand analyses. American Journal of Agricultural Economics. 69(4): 828-837.**

Omitting substitute prices from a travel cost model is shown to cause a significant bias in consumer surplus estimates. Three sets of travel cost models are developed from a common data base representing 60,000 day-users of U.S. Army Corps of Engineer Reservoirs in Kansas and Missouri. The first set of models omitted substitute prices; the latter two sets included them. An analysis of variance test showed that consumer surplus estimates from the first set of models were significantly higher than the other two ($F = 26.2$ with 2, 20 degrees of freedom). The theoretical and practical implications of these findings are discussed.

1526. **Rosenthal, Donald H. 1984. Pricing recreation on public lands.** *In:* **Proceedings, 1984 conference on fees for outdoor recreation on lands open to the public; 1984 January 12-13; Durham, NH. Gorham, NH: Appalachian Mountain Club: 69-72.**

1527. Rosenthal, Donald H.; Anderson, Jana C. 1984. Travel cost models, heteroskedasticity, and sampling. Western Journal of Agricultural Economics. 9(1): 58-65.

Using theoretical derivations, it is shown that collecting data on individuals' visitation rates to a recreation site by each of these methods: (1) on-site sampling of visits, (2) sampling individuals surrounding the recreation site; and (3) sampling license holders, results in three unique heteroskedasticity problems. Furthermore, to the extent that individuals within an origin zone face different prices, there is an inherent aggregation bias when estimating consumer surplus.

1528. Rosenthal, Donald H.; Brown, Thomas C. 1985. Comparability of market prices and consumer surplus for resource allocation decisions. Journal of Forestry. 83(2): 105-109.

When a consistent theoretical structure is used for assessing the economic worth of different resources, monetary values assigned to nonmarketed outputs from forested lands (such as recreation) are comparable to market prices for marketed outputs. Combining information about the dollar value of outputs with similar information about costs facilitates economic efficiency analysis for the purpose of resource allocation decisions.

1529. Rosenthal, Donald H.; Cordell, H. Ken. 1986. Pricing river recreation: some issues and concerns. *In:* Proceedings, 1984 national river recreation symposium; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 272-284.

1530. Rosenthal, Donald H.; Donnelly, Dennis M.; Schiffhauer, Marie B.; Brink, Glen E. 1986. User's guide to RMTCM: software for travel cost analysis. General Technical Report RM-132. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.

RMTCM is an interactive, menu-driven program for performing travel cost analysis. The program consists of four main modules: (1) data input, (2) data modification, (3) regression analysis, and (4) report writing. The report graphs the "second-stage" demand curve and estimates consumer surplus. The program is written in Fortran-V, and a version is available for use on an IBM personal computer or compatible machine.

1531. Rosenthal, Donald H.; Driver, B. L. 1983. Managers' perceptions of experiences sought by ski-tourers. Journal of Forestry. 81(2): 88-90, 105.

Recreation managers' perceptions of experiences desired by ski-tourers in the Colorado Rockies' Front Range were similar to preferences stated by the ski-tourers themselves. These findings contrast with the results of previous research on other forms of recreation.

1532. Rosenthal, Donald H.; Driver, B. L.; Rauhauser, Donna. 1980. Skiing environments preferred by Colorado cross-country skiers. *In:* Proceedings of the national symposium on dispersed winter recreation; 1980 February 27-29; University of Minnesota, St. Paul, MN. Education Series 2-3. St. Paul, MN: Office of Special Programs, University of Minnesota: 57-63. 171 p.

This paper summarizes the findings of two surveys conducted during the winters of 1976-1977 and 1977-1978, along the Front Range of the Colorado Rockies. Information is presented concerning (1) the characteristics of the users, (2) their preferences toward selected features of the ski touring environment (physical and social attributes are considered), and (3) skier opinion toward 18 possible management actions.

1533. Rosenthal, Donald H.; Loomis, John B.; Peterson, George L. 1984. Pricing for efficiency and revenue in public recreation areas. Journal of Leisure Research. 16(3): 195-208.

1534. Rosenthal, Donald H.; Loomis, John B.; Peterson, George L. 1984. The travel cost model: concepts and applications. General Technical Report RM-109. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.

The travel cost model (TCM) estimates the demand and supply curves for a recreation site in a manner commensurate with methods used for other resources. Issues benefitting from TCM analysis include: the effect of raising entrance fees on visitation, the benefit of constructing a new recreation site, the benefit of modifying an existing site, and estimating use at existing or proposed sites.

1535. Rosenthal, Donald H.; Waldman, David A.; Driver, B. L. 1982. Construct validity of instruments measuring recreationists' preferences. Leisure Sciences. 5(2): 89-108.

The construct validity of eight psychometric scales designed to measure the experiences that recreationists desire was investigated. A multitrait-multimethod analysis was performed employing two likert-style formats, fractionation scaling, and paired comparisons. Implications are made concerning the use of these instruments in order to provide valid information for recreation research and planning.

1536. **Rosenthal, Donald H.; Walsh, Richard G. 1986. Hiking values and the recreation opportunity spectrum. Forest Science. 32(2): 405-414.**

The contingent valuation technique is used to estimate the net economic value of hiking and backpacking in a national forest in the Front Range of the Colorado Rockies. The study is based on on-site interviews of 202 hikers, conducted during the summer of 1981. The relationship between dollar value and recreation opportunity spectrum (ROS) class reverses when the unit of measure is switched from trips to recreation visitor days. Trips to the more primitive ROS classes have high consumer surplus, but last a long time, thereby lowering the consumer surplus per recreation visitor day.

1537. **Ross, D. G.; Fox, Douglas G. 1989. Air quality modeling: Its current state and future direction. *In:* Clean air: special issue air quality modeling workshop, part 1. 23-2: 60-66.**

1538. **Ross, D. G.; Fox, Douglas G.; Dietrich, David L.; Childs, J. E.; Marlatt, William E. 1985. CITPUFF: A Gaussian puff model for estimating pollutant concentration in complex terrain. Research Paper RM-261. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 24 p.**

CITPUFF is a puff-type dispersion model that uses a wind field calculated from a complex-terrain wind model. It accommodates a variety of source types including point, area, and line sources; calculates plume rise where applicable; and outputs a graphic display of puff trajectories and concentrations. The model is compared against models currently used for assessing air quality impacts in complex topography.

1539. **Ross, D. G.; Fox, Douglas G.; Thompson, R. T. 1984. Evaluating a complex terrain air quality modeling system. *In:* Proceedings, Eighth international clean air conference; 1984 May 6-11; Melbourne, Australia. Melbourne, Australia: The Clean Air Society of Australia and New Zealand: 603-619.**

1540. **Ross, D. G.; Lorimer, G.; Fox, Douglas G.; Smith, I. N. 1989. Results of applying wind and dispersion models in complex topography. *In:* 82nd annual meeting of AWMA; 1989 June 25-30; Anaheim, CA. 16 p.**

1541. **Ross, D. G.; Smith, I. N.; Manins, P. C.; Fox, Douglas G. 1988. Diagnostic wind field modeling for complex terrain: model development and testing. Journal of Applied Meteorology. 27(7): 785-596.**

A three dimensional diagnostic wind field model is shown to be capable of generating potential flow solutions associated with simple terrain features. This is achieved by modifying an initially uniform background wind to make the flow divergence free. Atmospheric stability effects can be incorporated by considering the relative degree of adjustment that is allowed between the horizontal and vertical components of the wind. A framework for developing a Froude-number-dependent expression for this ratio is proposed and evaluated by comparing modeled streamline deflections of flow past an ideal hill with results from wind tunnel and tow tank experiments.

1542. **Ross, David M.; Driver, B. L. 1988. Benefits of residential and nonresidential youth summer camps. Journal of Outdoor Recreation. 22: 14-20.**

In 1979, a 5-year longitudinal study was started to identify and assess possible long-term benefits of the YCC program. The major purpose of the study was to determine if a random sample of enrollees differed over time from a random sample of unsuccessful applicants on measures of different types of benefits. As part of the data analysis, the benefits realized by enrollees in residential and nonresidential camps were compared. The results obtained 9 month after the end of the 1979 program are reported in this article.

1543. **Ross, David M.; Driver, B. L. 1986. Importance of appraising responses of subgroups in evaluation: Youth Conservation Corps. Journal of Environmental Education. 17(3): 16-23.**

A sample of applicants to the 1979 Youth Conservation Corps (YCC) program were surveyed twenty-six months after camp to assess possible long-term perceived benefits to program participants. Successful applicants (enrollees) served as the experimental group, unsuccessful applicants as the control group. Particular subgroups of enrollees showed sizable benefits not realized by other subgroups, especially when two classifying variables were used to define subgroups.

1544. Roth, William B.; Carr, Merle E.; Davis, Edwin A.; Bagby, Marvin O. 1985. New sources of gutta-percha in *Garrya flavescens* and *G. wrightii*. Phytochemistry. 24(1): 183-184.

Analyses of extracts from whole-plant samples revealed that *Garrya flavescens* and *Garrya wrightii* produced gutta (Trans-1, 4-polyisoprene) as the major hydrocarbon in yields of 1.2 and 0.4%, respectively. The average MW's of gutta were 142000 for *G. flavescens* and 10000 for *G. wrightii*. These species also yielded moderate amounts of "oil" and "polyphenol." To our knowledge, these are the first species of *Garryaceae* reported to produce gutta.

1545. Roussopoulos, Peter J. 1980. Improving wildland fuel information for wildlife decisionmaking. *In:* Proceedings of the Society of American Foresters national convention; 1979 October 14-17; Boston, MA. 138-142.

An analysis of user needs for a wildland fuel inventory and appraisal system is discussed. One particular case study to determine the value of improved fuel information for establishing the fire management budget on the Mount Hood National Forest is described in detail.

1546. Roussopoulos, Peter J.; Yancik, Richard F.; Radloff, David L. 1980. A national fire occurrence data library for fire management planning. *In:* Proceedings: sixth conference on fire and forest meteorology; 1980 April 22-24; Seattle, WA. Washington, DC: Society of American Foresters: 7-12. 304 p.

An automated fire occurrence library, containing all USDA Forest Service, 5100-29 fire report data for 1970-1978, is described. The library, maintained at the USDA Fort Collins Computer Center, provides for nationally uniform editing, storage, retrieval, and analysis of wildland fire report data. Means of accessing the library and associated analysis software are discussed.

1547. Rudd, William J.; Ward, A. Lorin; Irwin, Larry L. 1983. Do split hunting seasons influence elk migrations from Yellowstone National Park? The Wildlife Society Bulletin. 11(4): 328-331.

A study of the influence of new hunting regulations and weather on movements and migrations of elk produced information that may be useful in developing recommendations for elk harvests in areas adjacent to parks or other refuges.

1548. Ruehle, John L.; Riffle, Jerry W. 1989. Nematodes. *In:* Forest nursery pests. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture, Forest Service: 122-123. 184 p.

Seedlings of all tree species are susceptible, at least to some degree, to plant-parasitic nematodes. The nematodes most damaging in forest nurseries include root-knot, pine cystoid, lance, lesion, stunt, stubby-root, and dagger nematodes. Some parasitic nematodes have a wide host range, feeding on many different forest tree species. Others have more restricted feeding habits.

1549. Rumble, Mark A. 1987. Avian use of scoria rock outcrops. Great Basin Naturalist. 47(4): 625-630.

Avian use of scoria outcrop habitats was compared with the use of surrounding sagebrush/grassland habitats. Species richness, total avian density, and densities of several species were greater in outcrop habitats. Habitat relationship analyses showed that the unique plant community and structural diversity of the outcrop habitats were correlated with increased avian use.

1550. Rumble, Mark A. 1983. Classifying aquatic resources: quantitative approach. *In:* Scott, M. Douglas, editor. Proceedings of the third biennial plains aquatic research conference; 1983 August 24-25; Bozeman, MT. Bozeman, MT: Institute of Natural Resources, Department of Earth Sciences, Montana State University: 89-99. 243 p.

If proper considerations are given to the requirements and needs of the classification system, adequate data collection and analyses should yield a quantitative classification system which meets the goals of resource managers.

1551. Rumble, Mark A. 1985. Quality of water for livestock in man-made impoundments in the northern High Plains. Journal of Range Management. 38(1): 74-77.

Sulfate concentrations in some coal and bentonite surface mine impoundments were higher than recommended for safe livestock use. Total dissolved solids in bentonite surface mine impoundments may be higher than considered safe. Lead concentrations in some coal surface mine impoundments and livestock ponds exceeded the recommended safe levels for livestock drinking water.

1552. Rumble, Mark A. 1986. Radiation dosimetry on revegetated uranium mill tailings in western South Dakota. Northwest Science. 60(3): 145-149.

Measurement of gamma radiation using thermoluminescent dosimeters on three uranium mill tailings areas and a control area showed exposure rates belowground depended on the amount and type of soil covering. Covering tailings with 30 cm of shale and 60 cm of topsoil reduced gamma radiation exposure belowground to rates similar to the control area. Soil covering of 30 cm was adequate to reduce gamma radiation exposure rates aboveground to background levels. Gamma exposure rates to small mammals were correlated to measurements belowground near the surface. Gamma radiation exposure to small mammals inhabiting uranium mill tailings exceeded standards recommended for the general public.

1553. Rumble, Mark A. 1989. Surface mine impoundments as wildlife and fish habitat. General Technical Report RM-183. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Unreclaimed surface mine impoundments provide poor fish and wildlife habitat. Recommendations given here for reclaiming "prelaw" impoundments and creating new impoundments could provide valuable fish and wildlife habitat if incorporated into existing laws and mine plans.

1554. Rumble, Mark A. 1986. Using twig diameters to estimate browse utilization on three shrub species in southeastern Montana. *In:* Provenza, Frederick D.; Flinders, Jerran T.; McArthur, E. Durant, compilers. Proceedings—symposium on plant-herbivore interactions; 1985 August 7-9; Snowbird, UT. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 172-175.

Browse utilization estimates based on twig length and twig weight were compared for skunkbrush sumac, wax currant, and chokecherry. Linear regression analysis was valid for twig length data; twig weight equations are nonlinear. Estimates of twig weight are more accurate. Problems encountered during development of a utilization model are discussed.

1555. Rumble, Mark A. 1989. Wildlife associated with scoria outcrops: implications for reclamation of surface-mined lands. Research Paper RM-275. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Bird and mammal populations in scoria rock outcrops and sagebrush/grasslands were sampled to determine the benefits to wildlife of the outcrop habitat in terms of diversity, populations, and species richness. Each habitat supported greater numbers of some species of both birds and mammals. Scoria outcrops supported some species that were unique to that habitat.

1556. Rumble, Mark A.; Anderson, Mark T.; Hawkes, Clifford L. 1984. Morphometry of coal and bentonite surface mine and livestock impoundments in the northern Great Plains. Reclamation and Revegetation Research. 3: 293-300.

Mining for coal and bentonite in the northern High Plains has resulted in water impoundments which, along with livestock watering impoundments, can provide habitat for aquatic and wetland organisms, waterfowl and other terrestrial wildlife. The Morphometric findings of this study represent a baseline from which improved designs are suggested, and can be developed to provide the desired aquatic and wetland habitats. Factors measured or computed were surface area, mean depth, maximum depth, shoreline development, percentage mean slope and percentage shallow water.

1557. Rumble, Mark A.; Anderson, Stanley H. 1987. Turkey habitat use and nesting characteristics in ponderosa pine. *In:* Fisser, Herbert G., editor. Wyoming shrublands: proceedings of the 16th Wyoming shrub ecology workshop; 1987 May 26-27; Sundance, WY. Laramie, WY: Wyoming Shrub Ecology Workshop: 36-39.

Turkeys showed a distinct preference for rocks and rock outcrop habitats for locations of initial nests and shrub patches in meadows for locations of renests. Broods up to age 4 weeks selected the edges of large meadows almost exclusively. Older broods selected habitats with high herbaceous cover under some tree canopy. Seasonal habitat selection patterns for adult turkeys indicated few differences from random selection patterns.

1558. Rumble, Mark A.; Bjugstad, Ardell J. 1986. Uranium and radium concentrations in plants growing on uranium mill tailings in South Dakota. Reclamation and Revegetation Research. 4: 271-277.

Vegetation and soil samples were collected from a uranium mill tailings site and control sites in South Dakota. Concentration ratios (amount in plant/amount in soil) of radionuclides indicated that two grasses and one forb were not concentrating uranium or 226 ra.

1559. Rumble, Mark A.; Denison, Steve A. 1986. An alternative technique for attaching thermoluminescent dosimeteres to small mammals. Health Physics. 51(2): 245-248.

This paper reports the results of a study designed to evaluate the ear-tag technique against the surgical technique and describes the methods used to construct and attach ear-tag thermoluminescent dosimeters.

1560. Rumble, Mark A.; Flake, Lester D. 1982. A comparison of two waterfowl brood survey techniques. Journal of Wildlife Management. 46(4): 1049-1053.

The objective of this study was to compare 2 techniques, flush counts and hidden observation counts, for censusing duck broods on livestock watering ponds (stock ponds).

1561. Rumble, Mark A.; Flake, Lester D. 1983. Management considerations to enhance waterfowl brood use of stock ponds. Journal of Range Management. 36(6): 691-694.

Pond size, shallow water areas with submersed vegetation, natural wetlands nearby, spikerush, smartweed, and wheat stubble were associated with broods. Arrowhead/water plantain, river bullrush/burreed, and trees along the shoreline were negatively associated with broods. Recommendations for management and construction are made.

1562. Rumble, Mark A.; Newell, Jay A.; Toepfer, John E. 1988. Diets of greater prairie chickens on the Sheyenne National Grasslands. *In:* Bjugstad, Ardell J., technical coordinator. Prairie chickens on the Sheyenne National Grasslands: proceedings of the symposium; 1987 September 18; Crookston, MN. General Technical Report RM-159. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 49-54. 73 p.

Diets of greater prairie chicken on the Sheyenne National Grasslands of North Dakota were examined. During the winter months, agricultural crops (primarily corn) were the predominant food items. Green vegetation was consumed in greater quantities as spring progressed. Dandelion flowers and alfalfa/sweetclover were the major vegetative food items through the summer. Both juveniles and adults selected diets high in digestible protein obtained through consumption of arthropods and some plants.

1563. Running, Steven W. 1984. Documentation and preliminary validation of H20TRANS and DAYTRANS, two models for predicting transpiration and water stress in western coniferous forests. Research Paper RM-252. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 45 p.

The models, H20TRANS and DAYTRANS, are for hourly and daily timesteps, respectively, and use routine meteorological data. The models incorporate rates of snowmelt, precipitation, canopy interception, and litter and soil evaporation. Complete documentation of all equations is presented, as are the results from an initial evaluation on lodgepole pine at the Fraser Experimental Forest, in Colorado. A sensitivity analysis of the models and a discussion of their range of applicability also are presented.

1564. Ruyle, G. B.; Abu-Zanat, M.; Rice, R. W. 1988. The influence of grazed patches on cattle foraging behavior. Proceedings, Western Section, American Society of Animal Science. 39: 234-236.

1565. Ruyle, G. B.; Hasson, Oren; Rice, R. W. 1987. The influence of residual stems on biting rates of cattle grazing *Eragrostis lehmanniana* Ness. Applied Animal Behaviour Science. 19: 11-17.

1566. Ryan, Michael G. 1987. Growth efficiency, leaf area, and sapwood volume in subalpine conifers. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 180-184. 253 p.

Growth efficiency (stemwood produced per unit leaf area) estimates the ability of a tree to convert light energy into wood, and indicates carbon allocation processes. Maintenance respiration of woody tissues may cause observed patterns in growth efficiency decline in subalpine conifers.

1567. Ryan, Michael G. 1988. The importance of maintenance respiration by living cells in the sapwood of subalpine conifers. Corvallis, OR: Oregon State University. 104 p. M.S. thesis.

1568. **Ryan, Michael G. 1989. Sapwood volume for three subalpine conifers: predictive equations and ecological implications. Canadian Journal of Forest Research. 19: 1397-1401.**

1569. **Ryan, Michael G.; Covington, W. Wallace. 1986. Effect of a prescribed burn in ponderosa pine on inorganic nitrogen concentrations of mineral soil. Research Note RM-464. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.**

Soil inorganic nitrogen was measured during the summer after a fall prescribed burn at a ponderosa pine site in northern Arizona. Fire behavior varied among sawtimber, pole, and sapling stands; the greatest fuel reduction occurred in the sawtimber. Ammonium-nitrogen content of the upper 15 cm of soil in the burned sawtimber plots was as much as 80 times greater than in unburned plots. The increased availability of nitrogen after burning may affect regeneration, understory growth, and growth of overstory trees.

1570. **Sabey, B. R.; Herron, Jim; Scholl, David G.; Bokich, John. 1987. Particle size distribution. Chapter 4. Reclaiming mine soils and overburden in the western United States. Ankeny, IA: Soil Conservation Society of America: 54-74.**

1571. **Sackett, Stephen S. 1980. An instrument for rapid, accurate determination of fuel moisture content. Fire Management Notes. 41(2): 17-18.**

The compu-trac moisture analyzer completely eliminates operator skill and judgment by using a rugged load sensor and electronic microprocesor to automatically process fuel moisture samples.

1572. **Sackett, Stephen S. 1984. Observations on natural regeneration in ponderosa pine following a prescribed fire in Arizona. Research Note RM-435. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

A good seed crop, coupled with a prescribed burn, designed to reduce fuels in an undisturbed stand of ponderosa pine, resulted in the establishment of many pine seedlings. In addition to an adequate seed source which was being dispersed during the fall burning, conditions that appeared to favor germination and survival included a more receptive seedbed, increased nutrient availability, and more favorable conditions of soil moisture and temperature.

1573. **Sackett, Stephen S. 1980. Reducing natural ponderosa pine fuels using prescribed fire: two case studies. Research Note RM-392. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.**

Dead, natural fuels were reduced in weight by 65 percent and 43 percent, respectively, when burned under different conditions, in two ponderosa pine stands, in Arizona. Fine, surface fuel reductions temporarily lessen the threat of rapidly spreading wildfires. Large fuels were not as effectively altered by a single prescribed fire.

1574. **Sackett, Stephen S. 1980. Woody fuel particle size and specific gravity of southwestern tree species. Research Note RM-389. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Average squared diameters and specific gravities were determined for eight species of forest trees in Arizona and New Mexico. These figures are used to help estimate weights and volumes of dead, down forest fuels using the planar intersect method. Values in the 0- to 0.25-inch, 0.25- to 1-inch, and 1- to 3-inch diameter size classes are given for natural and activity-generated fuels.

1575. **Sadeh, Willy Z. [and others]. 1981. A survey of micrometeorological parameters within a forest canopy at Fort Polk, Louisiana. ASL-CR-82-0100-1. White Sands Missile Range, NM: U.S. Army, Atmospheric Sciences Laboratory. 125 p.**

1576. **Sadeh, Willy Z.; Baron, Yehuda; Fox, Douglas G. 1982. Estimating the power-law index for wind. Unnumbered Publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service,. Rocky Mountain Forest and Range Experiment Station.**

The reliability of the power law in describing the wind shear above surface roughness under normally neu-

tral conditions is examined. The method was successfully tested using representative data in flow above very find, fine, and high surface roughness.

1577. Sadeh, Willy Z.; Cionco, Ronald M.; Fox, Douglas G. 1983. Working meeting on meteorological and diffusion characteristics in wooded and urban domains in complex terrain. ASL-CR-83-8035-1. White Sands Missile Range, NM: U.S. Army Atmospheric Sciences Laboratory. 25 p.

1578. Sadeh, Willy Z.; Fox, Douglas G. 1982. Canopy effects in turbulence and diffusion. *In:* Cionco, Ronald M., editor. Proceedings of the workshop on parameterization of mixed layer diffusion; 1981 October 20-23; White Sands, NM. U.S. Army, Atmospheric Sciences Laboratory: 217-234.

1579. Saliba, Bonnie Colby. 1987. Do water markets "work"? market transfers and trade-offs in the southwestern states. Water Resources Research. 23(7): 1113-1122.

1580. Saliba, Bonnie Colby. 1985. Irrigated agriculture and groundwater quality—a framework for policy development. American Journal of Agricultural Economics. 67(5): 1231-1237.

1581. Saliba, Bonnie Colby. 1986. Market transactions and pricing of water rights in the West. *In:* Water marketing: opportunities and challenges of a new era. Denver, CO: University of Denver, College of Law: 1-34.

1582. Saliba, Bonnie Colby. 1987. Market transfers: resolving the tradeoffs—a challenge for public policy. *In:* Water markets and transfers. Phoenix, AZ: Arizona Section of the American Water Resources Association and the Arizona Hydrological Society: 61-72.

1583. Saliba, Bonnie Colby. 1987. What are water rights worth? Valuation approaches and the value of water in alternative uses. *In:* Water marketing profits and policies in the western United States. Denver, CO: University of Denver, College of Law: 37. p.

1584. Saliba, Bonnie Colby; Bush, David B.; Martin, William E.; Brown, Thomas C. 1987. Do water market prices appropriately measure water values. Natural Resources Journal. 27(3): 617-651.

1585. Saliba, Bonnie Colby; Bush, David B. 1987. Water markets in theory and practice: market transfers, water values, and public policy. Studies in Water Policy and Management 12. Boulder CO: Westview Press. 373 p.

1586. Saliba, Bonnie Colby; Bush, David B.; Martin, William E. 1987. Water marketing in the Southwest—can market prices be used to evaluate water supply augmentation projects? General Technical Report RM-144. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.

Price behavior over time in selected western water markets is observed and assessed as a useful measure of the economic value of water. Market characteristics that may distort prices include imperfect competition, third-party effects, institutional and hydrologic uncertainty, and equity considerations. Nonmarket valuation techniques are useful in supplementing market price information.

1587. Salwasser, Hal; Barrett, Reginald H.; Sorg, Cindy F. 1984. Fish and wildlife values: new clout for a conservation ethic. *In:* Annual meeting, Western Section, Wildlife Society, California-Nevada Chapter, American Fisheries Society; 1984 February 3-4; Sacramento, CA. Smartsville, CA: The Wildlife Society: 7-11.

1588. Sampson, George R. 1981. Evaluating inwoods chipping feasibility. *In:* Harvesting and utilization opportunities for forest residues in the northern Rocky Mountains; 1979 November 28-30; Missoula, MT. General Technical Report INT-110. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 159-167. 294 p.

Economic analysis of data from a demonstration test showed that inwoods debarking-chipping was only marginally competitive with conventional methods of harvesting roundwood for pulp chips. The future for inwoods chipping appears to be whole tree chipping.

1589. Sampson, George R.; Betters, David R.; Brenner, Robert N. 1980. Mountain pine beetle, timber management, and timber industry in Colorado's Front Range: production and marketing alternatives. Resource Bulletin RM-3. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Current harvest levels and processing capacity do not take full advanatage of timber potentially available in six Front Range timbersheds. Four alternatives for utilizing this resource were analyzed using a goal programming technique. Multiproduct operations based on numerous small sawmills appear to offer the best solution.

1590. **Sampson, George R.; Betters, David R.; Love, Robert. 1980. Processing potential for insect-infected Front Range forests. Resource Bulletin RM-1. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Increased timber harvesting by forest industry, resulting in more intensive forest management, would be a means for combating insect problems such as the current mountain pine beetle outbreak. However, existing timber processing capacity is far less than potential annual harvest of live timber for Colorado's Front Range.

1591. **Sartwell, Charles Jr; Daterman, Gary E.; Koerber, Thomas W.; Stevens, Robert E.; Sower, Lonne L. 1980. Distribution and hosts of *Eucosma sonomana* in the western United States as determined by trapping with synthetic sex attractants. Annals of the Entomological Society of America. 73: 254-256.**

1592. **Scarpa, Valerie J. 1982. The anatomy of drooping aspen. *In:* Proceedings, 29th annual western international forest disease work conference; 1981 September 15-17; Vernon, BC, and Juneau, AK. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region: 95-96.**

1593. **Schaffer, Bruce; Hawksworth, Frank G.; Wullschleger, Stan D.; Reid, C. P. P. 1983. Cytokinin-like activity related to host reactions to dwarf mistletoes (*Arceuthobium* spp.). Forest Science. 29: 66-70.**

1594. **Schaffer, Bruce; Hawksworth, Frank G.; Beemsterboer, Paul. 1983. Effects of dwarf mistletoe and vigor classes on electrical resistance in lodgepole pine. Forest Science. 29(1): 124-126.**

In greenhouse seedlings with bole infections, electrical resistance (ER) was lowest at the infection, was intermediate below, and was highest above the infection. In the field, ER of 100-year old trees of different dwarf mistletoe intensity and vigor ratings was measured at breast height. Trees of poor vigor or those with high mistletoe ratings had significantly elevated ER.

1595. **Schaffer, Bruce; Hawksworth, Frank G.; Jacobi, William R. 1983. Effects of comandra blister rust and dwarf mistletoe on cone and seed production of lodgepole pine. Plant Disease. 67(2): 215-217.**

Effects of comandra blister rust and dwarf mistletoe on cone and seed production of infected lodgepole pine trees were determined. Reduction of live crown size in trees heavily infected with *C. comandrae* resulted in significantly fewer cones and seeds than were found in healthy trees. Trees heavily infected with dwarf mistletoe had significantly smaller cones and seeds, which may have been a result of a reduction in tree vigor caused by the parasite.

1596. **Schaid, Tim A.; Uresk, Daniel W.; Tucker, W. Lee; Linder, Raymond L. 1983. Effects of surface mining on the vesper sparrow in the northern Great Plains. Journal of Range Management. 36: 500-503.**

1597. **Scharpf, Robert F.; Hawksworth, Frank G. 1986. Exotic pines infected by two dwarf mistletoes in southern California. Plant Disease. 70: 173.**

1598. **Schenbeck, Greg L.; Myhre, Richard J. 1986. Aerial photography for assessment of black-tailed prairie dog management on the Buffalo Gap National Grassland, South Dakota. Report 86-7. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Pest Management Methods Application Group. 15 p.**

1599. **Schier, George A.; Jones, John R.; Winokur, Robert P. 1985. Vegetative regeneration. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 29-33. 283 p.**

1600. **Schier, George A.; Shepperd, Wayne D.; Jones, John R. 1985. Regeneration. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 197-208. 283 p.**

1601. Schlatterer, E. F.; Joyce, Linda A.; Bones, James T.; Carey, A. E. 1989. National overview. Chapter 1. *In:* An analysis of the land base situation in the United States: 1989-2040. General Technical Report RM-181. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-18. 76 p.

1602. Schmid, John M. 1981. Distribution of western spruce budworm insect parasites in the crowns of host trees. Canadian Entomologist. 113: 1101-1106.

Percent parasitism for each insect species was not significantly different among aspects of host trees. Percent parasitism for *Meteorus trachynotus* Viereck and *Glypta fumiferanae* Viereck differed significantly between crown levels. For all other species, differences between crown levels were nonsignificant or were insufficient to provide an adequate test.

1603. Schmid, John M. 1984. Emergence of adult pandora moths in Arizona. Great Basin Naturalist. 44(1):161-165.

Adult pandora moths began emerging in late July, and peak daily emergence occurred during August 10-15. The mean density of moths emerging per 929 square centimeters of ground surface ranged from 0.1. to 2.4. The ratio of emerging males to females varied from 3-4:1 during the initial days of emergence to 1:1.5 during the last 10 days of August. Postemergence behavior is described and discussed in relation to egg mass deposition and species survival.

1604. Schmid, John M. 1981. Incidence of western spruce budworm parasites in New Mexico after aerial spraying with carbaryl. Research Note RM-397. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Present parasitism by two icheumonids changed significantly after spraying. one tachinid fly decreased significantly in the sprayed area during the first year after spraying. Other insect parasites exhibited similar trends on sprayed and unsprayed areas or their numbers were too meager to determine a trend.

1605. Schmid, John M. 1988. Insects of ponderosa pine: impacts and control. *In:* Baumgartner, David M.; Lotan, James E., editors. Ponderosa pine: the species and its management; 1987 September 29-October 1; Spokane, WA. Pullman, WA: Washington State University: 93-97.

1606. Schmid, John M. 1984. Larval densities, mortality, and sampling at different canopy levels during a western spruce budworm (Lepidoptera: Tortricidae) suppression project. Environmental Entomology. 13(3): 781-786.

Larval densities were not generally different between crown levels of large Douglas-fir trees, but were significantly different between crown levels in white fir. Densities on seedlings were significantly less than on large trees for both tree species. Mortality attributed to the treatment was relatively uniform between crown levels of large trees and between large trees and saplings, but was less on white fir seedlings. The significance of the variation in larval counts associated with plots, trees within plots, crown levels, and branches within crown levels are discussed in relation to sampling design.

1607. Schmid, John M. 1984. A New nearctic of *Barylypa* (Hymenoptera: Ichneumonidae). Annals of the Entomological Society of America. 77(2): 123-124.

Barylypa postpetiolis is described as new. It occurs from Michigan and Ontario south to south Carolina.

1608. Schmid, John M. 1987. Partial cutting in MPB-susceptible pine stands: will it work and for how long? *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 243-245. 253 p.

Partial cutting in mountain pine beetle-susceptible stands shows promise in reducing tree mortality. Mortality appears to be least in the lower growing stock levels. RMYLD predicts GSL 80 and GSL 120 stands will remain unsusceptible for 40 to 50 years and <20 years, respectively. The Berryman model predicts GSL 80 and GSL 120 stands will be highly and extremely susceptible within 10 years after cutting.

1609. Schmid, John M. 1985. Percentage of parasitism of the western spruce budworm in tree crowns and following a suppression project. *In:* Sanders, C. J.; Stark, P. W.; Mullins, E. G.; Murphy, J., editors. Recent advances in spruce budworms research; CANUSA spruce budworms research symposium; 1984 September 16-20; Bangor, ME. Canadian Forestry Service. 103 p.

1610. Schmid, John M. 1981. Spruce beetles in blowdown. Research Note RM-411. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Attack and beetle densities varied significantly among trees and among the top, lateral, and bottom surfaces of the bole, but insignificantly throughout the infested portion of any one surface. These characteristics are discussed in relation to outbreak potential and biological evaluation procedures.

1611. Schmid, John M.; Bennett, D. D.; Andrews, M. 1983. Distribution of pandora moth egg masses and first stage larvae. Research Note RM-432. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Egg mass counts were significantly greater in stands severely defoliated by the previous larval generation than they were in stands severely defoliated by two previous larval generations or in stands with no previously significant defoliation.

1612. Schmid, John M.; Bennett, D. D. 1988. The North Kaibab pandora moth outbreak. General Technical Report RM-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 18 p.

A pandora moth outbreak in Arizona was studied from 1979 to 1985 to determine the moth's life cycle, densities, and distribution of life stages, larval and adult behavior, effects of the defoliation, sampling procedures, importance of biotic mortality factors, and the effectiveness of insecticides. This report summarizes the available published and unpublished information on the outbreak.

1613. Schmid, John M.; Bennett, D. D.; Yound, R. W.; Mata, Steven A., Jr.; Andrews, M.; Mitchell, James C. 1982. Sampling larval populations of the pandora moth. Research Note RM-421. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Plots and aspects generally contributed significant variation in larval counts in prespray samples, while trees within plots did not. These results are discussed in relation to operational sampling procedures for an outbreak under specific stand conditions.

1614. Schmid, John M.; Farrar, Pamela A. 1982. Distribution of western spruce budworm egg masses on white fir and Douglas-fir. Research Paper RM-241. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Differences among trees and crown levels usually contributed significant variation to egg mass (EM) counts, while differences among aspects and between branches within the same crown level did not. When EM's per branch differed significantly among crown levels, branch size accounted for most of the difference. EM's per square meter of foliage of Douglas-fir were not generally significantly different among crown levels. EM's per square meter of foliage of white fir were significantly greater in the upper browns than in the middle and lower crowns more than 50 percent of the time. The importance of each source of variation is discussed in relation to current EM-sampling techniques.

1615. Schmid, John M.; Farrar, Pamela A.; Mitchell, James C. 1982. Distribution of pandora moth egg masses and pupae near Jacob Lake. Environmental Entomology. 11: 701-704.

Egg masses per branch on trees over 30 cm in diameter were about the same in heavily and lightly defoliated stands. Egg masses per branch on trees 18-24 cm in diameter were significantly greater in heavily defoliated stands. Egg masses on boles were greatest just aboveground. Pupae averaged about 30 per m^2 of ground surface.

1616. Schmid, John M.; Farrar, Pamela A.; Ragenovich, I. R. 1981. Length of western tent caterpillar egg masses and diameter of their associated stems. The Great Basin Naturalist. 41(4): 465-466.

Stems bearing egg masses of the western tent caterpillar, collected in Arizona and northern New Mexico during 1977-1980, had mean diameters between 2.9 and 4 mm. Mean lengths of the egg masses were consistently between 11 and 14 mm.

1617. Schmid, John M.; Mata, Steven A., Jr.; Averill, R. D. 1989. Containment of small group infestations of the mountain pine beetle in ponderosa pine. Research Note RM-493. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Mountain pine beetle tree baits were placed on two sides of each of 11 small infestations. Baited trees were attacked, and 82% of the new infestations developed within a 55-foot radius of the baited trees. Infestations

outside of the baited area but within 5 acres surrounding the baited trees were found on 2 of the 11 sites. This tree baiting strategy effectively contained MPB populations.

1618. Schmid, John M.; Mata, Steven A., Jr.; Mitchell, James C. 1985. Estimating sound seeds in ponderosa pine cones from half-face counts. Research Note RM-459. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Cones from 10 areas in Arizona were dissected to determine the percentage of sound, hollow, and insect-damaged seed. The mean percentage of sound seed in the half-faces of 20 cones (two cones from each of 10 trees) from a stand estimated the same percentage for whole cones for that area within •10 units of the mean.

1619. Schmid, John M.; Mata, Steven A., Jr.; Edminster, Carleton B. 1989. Frequency of external defect and skidding damage in ponderosa pine stands in the Black Hills. Research Note RM-496. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

The average frequency of defect and skidding damage in eight ponderosa pine stands in the Black Hills was less than 8%. Forked tops and crook in the bole were the most common natural defects. skidding damage was present in about the same frequency as forked tops and crook and was not related to residual growing stock level.

1620. Schmid, John M.; Mata, Steven A., Jr.; McCambridge, William F. 1985. Natural falling of beetle-killed ponderosa pine. Research Note 454. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Beetle-killed trees in the Front Range of Colorado were observed for their rate and direction of falling. No trees fell within the 2 years following infestation. Thereafter, trees generally fell at the rate of 3-5% per year unless winds exceeded 75 mph. Most trees fell to the east and broke off between ground level and 2 feet above ground.

1621. Schmid, John M.; Mata, Steven A., Jr.; Mitchell, James C. 1986. Number and condition of seeds in ponderosa pine cones in central Arizona. Great Basin Naturalist. 46: 449-451.

Ponderosa pine cones from 10 areas in Arizona were collected prior to natural seed dispersal and dissected to determine the number of sound, hollow, and insect-damaged seeds in each cone. Total and sound seed yields per cone did not vary significantly among areas but did vary significantly among trees within each area. Numbers of hollow and megastigmus-infested seeds varied significantly among areas and trees within areas. Numbers of sound seed increased significantly with increasing cone length but did not change with increasing numbers of cones per cluster. The percentages of megastigmus-infested seed did not change significantly with increasing cone length or number of cones per cluster.

1622. Schmid, John M.; Mitchell, James C.; Stevens, Robert E. 1981. *Cydia youngana* (Kearfott) (Lepidoptera: Tortricidae) and associates in Engelmann spruce cones, Fraser Experimental Forest, Colorado, 1974-1977. Research Note RM-394. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Of the 20 species associated with Engelmann spruce cones, *Cydia youngana* (Kearfott) was the important damaging insect and caused an average annual seed loss of 28 percent. Because damaged cones cannot be differentiated from sound cones, seed collectors should consider the amount of potential damage when determining their needs.

1623. Schmid, John M.; Mitchell, James C.; Carlin, K. D.; Wagner, Michael R. 1984. Insect damage, cone dimensions, and seed production in crown levels of ponderosa pine. Great Basin Naturalist. 44(4): 575-578.

Insect damage to second-year cones was generally not significantly different between crown levels, but was significantly different among areas and among trees within areas for *Conophthorus*, *Megastigmus*, and *Cydia*. Both cone length and width were not significantly different between lower and middle crown, but cone length was significantly greater in the upper crown. Seeds per cone ranged from 34 to 66, but the percent of sound seed per cone varied significantly according to the amount of insect damage.

1624. Schmid, John M.; Mitchell, James C.; Mata, Steven A., Jr. 1986. Ponderosa pine conelet and cone mortality in central Arizona. Great Basin Naturalist. 46: 445-448.

Ponderosa pine conelets in 10 stands on the Coconino and Kaibab National Forests were observed periodi-

cally from July 1982 until they matured in September 1983. Abortion, ponderosa pine cone beetles and ponderosa pine coneworms were the significant mortality factors. Cattle, tip moths, and squirrels rarely destroyed conelets or cones.

1625. Schmid, John M.; Morton, M. B. 1981. Distribution of foliage on open grown white fir and Douglas-fir in northern New Mexico, USA. Canadian Journal of Forest Research. 11(3): 615-619.

Foliage area and needle biomass of Douglas-fir were distributed in the ratio of 1:3.5:2 in the upper, middle, and lower crown. In white fir, the ratio was 1:2:1. The 1979 new shoot growth, expressed as a percentage of the total needle weight for the branch, decreased from the top of the crown to the middle in white fir. The weight of the foliage in Douglas-fir ranged from 14 to 38 kg. The range in white fir was from 22 to 59 kg.

1626. Schmid, John M.; Thomas, L.; Rodgers, T. 1981. Prescribed burning to increase mortality of pandora moth pupae. Research Note RM-405. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Prescribed burning of three different locations did not consistently cause satisfactory mortality to pandora moth pupae. It should be used only when the burning simultaneously achieves other objectives. Litter depth and distribution are important in uniformly heating and burning the proposed area.

1627. Schmidt, Ralph A. 1981. Estimates of threshold windspeed from particle sizes in blowing snow. Cold Regions Science and Technology. 4(3): 187-193.

Particle size distributions measured in the saltation layer of drifting snow are fitted reasonably well by the two-parameter gamma function. Average particle diameters, measured with a photoelectric snow particle counter at a site in southeastern Wyoming, USA, during drifting of moderate intensity, are larger than mean sizes predicted by theory. These experiments provide empirical equations that allow threshold windspeeds for snow transport to be estimated by monitoring an anemometer and particle counter.

1628. Schmidt, Ralph A. 1984. Measuring particle size and snowfall intensity in drifting snow. Cold Regions Science and Technology. 9: 121-129.

Distributions of particle diameters in drifting snow with concurrent snowfall extend to larger sizes and exhibit a tendency to be dimodal compared to distributions in drifting without snowfall. An electronic system provides measures of these distributions that allow precipitation rates to be estimated even with strong transport of snow along the surface. The system uses a low-power microcomputer to accumulate signals from a photo-electric snow particle counter, facilitating real-time monitoring of conditions. Measured size distributions at five heights in the lowest 1m above an alpine ridge crest show that falling snow crystals are concentrated in the accelerated flow.

1629. Schmidt, Ralph A. 1982. Properties of blowing snow. Reviews of Geophysics and Space Physics. 20(1): 39-44.

This review of research on properties of the multiphase flow of snow in air draws attention to recent measurements of turbulence, flow development, and transport rate that have been published in English.

1630. Schmidt, Ralph A. 1986. Snow surface strength and the efficiency of relocation by wind. *In:* Kane, Douglas L., editor. Proceedings of the symposium. Cold regions hydrology. Bethesda, MD: American Water Resources Association: 355-358.

An automated system developed by Martinelli and Ozment samples forces required to fracture grains from a snow surface. The device has sufficient sensitivity to measure differences in surface erodibility under saltating drift. Such measurements help explain differences in the efficiency with which wind transports snow.

1631. Schmidt, Ralph A. 1980. Threshold windspeeds and elastic impact in snow transport. Journal of Glaciology. 26(94): 453-467.

Cohesive forces are added to the analysis of forces on sand and soil particles to show that fluid drag alone often cannot initiate movement of a snow surface. The impact force of saltating ice spheres, however, can easily provide the force to break cohesive bonds, according to these calculations. The argument suggests a balance between the distribution of bond strengths of exposed surface particles and the distribution of saltation trajectory heights.

1632. Schmidt, Ralph A. 1986. Transport rate of drifting snow and the mean wind speed profile. Boundary-Layer Meteorology. 34: 213-241.

Transport rates, measured by weighing snow blown into a filter fabric trap, were greater over hard snow or ice than for the same wind speed over soft, fresh snow surfaces. Analysis of wind speed profile from nine blizzards showed that friction between moving

particles and the surface was less, and particle speeds were greater over hard surfaces. Transport rates at a given wind speed increased rapidly as aerodynamic roughness decreased in the rough-smooth transition region. Bagnold's theory for bed load transport provided a useful framework for the analysis.

1633. Schmidt, Ralph A. 1982. Vertical profiles of wind speed, snow concentration, and humidity in blowing snow. Boundary Layer Meteorology. 23: 223-246.

To estimate the sublimation rate of snow during relocation by wind, sizes and concentration of ice crystal fragments were measured at 6 levels in the lowest 1 m, during ten 10-min runs, in a nocturnal blizzard. The vertical gradient of water vapor, measured with a thermocouple psychrometer, was approximately linear from 0.2 to 1.0 m above the surface. Evaporation of blowing snow over 3 km of transport distance was estimated to be 39 percent of transport rate, under conditions of the experiment.

1634. Schmidt, Ralph A.; Gubler, Hans; Hiller, M. 1984. Swiss improvements of the FMCW radar for snow measurements. *In:* Proceedings of the western snow conference, 52nd annual meeting; 1984 April 17-19; Sun Valley, ID. Spokane, WA: Executive Secretary of the Conference: 24-32. 192 p.

Low-power electronic circuits that produce greater sweep stability, improve signal-to-noise ratio, and permit remote operation from batteries have enhanced snow measurements with a swept-frequency, x-band radar. If snow depth is determined with 1% accuracy, the system predicts water equivalent of a dry snowpack within 5% of gravimetric measurements. Snow depths up to 6 m, determined by radar, compared well with probed depths, when density was estimated from an empirical depth-density relationship.

1635. Schmidt, Ralph A.; Hartman, Hal. 1986. Storage and redistribution of snow upwind of an avalanche catchment. *In:* Proceedings, international snow science workshop; 1987 October 22-25; Lake Tahoe, CA. Homewood, CA: International Snow Science Workshop Committee: 37-40.

1636. Schmidt, Ralph A.; Jairell, Robert L.; Pomeroy, John Willard. 1988. Measuring snow interception and loss from an artificial conifer. *In:* Proceedings, 56th western snow conference; 1988 April 19-21; Kalispell, MT. Fort Collins, CO: Colorado State University: 166-169.

A 1-m-high artificial Christmas tree and the snow held on its branches was weighed by an electronic balance that transferred values to a computer in a nearby mobile laboratory. These measurements allowed evaporation of intercepted snow to be correlated with environmental factors during periods as short as 10-15 minutes.

1637. Schmidt, Ralph A.; Jairell, Robert L. 1987. A system that monitors blowing snow in forest canopies. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 227-230. 253 p.

An electronic system that connects a desktop computer (PC) to tower-mounted arrays of snow particle counters provides a new approach to an old problem—why more snow accumulates in small openings than in the surrounding forest. Each photoelectric sensor generates a pulse for a particle passing through its light beam. These are counted by a microprocessor system that passes the sums to the PC. Preliminary measurements in both a clearing and the forest upwind show counts increasing with height in the 15-m region centered near the mean canopy height (18 m).

1638. Schmidt, Ralph A.; Meister, Roland; Gubler, Hans. 1984. Comparison of snow drifting measurements at an alpine ridge Crest. Cold Regions Science and Technology. 9: 131-141.

Experiments at Weissfluhjoch, Davos, Switzerland, compared mass flux measured by rocket-shaped snowdrift gages (modified mellor traps), with gages made of porous filter fabric, and with several electronic systems. A new method of electronic analysis gave results similar to the mass flux measured by mechanical traps. The experiments also reexamined the vertical profile of drift flux in the vicinity of the ridge crest, confirming the flux maximum at about 1 m height above the ridge crest, and adding details near the surface.

1639. Schmidt, Ralph A.; Randolph, Kristine L. 1981. Predicting deposition of blowing snow from particle trajectories. *In:* Proceedings of the western snow conference: forty ninth annual meeting; 1981 April 14-16; St. George, UT. 34-42. 138 p.

Deposition of blowing snow behind a downwind-facing step, predicted from particle trajectories based

on settling velocity and wind speed, is greatest at the step face, in agreement with observations. Trapping efficiency of the empty step decreases as windward slopes change from downhill to uphill. Results apply to design for revegetation.

1640. **Schmidt, Ralph A.; Schmidt, Scott D. 1987. Why are Wyoming snow fences so tall? *In:* Morel-Seytoux, Hubert J.; Sanders, Thomas G., editors. Proceedings, seventh annual AGU Front Range Branch, Hydrology Days; 1987 April 21-23; Fort Collins, CO. Fort Collins, CO: Hydrology Days Publications: 58-66.**

1641. **Schmidt, Ralph A.; Tabler, Ronald D.; Jairell, Robert L. 1982. A new device for sampling mass flux in blowing snow. *In:* Proceedings of the 50th western snow conference; 1982 April 19-23; Reno, NV. Fort Collins, CO: Colorado State University: 102-111. 225 p.**

To determine more accurately the relationship between transport rate and wind speed in blizzards, blowing snow trapped in a porous bag of filter fabric is shaken by wind into a below-surface container where it is weighed and the data recorded by remote computer every 15 seconds during experiments.

1642. **Schmidt, Ralph A.; Troendle, Charles A. 1989. Snowfall into a forest clearing. Journal of Hydrology. 110: 335-348.**

Experiments comparing the number flux of snow particles above the center of an 80-m-wide clearing with simultaneous samples in and above the forest 85 m upwind show greater average fluxes in the clearing. Flux decreased below the canopy top in the forest and also nearer the surface in the clearing.

1643. **Schmidt, Wyman C.; Alexander, Robert R. 1985. Strategies for managing lodgepole pine. *In:* Baumgartner, David M.; Krebill, Richard G.; Arnott, James T.; Weetman, Gordon F., compilers and editors. Lodgepole pine, the species and its management: symposium proceedings; 1984 May 8-10 and May 14-16; Spokane, WA and Vancouver, BC. Pullman, WA: Washington State University, Cooperative Extension Service: 201-210.**

1644. **Schoettle, Anna W. 1989. Potential effect of premature needle loss on leaf area and nutrient retention of the canopy of *Pinus contorta* ssp. Latifolia. *In:* Air Pollution Control Association's annual meeting. 443-454.**

1645. **Scholl, David G. 1982. Properties of coal spoils of the Navajo Mine in northwest New Mexico. *In:* Aldon, Earl F.; Oaks, Wendell R., co-editors. Proceedings of reclamation of mined lands in the Southwest; 1982 October 20-22; Albuquerque, NM. Albuquerque, NM: Soil Conservation Society of America, New Mexico Chapter: 35-42. 218 p.**

The three spoil types had distinctly different amounts of a given geologic material. Chemical and physical analysis indicated that the shale materials could produce both physiologic and water management problems and that the sandy spoils have restricted water holding capacity.

1646. **Scholl, David G. 1989. Soil compaction from cattle trampling on a semiarid watershed in northwest New Mexico. New Mexico Journal of Science. 29(2): 105-112.**

Effects of cattle grazing on soil bulk density, macroporosity, and hydraulic conductivity were evaluated in individual hoof prints and undisturbed areas beside them on five soil textures during spring and fall. A cone penetrometer was used to quantify soil compaction. The proportion of an area actually compacted by hoof prints during normal grazing was small compared to that of traffic areas.

1647. **Scholl, David G. 1987. Soil salinity and water movement during irrigation of a topsoil-coal spoil profile. *In:* Billings symposium on surface mining and reclamation in the Great Plains; 1987 March 17-19; Billings, MT. Reclamation Research Unit Report No. 8704. Billings, MT: American Society for Surface Mining and Reclamation: D-3-1 To D-3-7.**

This study of the irrigation phase of reclamation was conducted to evaluate the potential for salt accumulation in topsoil placed over a saline-sodic coal spoil under controlled conditions. Topsoil depth and irrigation rate were evaluated for their influence on the concentration and location of salts in the profile.

1648. **Scholl, David G. 1986. The study of soil water in mine reclamation. *In:* Reith, Charles C.; Potter, Loren D., editors. Principles and methods of reclamation science with case studies from the arid Southwest. Albuquerque, NM: University of New Mexico Press: 135-149. 224 p.**

This paper discusses the pervasiveness of soil water as a factor in the reclamation of arid and semiarid lands. Soil-water relationship are the root of many problems in revegetation and stabilization. Thus,

researchers should recognize and account for the status and behavior of water in spoils which are being reclaimed.

1649. **Scholl, David G. 1985. Vegetation and soil water response to contour furrows, dozer basins, and surface additions of topsoil or power plant ash on arid coal spoils. *In:* Williams, Dean; Fisher, Scott E., Jr., editors. Proceedings of the second annual meeting of the American Society for Surface Mining and Reclamation; 1985 October 8-10; Denver, CO. Princeton, WV: American Society for Surface Mining and Reclamation: 217-220. 412 p.**

Two native shrubs and several native grasses were evaluated on two sodic coal spoils. The contour furrows and dozer basins produced the only significant establishment of plants in the study.

1650. **Scholl, David G.; Aldon, Earl F. 1986. Grass establishment on uranium exploration sites in New Mexico. *In:* Proceedings—new horizons for mined land reclamation; 1986 March 17-20; Jackson, MS. Princeton, WV: American Society for Surface Mining and Reclamation: 95-97.**

This study was conducted in the Grants Uranium District on a site disturbed by linear prospecting. Eight prospects within a 2-km^2 area were regraded and grasses established using four treatments: combinations of straw incorporation, furrowing, straw mulching, and drill seeding. Treatments were evaluated after 5 years. Galleta and blue grama grasses responded well to the furrowing and straw incorporation treatments. Total cover and production were also improved by straw incorporation. Because galleta and blue grama are valuable for both forage and watershed protection, their improved establishment through incorporation of straw and furrowing is recommended.

1651. **Scholl, David G.; Aldon, Earl F. 1988. Runoff and sediment yield from two semiarid sites in New Mexico's Rio Puerco Watershed. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.**

Precipitation, runoff, and sediment yield were measured from seven runoff plots at two different sites in a calibration phase. Correlations between individual plots at each site for runoff and sediment yield were all significant. A single plot at each site was selected (based on highest R values) as a control plot for future treatment testing, and the number of future events necessary to detect a 25% and 50% change due to treatment was determined.

1652. **Scholl, David G.; Honey, William E. 1984. An automatic instrument for recording the count rate of a moving neutron moisture probe. *In:* Proceedings of the NMWA/US EPA conference on characterization and monitoring of the Vadose Zone; 1983 December 8-10; Las Vegas, NV. 602-608.**

1653. **Scholl, David G.; Miyamoto, S. 1983. Response of alkali sacaton and fourwing saltbush to various amendments on coal mine spoils from northwestern New Mexico. Reclamation and Revegetation Research. 2: 227-236.**

Chemical and physical amendments were tested for their use in revegetation of acid coal spoil from northwestern New Mexico. Results indicate that the following amendments are promising: (1) sand or ash mulch over the spoil treated with p and lime, (2) shale or sand incorporated with P and lime, and (3) top-dressing on the spoil with P.

1654. **Scholl, David G.; Miyamoto, S. 1984. Response of alkali sacaton and fourwing saltbush to various amendments on coal mine spoils from northwestern New Mexico. II. Sodic spoil. Reclamation and Revegetation Research. 2: 243-252.**

The following amendments were found to be promising: for sandstone-based spoils, sulfuric acid treatment. Gypsum plus phosphorus application or phosphorus fertilization alone, depending on severity of sodium problems; for shale-based spoils, acid treatment can best be combined with either sand mulching, sand top-dressing, or sand incorporation.

1655. **Scholl, David G.; Pase, Charles P. 1984. Wheatgrass response to organic amendments and contour furrowing on coal mine spoil. Journal of Environmental Quality. 13(3): 479-482.**

The growth response of several wheatgrasses was tested on sodic and nonsodic coal spoils in New Mexico following amendments with pine bark and barley straw. Contour furrowing was also tested in combination with the amendments. Plant height and production were increased by the amendments and, to a lesser extent, by the contour furrowing. Production was greatest on the nonsodic spoils. Incorporating straw into nonsodic spoil increased the growth of intermediate wheatgrass; however, topsoiling the untreated spoil did not increase growth.

1656. Schreuder, Hans T. 1986. Design-dependent and model-dependent procedures in timber sale and updating survey. *In:* **Proceedings, SAF; 1986 October; Birmingham, AL. Publication 87-02. Washington, DC: Society of American Foresters: 74-76.**

In timber sale sampling and updating surveys of forest resources, model-dependent sampling based on an underlying weighted regression model is often quite efficient relative to design-dependent sampling schemes. The Horvitz-Thompson is invariably used with pps estimation because it yields unbiased and presumably highly efficient estimates Y T. This paper attempts to identify the reasons why certain model-dependent sampling strategies can be more efficient for obtaining initial and updated timber volume estimates with YHT.

1657. Schreuder, Hans T. 1985. Mickey's unbiased ratio and regression estimators. *In:* **Encyclopedia of Statistical Sciences. New York, NY: John Wiley & Sons, Inc. 5: 479-481.**

A short review of the Mickey class of ratio and regression estimators is given. The performance of the ratio estimator relative to some othe ratio estimators is discussed.

1658. Schreuder, Hans T. 1985. Pascual's estimator. *In:* **Johnson, N. L.; Kotz, S., editors. Encyclopedia of statistical sciences. New York, NY: Wiley Publishers; 6: 630.**

1659. Schreuder, Hans T. 1984. Poisson sampling and some alternatives in timber sales sampling. Forest Ecology and Management. 8: 149-160.

Poisson (3-P) sampling literature is reviewed for sales where every tree is visited. Model-based sampling with x-values closest to the average x-value of the N sorted, cumulated (X/N), I, I = 0, 1,..., (N-1) classes is a recommended alternative to stratified and pps sampling for efficiency for a situation where the model is correct.

1660. Schreuder, Hans T. 1986. Quenouille's estimator. Encyclopedia of Statistical Sciences. 7: 473-476.

Quenouille's ratio estimator and its utility relative to other ratio estimators is reviewed. The ratio estimator is generally one of the more efficient estimators available.

1661. Schreuder, Hans T. 1982. Sampling designs for multiresource inventories. *In:* **Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Bethesda, MD: Society of American Foresters: 389-394. 1101 p.**

The effect on sampling design of several classes of multiresource variables are briefly discussed, including designs incorporating LANDSAT, high-altitude photography, ground sampling, and model-based sampling.

1662. Schreuder, Hans T. 1988. Tin's ratio estimators. Encyclopedia of Statistical Sciences. 9: 270-271.

Tin's ratio-type estimators and their utility relative to other ratio estimators is reviewed. The principal ratio estimator is generally one of the more efficient estimators available.

1663. Schreuder, Hans T.; Anderson, Jana C. 1984. Variance estimation for volume when D2H is the covariate in regression. Canadian Journal of Forest Research. 14(6): 818-821.

For two realistic (but not real) populations of loblolly pine, variance estimators for weighted regression estimates of total volume are compared. The traditional variance estimators, and two robust variance estimators proposed by Royall and Cumberland (1981), are found to be quite unreliable. In contrast, the jackknife variance estimate and confidence intervals based on it are found to be much more reliable.

1664. Schreuder, Hans T.; Banyard, S.; Brink, Glen E. 1987. Comparison of three sampling methods in estimating stand parameters for a tropical forest. Forest Ecology and Management. 21(1987): 119-127.

Fixed-area plot sampling is most efficient for number of trees; horizontal-line sampling for total basal area, sum of tree diameters, and average tree diameter. The angle-count method is best for number of trees by diameter class for the larger diameter classes; the fixed-area plot method is best for the smallest trees. All three methods are most efficient with sample locations based on square sample plots. A count sampling method combining the three methods using a long rectangular plot is recommended for practical purposes if interest is in all parameters except frequencies by diameter class, so that tree diameters do not need to be measured. If interest is in frequencies by diameter class, the angle-count sample trees should be measured to give the most reliable results.

1665. Schreuder, Hans T.; Bhattacharyya, Helen T.; McClure, Joe P. 1982. The SBBB distribution: a potentially useful trivariate distribution. Canadian Journal of Forest Research. 12(3): 641-645.

The SBBB distribution allows for a more complete summarization of stand structure data than has been possible in forestry until now. The medium regression of volume in terms of diameter and height gave results almost as good as the standard combined variable model. Computer programs needed to implement the system are available.

1666. Schreuder, Hans T.; Bhattacharyya, Helen T.; McClure, Joe P. 1982. Towards a unified distribution theory for stand variables using the SBBB distribution. Biometrics. 38: 137-142.

1667. Schreuder, Hans T.; Bonner, G. M. 1987. Forest inventories in the United States and Canada. Forestry Chronicle. December (1987): 431-434.

Canadian and United States (U.S.) extensive forest inventories are contrasted. The Canadians have had more experience in mapping and remote sensing; the U.S. in collecting, handling, and reporting change data. Development of common standards, terms, and definitions, as well as a common forest and land classification system, would facilitate cooperation and exchange of information.

1668. Schreuder, Hans T.; Brink, Glen E.; Wilson, Rodney L. 1984. Alternative estimators for point-Poisson sampling. Forest Science. 30(3): 803-812.

L. R. Grosenbaugh's and a jackknife variance estimate are shown to be best for point-Poisson sampling. Both the standard point-Poisson and a proposed unbiased jackknife estimate of total variance are equally efficient. Variance estimates based on point-pps with and without replacement sampling are erratic.

1669. Schreuder, Hans T.; Brink, Glen E. 1983. The jackknife—a useful statistical tool. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University: 531-535. 737 p.

The jackknife technique is a statistical approach for distribution-free bias reduction and standard error estimation. The technique is primarily useful to estimate standard errors for complex sampling strategies where no good standard error estimates can be computed. This is critical for the complex sampling strategies now being developed by the forest survey units to update their timber estimates.

1670. Schreuder, Hans T.; Brink, Glen E.; Schroeder, Daniel L.; Dieckman, Richard. 1984. Model-based sampling versus point-poisson sampling on a timber sale in the Roosevelt National Forest in Colorado. Forest Science. 30(3): 652-656.

Model-based (MB) sampling and point-Poisson (PP) sampling strategies are compared to large sample results in a timber sale on the Roosevelt National Forest, Colorado. The MB procedure is shown to yield a better estimate of total volume in cubic meters and to be about equally efficient as the PP sampling. The MB sampling also appears to be easier to implement in practice.

1671. Schreuder, Hans T.; Brink, Glen E. 1986. Model-dependent sampling versus point-Poisson sampling on a Colorado timber sale. Research Note RM-465. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.

Estimates from point-poisson and a model-dependent sampling procedure called PSC x are compared with large sample estimates in a timber sale area. The PSC x estimates are closer to the large sample estimates for both sawtimber volume in board feet and fuelwood volume in cobic meters. Similar results have been observed in other studies. The PSC x procedure was more precise for fuelwood but less precise for sawtimber volume than the point-Poisson procedure.

1672. Schreuder, Hans T.; Brink, Glen E. 1987. Volume estimation by diameter class using bootstrap variance estimates. Forest Ecology and Management. 20(1987): 189-194.

Bootstrap estimation is used to provide standard errors of estimates for volume by diameter class in a test data set of the IVth Dutch forest survey. Such standard errors of estimates cannot currently be obtained by classical methods.

1673. Schreuder, Hans T.; Labau, Vernon J.; Hazard, J. 1985. Regression estimation for key variables in the Tanana basin survey in Alaska. *In:* Inventorying forest and other vegetation of the high latitude and high altitude regions: proceedings of an international symposium; 1984 July 23-26; Fairbanks, AK. Bethesda, MD: Society of American Foresters: 74-77.

1674. Schreuder, Hans T.; Li, H. G.; Scott, C. T. 1987. Jackknife and bootstrap estimation for sampling with partial replacement. Forest Science. 33(3): 676-689.

Jackknife and bootstrap estimators and variance estimators were compared with a classical estimator and variance estimator for sampling with partial replacement (SPR) on two occasions. Forest plots were samples from the northeastern United States. The classical estimator is generally preferable to the jackknife and bootstrap estimators when both estimation bias and efficiency are important in SPR sampling.

1675. Schreuder, Hans T.; Li, H. G.; Hazard, J. 1987. Pps and random sampling estimation using some regression and ratio estimators for underlying linear and curvilinear models. Forest Science. 33(4): 997-1009.

Two thousand samples of 30 units were drawn from selected populations for which linear or curvilinear underlying models were postulated between the variable of interest and a covariate. Ratio and linear and nonlinear regression estimators were compared for bias and relative efficiency of the estimates generated.

1676. Schreuder, Hans T.; Schreiner, David S.; Max, Timothy A. 1981. Insuring an adequate sample at each location in point sampling. Forest Science. 27(3): 567-573.

To ensure and adequate sample size at each sample location, use of large, fixed-area, primary sampling units, which are subsampled by a cluster of point samples in which the basal area factor is specified before sampling, is recommended. Although little is known about either optimum primary sampling unitsize or subsampling rate, it seems likely that for estimating timber variables efficiently, either PSU's should be increased in size or subsampling rate should be reduced, or both.

1677. Schreuder, Hans T.; Singh, K. D. 1987. A proposed multiresource inventory for tropical forests. *In:* International conference and workshop; land and resource evaluation for national planning in the tropics; 1987 January 25-31; Chetumal, Mexico. 218-222.

The purpose of this manuscript is to propose a sampling strategy to assess and monitor a forest in a tropical country utilizing operationally available mapping, sampling, and modeling techniques that incorporate remote sensing and ground sampling.

1678. Schreuder, Hans T.; Snook, Paul W.; Czaplewski, Raymond L.; Catts, G. P. 1986. A proposed periodic national inventory of land use land cover change. *In:* 1986 ASPRS-ACSM fall convention; Fall 1986; Anchorage, AK. 255-264.

Three alternatives using digital thematic mapper (TM), analog TM, and a combination of either digital or analog TM data with low altitude photography are discussed for level I and level II land use/land cover classes for a proposed national inventory. Reliable estimates of precision can be obtained for those classes where lap is "truth.

1679. Schreuder, Hans T.; Thomas, C. E. 1985. Efficient sampling techniques for timber sale surveys and inventory updates. Forest Science. 31(4): 857-866.

Three different regression estimators, predicting tree or plot volume from tree diameter squared times total height or previous plot volume 5 or 10 years earlier for specific populations, were studied with respect to minimum relative bias, minimum variance, percentage of confidence intervals containing true volume, and consistency in estimating total volume using six sampling rules. Two of the sampling rules yielded the most efficient volume estimators in all three populations.

1680. Schreuder, Hans T.; Wood, Geoff B. 1986. The choice between design-dependent and model-dependent sampling. Canadian Journal of Forest Research. 16: 260-265.

Design-dependent and model-dependent sampling strategies are discussed. Model-dependent strategies can be very efficient in highly specialized sampling situations where an underlying model can reasonably be assumed, such as in sampling for timber sales, but can also be very unreliable if the wrong model is assumed. This is illustrated by the application of stratified sampling with probability proportional to size (a design-dependent sampling scheme) and stratified sampling from the cumulated values of an independent variable x (a model-dependent, purposive sampling scheme) to selected data sets with somewhat diverse characteristics.

1681. Schreyer, Richard; Driver, B. L. 1989. The benefits of leisure: Needs for more study of cause and effect. *In:* Jackson, Edgar L.; Burton, Thomas L., compilers, editors. Understanding leisure and recreation: mapping the past, charting the future. College Station, PA: Venture Publishing, Inc. 385-419.

1682. Schroeder, Herbert W.; Brown, Thomas C. 1983. Alternative functional forms for an inventory-based landscape perception model. Journal of Leisure Research. 15(2): 156-163.

1683. Schroeder, Herbert W.; Daniel, Terry C. 1981. Progress in predicting the perceived scenic beauty of forest landscapes. Forest Science. 27(1): 71-80.

1684. Schroeder, Herbert W.; Dwyer, John F. 1988. Overview: gains, losses, and contingent valuation. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 103-106.

1685. Schroeder, Max H.; Sturges, David L. 1980. Spraying of big sagebrush with 2,4-D causes negligible stream contamination. Journal of Range Management. 33(4): 311-312.

1686. Schubert, Gilbert H.; Wellner, Charles A.; Hudson, Russell H.; Barrett, James W. 1981. Interior ponderosa pine. *In:* Choices in silviculture for American forests. Washington, DC: Society of American Foresters with cooperation of the Wildlife Society: 54-63.

1687. Schuler, Thomas M.; Smith, Frederick W. 1988. Effect of species mix on size/density and leaf-area relations in southwest pinyon/juniper woodlands. Forest Ecology and Management. 25: 211-220.

The effects of species mix on stand structure and growth are evaluated for 117 pinyon and juniper woodlands of the southwestern United States. Maximum-size/density relations, leaf area, and growth of pure and mixed-species woodlands are compared. We suggest that higher size/density, leaf area, and growth relations in mixed-species woodland than in pure woodlands are related to differences in rooting habit and water relations between pinyon and juniper.

1688. Schwartz, Charles C.; Nagy, Julius G.; Regelin, Wayne L. 1980. Juniper oil yield, terpenoid concentration and antimicrobial effects on deer. Journal of Wildlife Management. 44(1): 107-113.

Samples of alligator, Rocky Mountain, and Utah junipers were analyzed for volatile oil yield and terpenoid concentration. Oil yield varied 0.05 among species, with alligator lowest, utah higher, and Rocky Mountain juniper highest.

1689. Schwartz, Charles C.; Regelin, Wayne L.; Nagy, Julius G. 1980. Deer preference for juniper forage and volatile oil treated foods. Journal of Wildlife Management. 44(1): 114-120.

Cafeteria feeding trails were used to determine preferences by mule deer among alligator juniper, Utah juniper, and Rocky Mountain juniper foliage, and for pelleted feeds treated with their volatile oils. Deer preferred alligator juniper, but did not differentiate between Utah and Rocky Mountain junipers.

1690. Schweitzer, Dennis L. 1981. An economist's perspective of residues. *In:* Proceedings, symposium on harvesting and utilization opportunities for forest residues in the northern Rocky Mountains. General Technical Report INT-110. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 273-279.

1691. Schweitzer, Dennis L. 1980. Wildlife values information—Forest Service requirements and availability. *In:* Shaw, William W.; Zube, Ervin H., editors. Wildlife values. Institutional Series Report 1. Tucson, AZ: Center for Assessment of Noncommodity Natural Resource Values, School of Renewable Natural Resources, University of Arizona: 191-198.

1692. Schweitzer, Dennis L.; Hoekstra, Thomas W.; Cushwa, Charles T. 1981. Lessons from past national assessments of wildlife and fish: information and coordination needs for the future. *In:* Transactions of the 46th North American wildlife and natural resources conference. Washington, DC: Wildlife Management Institute: 147-155.

Past assessments of wildlife and fish, the most serious shortcomings of those assessments, and current efforts to correct these shortcomings are reviewed.

1693. Scott, Virgil E.; Crouch, Glenn L. 1988. Breeding birds and small mammals in pole-sized lodgepole pine and small inclusions of aspen in central Colorado. Research Note RM-482. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Numbers of birds and mammals in small aspen stands within a pole-sized lodgepole pine forest were

compared with those found in the surrounding conifer forest. Some birds and one mammal that are usually associated with conifer forests were more abundant in the aspen than in the lodgepole pine. However, the aspen stands appear too small to provide habitat for aspen obligates.

1694. Scott, Virgil E.; Crouch, Glenn L. 1988. Breeding birds in uncut aspen and 6- to 10-year-old clearcuts in southwestern Colorado. Research Note RM-485. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Numbers of breeding birds were estimated for various sizes and ages of clearcuts, for edge habitat created by the clearcuts, leave strips between clearcuts, and uncut aspen forest (controls). Total numbers of birds were not different among three size classes or five age classes of clearcuts. Totals were lower on clearcuts than on edges but not different from controls or leave strips.

1695. Scott, Virgil E.; Crouch, Glenn L.; Whelan, Jill A. 1982. Responses of birds and small mammals to clearcutting in a subalpine forest in central Colorado. Research Note RM-422. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Total numbers of birds were not significantly changed after 36 percent of a 100-acre timber stand was harvested in 12, small clearcuts. A small, post-harvest decline occurred in the "foliage nesting" and "pickers and gleaner" feeding guilds. There was not significant change in small mammal populations after timber harvest.

1696. Scott, Virgil E.; Crouch, Glenn L. 1987. Response of breeding birds to commercial clearcutting of aspen in southwestern Colorado. Research Note RM-475. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Breeding birds on an aspen forest in southwestern Colorado increased in species diversity after 25% of the timber sale area forest was clearcut in patches of 3 to 20 acres. Bird population density on the forest with clearcuts was not significantly different from that on an uncut forest. Of the 20 species evaluated, six were more and one was less abundant than on the uncut forest.

1697. Scott, Virgil E.; Crouch, Glenn L. 1988. Summer birds and mammals on aspen-conifer forests in west-central Colorado. Research Paper RM-280. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Breeding birds and small mammals were inventoried in west-central Colorado, in stands ranging from pure aspen to nearly pure spruce-fir. In aspen, the bird community included several species not found in the conifer-dominated stands, but bird density and diversity were not different. In all, 18 bird species and three small mammals showed responses to the various characteristics.

1698. Scott, Virgil E.; Gottfried, Gerald J. 1983. Bird response to timber harvest in a mixed conifer forest in Arizona. Research Paper RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.

Total bird numbers were slightly lower after timber cutting, but the number of species observed increased from 28 to 35. Analysis of bird species by nesting and feeding guilds showed no significant differences in numbers before and after cutting for any of the guilds.

1699. Scott, Virgil E.; Oldemeyer, John L. 1983. Cavity nesting bird requirements and responses to snag cutting in ponderosa pine. *In:* **Davis, Jerry W.; Goodwin, Gregory A.; Ockenfels, Richard A., technical coordinators. Snag habitat management: proceedings of the symposium; 1983 June 7-9; Flagstaff, AZ. General Technical Report RM-99. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 19-23. 226 p.**

1700. Scott, Virgil E.; Patton, David R. 1989. Cavity-nesting birds of Arizona and New Mexico forests. Phoenix, AZ: Arizona Wildlife Foundation. 69 p. (Revised. Originally published as General Technical Report RM-10. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station).

Summarizes published data and personal observations of nesting and food habits of 41 species of cavity-nesting birds in five southwestern forest types.

1701. Seaver, David A.; Roussopoulos, Peter J.; Freeling, Anthony N. S. 1983. The escaped fire situation: a decision analysis approach. Research Paper RM-244. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

A preliminary decision analysis model addressing the choice among alternative suppression strategies on escaped wildfires is presented. A case study application of the model, in the context of an escaped fire situation analysis on the Wallowa-Whitman National Forest is described and discussed.

1702. Sedransk, Joseph. 1982. New developments in statistics to more completely summarize survey results for analytical purposes. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 421-427.

1703. Sedransk, Joseph. 1983. The uses of likelihood methods in renewable resource inventories. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference, renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 584-590.

1704. Senn, Ronald A., Jr.; McMurtray, Maggie; Ffolliott, Peter F. 1981. Effects of southwestern ponderosa pine mortality on potential wood product recovery. Research Note RM-399. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

No differences were found between the quality of trees killed by natural causes and of surviving trees. Mortality, primarily caused by lightning, was 18 percent of annual cubic foot volume increment.

1705. Sestak, M. L.; Riebau, Al R. 1987. Development of SASEM: a simple smoke management model for controlled burning. *In:* Ninth conference on fire and forest meteorology; 1987 April 21-24; San Diego, CA. Boston, MA: American Meteorological Society: 14-18.

1706. Severson, Kieth E. 1981. Chapter VII: food habits and nutritional relationships of mule deer in southwestern United States. *In:* Ffolliott, Peter F.; Gallina, Sonia, editors. Deer biology, habitat requirements, and management in western North America. Mexico, D.F. Instituto De Ecologia, A.C. 152-164. 238 p.

Knowledge of foods consumed by mule deer is basic to most management decisions concerning habitat. Three types of information are needed to provide a complete analysis of the value of the forage complex. These are: food items consumed by deer; nutritive contents of food items consumed; and nutritional requirements of deer for maintenance, growth, and productivity.

1707. Severson, Kieth E. 1987. Deer and elk nutrition in Rocky Mountain ponderosa pine forest. *In:* Fisser, Herbert G., editor. Proceedings of the 16th Wyoming shrub ecology workshop; 1987 May 26-27; Sundance, UT. Laramie, WY: Unviersity of Wyoming, Department of Range Management: 23-27.

1708. Severson, Kieth E. 1981. Plains habitats. *In:* Wallmo, Olof C., editor and compiler. Deer of North America: A wildlife management institute book. Lincoln, NE: University of Nebraska Press: 459-485. 605 p.

Discusses the history of deer populations in the Great Plains, various aspects of deer habitat types, and influences on and uses of Plains habitats.

1709. Severson, Kieth E. 1982. Production and nutritive value of aspen understory, Black Hills. Journal of Range Management. 35(6): 786-789.

Production of and nutrient concentrations in understory vegetation was measured in aspen stands representing three different seral stages in the Black Hills. The value each of the seral stages as to livestock and wildlife is discussed and management suggested.

1710. Severson, Kieth E. 1986. Small mammals in modified pinyon-puniper woodlands, New Mexico. Journal of Range Management. 39(1): 31-34.

The effects of pinyon-juniper treatments on rodent abundance, 13 to 18 years after treatment, were studied in southwestern New Mexico from 1981 to 1983. Treatments including bulldozing, bulldozing/piling/burning, thinning, and untreated woodland. Treatments did not influence number of different rodent species. Data indicate that numbers of individuals and proportions of rodent species can be affected by manipulation of pinyon-juniper overstory and method of slash disposal.

1711. Severson, Kieth E. 1986. Spring and early summer habitats and foods of male blue grouse in Arizona. Journal of the Arizona and Nevada Academy of Science. 21: 13-18.

Spring and early summer habitats of male blue grouse in eastern Arizona were associated with mixed conifer vegetation dominated by Douglas-fir. Forests stands were relatively heterogeneous, as indicated by variable tree spacing and a range of tree stocking levels and size classes that included both stable (Douglas-fir and white fir) and seral (aspen) species. Densities of tree roost areas varied from 1,347 to 1,477 trees/ha, while stands in general ranged from 694 to 1,300 trees/ha. Large Douglas-firs (18 to 33 m high; 33 to 84 cm d.b.h.) were selected for roosting. Microscopic analyses of feces of male blue grouse showed Douglas-fir needles to be the most prevalent item in diets.

1712. Severson, Kieth E. 1986. Woody plant reestablishment in modified pinyon-juniper woodlands, New Mexico. Journal of Range Management. 39(5): 438-442.

This paper reports densities of pinyon, junipers, and associated woody species growing where conifers were treated years previously. Treatments included check, thinning, pushing, and pushing and burning. Pinyon-juniper densities increased in check and thin plots but not in pushed plots. Associated woody species were most abundant in untreated plots.

1713. Severson, Kieth E.; Hayward, B. J. 1988. Rodent weights in modified pinyon-juniper woodlands of southwestern New Mexico. Great Basin Naturalist. 48(4): 554-557.

1714. Severson, Kieth E.; Medina, Alvin L. 1983. Deer and elk habitat management in the Southwest. Journal of Range Management Monograph No. 2. Denver, CO: Society of Range Management. 64 p.

Available information concerning habitat, habitat requirements, management direction, and research needs is summarized for three cervid species common to Arizona and New Mexico—elk, mule deer, and white-tailed deer. Emphasis is given to effects of timber and livestock management and prescribed fire and wild fire because of their existing and/or potential influence on deer and elk habitats.

1715. Severson, Kieth E.; Medina, Alvin L. 1983. El Campo Experimental Santa Rita. *In:* Patton, David R. [and others], technical coordinators. Reunion Sobre "La Fauna Y Su Medio Ambiente" Noreste de Mexico Suroeste Estados Unidos de America. Workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36S. Washington, DC: U.S. Department of Agriculture, Forest Service: 56-59. 120 p.

1716. Severson, Kieth E.; Medina, Alvin L. 1983. The Santa Rita Experimental Range. *In:* Patton, David R. [and others], technical coordinators. Wildlife and range research needs in northern Mexico and southwestern United States: workshop proceedings; 1981 April 20-24; Rio Rico, AZ. General Technical Report WO-36. Washington, DC: U.S. Department of Agriculture, Forest Service: 56-59. 108 p.

The Santa Rita Experimental Range was established in 1903 for research on arid land environments. Research emphasis supports range livestock production on semidesert grasslands. This paper describes the range, the background of information currently available, future research direction, and possibilities for cooperative studies.

1717. Severson, Kieth E.; Uresk, Daniel W. 1988. Influence of ponderosa pine overstory on forage quality in the Black Hills, South Dakota. Great Basin Naturalist. 48(1): 78-82.

Forage quality of one each grass, forb, and shrub was assessed in pole and sapling pinus ponderosa stands growing at five stocking levels ranging from clearcuts to unthinned in the Black Hills, South Dakota. Modifying overstory did not result in predictable changes in nutritional values of understory species.

1718. Shaffer, Donna M.; Ffolliott, Peter F.; Patton, David R. 1982. Management of riparian vegetation for southwestern wildlife. RUN WILD Wildlife/Habitat Relationships, Wildlife Unit Technical Report. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 20 p.

1719. Sharon, Edward M.; Riffle, Jerry W. 1986. Antrodia stem decay of eastern redcedar. *In:* Peterson, Glenn W.; Riffle, Jerry W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 134-135. 149 p.

1720. Sharon, Edward M.; Riffle, Jerry W. 1986. Tar spot of maple. *In:* Peterson, Glenn W.; Riffle, Jerry W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 12-13. 149 p.

1721. Shaw, Charles G., III. 1989. *Armillaria ostoyae* associated with mortality of new hosts in Chihuahua, Mexico. Plant Disease. 73(9): 775.

1722. Shaw, Charles G., III. 1989. Assessment of pest impacts in coniferous forests of western North America. *In:* 11th Australian national conference of plant pathology. 101 p.

1723. Shaw, Charles G., III. 1989. Is Heterobasidion annosum poorly adapted to incite disease in cool, wet environments? *In:* Ostrosina, William J.; Scharpf, Robert F., technical coordinators. Proceedings of the symposium on research and management of annosus root disease (Heterobasidion annosum) in western North America; 1989 April 18-21; Monterey, CA. General Technical Report PSW-116. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 101-104.

An argument is advanced to suggest that infection and damage caused in coniferous forests by Heterobasidion annosum are markedly less severe, and survival of the fungus less common, under cool, wet conditions than in other climates. This premise is supported by the author's incisive insights, experience in southeastern Alaska, and data from this area and from other sources.

1724. Shaw, Charles G., III. 1989. Root disease threat minimal in young stands of western hemlock and sitka spruce in southeastern Alaska. Plant Disease. 73(7): 573-577.

Colonization by *Heterobasidion annosum* was rare in standing live trees, and their survival was poor in inoculated and noninoculated trees and stumps of young-growth sitka spruce and western hemlock at several locations in southeastern Alaska. *H. annosum* survived less than 5 years in naturally infested stumps of either species. In contrast, stump colonization by *Resinicium bicolor* and, presumably, saprophytic *Armillaria* spp. was common, but mortality in adjacent trees was rare.

1725. Shaw, Charles G., III; Eglitis, Andris; Laurent, Thomas H.; Hennon, Paul E. 1987. An overview of decline and mortality of *Chamaecyparis nootkatensis* in southeast Alaska. *In:* Laderman, A. D., editor. Proceedings of the Atlantic white cedar wetlands symposium; 1984 October; Woods Hole, MA. Boulder CO: Westview Press: 327-330.

1726. Shaw, Charles G., III; Goheen, Donald J.; Eav, Bov B. 1989. Simulation of impacts of annosus root disease with the Western Root Disease Model. *In:* Ostrosina, William J.; Scharpf, Robert F., technical coordinators. Proceedings of the symposium on research and management of annosus root disease *(Heterobasidion annosum)* in western North America; 1989 April 18-21; Monterey, CA. General Technical Report PSW-116. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 129-139.

The Western Root Disease Model as it currently exists is described, and the assumptions that were made to adapt the model to simulate attack by *Heterobasidion annosum* in coniferous forests of south-central Oregon are defined. Some simulations produced by this adapted model are presented. Coupled with other information, this exercise provides a framework from which to build an annosus variant of the Western Root Disease Model.

1727. Shaw, Charles G., III; Jackson, R. M.; Thomas, G. W. 1987. Fertilizer levels and fungal strain influence the development of ectomycorrhizae on Sitka spruce seedlings. New Forests. 3: 215-223.

1728. Shaw, Charles G., III; Loopstra, Elaine M. 1988. Identification and pathogenicity of some Alaskan isolates of *Armillaria*. Phytopathology. 78(7): 971-974.

Twenty-six isolates of *Armillaria* spp. were collected in Alaska from mushroom stipes, spores, decayed wood, and rhizomorphs and paired in culture with haploid tester strains of the known north american biological species (NABS) of *Armillaria*. The NABS of isolates obtained from wood and rhizomorphs could not be determined by these tests, but NABS V and IX were identified from material for which single-spore isolates were available. Several isolates were also tested for pathogenicity on seedlings of Alaska-cedar and sitka spruce.

1729. Shaw, Charles G., III; Sidle, Roy C.; Harris, Arland S. 1987. Evaluation of planting sites common to a southeast Alaska clear-cut. III. Effects of microsite type and ectomycorrhizal inoculation on growth and survival of sitka spruce seedlings. Canadian Journal of Forest Research. 17: 334-339.

1730. Shaw, William W.; Zube, Ervin H. 1980. Wildlife values. Instutional Series Report 1. Tucson, AZ: Center for Assessment of Noncommodity Natural Resource Values. 117 p.

A workshop found extensive knowledge and available methodology for determining and applying wildlife values in decisionmaking. The major problem in utilizing this knowledge is that it is isolated within several disciplines. Disciplines must be integrated if wildlife values are to be properly assessed.

1731. Shea, Keith R. 1981. Our forest watersheds—a crucial link in the water chain. *In:* Arizona water symposium 23rd and 24th annual proceedings; 1979 September 27 and 1980 September 24; Phoenix, AZ. Report 2. Phoenix, AZ: Arizona Department of Water Resources: 37-42.

1732. Shepperd, Wayne D. 1985. Aspen ecology and management in the central and southern Rocky Mountains. *In:* Foresters future: leaders or followers? Proceedings of the 1985 Society of American Foresters national convention; 1985 July 28-31; Fort Collins, CO. Bethesda, MD: Society of American Foresters: 233-236. 445 p.

This paper presents a short discussion of the silvics, growth characteristics, and state of the art of aspen management in the central and southern Rocky Mountains. Methods of regeneration, factors affecting the establishment of new stands, and protection of regeneration also are discussed.

1733. Shepperd, Wayne D. 1980. Hand-held-calculator programs for the field forester. General Technical Report RM-76. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 17 p.

A library of programs written for hand-held, programmable calculators is described which eliminates many of the computations previously done by hand in the field. Programs for scaling aerial photos, variable plot cruising, basal area factor calibrations, and volume calculations are included.

1734. Shepperd, Wayne D. 1986. Silviculture of aspen forests in the Rocky Mountains and Southwest. RM-TT-7. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 p.

1735. Shepperd, Wayne D. 1987. Silviculture research in Rocky Mountain aspen. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 25-29. 253 p.

Recent intensification of aspen management in the central Rocky Mountains has resulted in the establishment of a silviculture research program to meet management needs. A brief history of management and past research in western aspen precedes a discussion of the results and management implications of several current silviculture studies.

1736. Shepperd, Wayne D. 1982. Stand characteristics of Rocky Mountain aspen. *In:* DeByle, Norbert V., editor. Proceedings, situation management of two intermountain species: aspen and coyotes, a symposium. Part I: Aspen; 1981 April 23-24; Logan, UT. Logan, UT: Utah State University: 22-31.

1737. Shepperd, Wayne D. 1981. Variation in growth of Engelmann spruce seedlings under selected temperature environments. Research Note RM-404. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

Seedlings grown with soil temperatures kept higher than air temperatures in the daytime and with soil and air temperatures kept equal at night produced significantly longer and heavier roots than seedlings grown under conditions previously considered optimum (i.e., soil and air temperatures both higher at night than in the daytime).

1738. Shepperd, Wayne D.; Alexander, Robert R. 1983. Overview to silvicultural systems in the central Rocky Mountains. Unnumbered publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 32 p.

1739. Shepperd, Wayne D.; Alexander, Robert R. 1983. Silviculture of lodgepole pine in the central Rocky Mountains. Unnumbered publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, . 36 p.

1740. Shepperd, Wayne D.; Alexander, Robert R. 1983. Silviculture of spruce-fir forests in the central Rocky Mountains. Unnumbered publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.

1741. Shepperd, Wayne D.; Engelby, Orville. 1983. Rocky Mountain aspen. *In:* Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, DC: U.S. Department of Agriculture, Forest Service: 77-79. 191 p.

1742. Shepperd, Wayne D.; Jeffers, Richard M.; Ronco, Frank Jr. 1981. An Engelmann spruce seed source study in the central Rockies. Research Paper RM-231. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Planted Engelmann spruce seedlings from 20 sources throughout North America were field tested in the central Rockies, at 9,600 feet (2,930 m) elevation. Overall survival was 73 percent after 10 years. The results demonstrate that Engelmann spruce planted at high elevations can survive when proper planting techniques and yearly maintenance procedures are used.

1743. Shepperd, Wayne D.; Jones, John R. 1985. Nurse crop. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and management in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 181-184. 283 p.

1744. Shepperd, Wayne D.; McElderry, Sue E. 1986. Ten-year results of a ponderosa pine progeny test in the Black Hills. Western Journal of Applied Forestry. 1(3): 79-83.

Ten-year survival and growth of seedlings from 77 parent trees from throughout the Black Hills were compared, using a cluster-analysis technique. Five clusters are identified that account for most of the variability in survival and growth of the open-pollinated families. One cluster, containing 6 families, exhibited exceptional survival and growth. Another, containing 12 families, exhibited poor survival and growth. The performance of families in these two groups appears to be related to location and elevation of parent trees.

1745. Shepperd, Wayne D.; Mowrer, H. Todd. 1984. Whole stand volume tables for aspen in the Rocky Mountains. Research Note RM-440. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Linear regression equations were developed to predict stand volumes for aspen, given average stand basal area and average stand height. Tables constructed from these equations allow easy field estimation of gross merchantable cubic and board foot scribner rules per acre, and cubic meters per hectare using simple prism cruise data.

1746. Shiflet, Thomas; Snyder, Dale E. 1982. What is mapping? *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Washington, DC: Society of American Foresters: 17-18.

1747. Shigo, Alex L.; Hawksworth, Frank G. 1980. A dwarf mistletoe on red spruce in New Hampshire. Forest Notes. 142: 22-23. (Society for Protection of New Hampshire Forests).

1748. Short, Henry L. 1981. Nutrition and metabolism. *In:* Wallmo, Olof C., editor. Mule and black-tailed deer in North America. Lincoln, NE: Wildlife Management Institute and U.S. Department of Agriculture, Forest Service, University of Nebraska Press: 99-127.

1749. Short, Robert A.; Ward, James V. 1980. Life cycle and production of *Skwala parallela* (Frison) (Plecoptera: Perlodidale) in a Colorado montane stream. Hydrobiologia. 69(3): 273-275.

1750. Short, Robert A.; Ward, James V. 1980. Macroinvertebrates of a Colorado high mountain stream. Southwestern Naturalist. 25(1): 23-32.

1751. Shuler, Craig E.; Markstrom, Donald C.; Ryan, Michael G. 1989. Fibril angle in young-growth ponderosa pine as related to site index, d.b.h., and location in tree. Research Note RM-492. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Young-growth ponderosa pine on two different sites in northern New Mexico were evaluated for differences in fibril angle. Measurements were made radially at the butt end, mid-length, and top end of the merchantable stem divided into multiple 8-foot log lengths. Results indicated that the butt ends have large fibril angles than the other two locations. Fibril angle did not vary significantly with either site index from 55 to 100 or d.b.h. from 9 to 14 inches.

1752. Sidle, Roy C.; Shaw, Charles G., III. 1987. Evaluation of planting sites common to a southeast Alaska clear-cut. IV. Nutrient levels on ectomycorrhizal sitka spruce seedlings. Canadian Journal of Forest Research. 17: 340-345.

1753. Sieg, Carolyn Hull. 1988. Small mammals: pests or vital components of the ecosystem. *In:* Uresk, Daniel W.; Schenbeck, Greg L.; Cefkin, Rose, technical coordinators. Eighth Great Plains wildlife damage control workshop proceedings. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 88-92. 231 p.

Small mammals regarded as "pests" should not be viewed separately from other components in the ecosystem. Small mammals have significant influences on vegetation and soils, exert predatory pressure on other animals, and provide food for predators. Future management efforts should include consideration of these diverse influences.

1754. Sieg, Carolyn Hull. 1988. The value of Rocky Mountain juniper *(Juniperus scopulorum)* woodlands in South Dakota as small mammal habitat. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 328-332. 458 p.

Small mammals and vegetation were sampled over 2 years in Rocky Mountain juniper woodlands and adjacent grassland in South Dakota. Juniper woodlands provided specialized habitat for two woodland species, white-footed mice, and bushy-tailed woodrats, and attracted a number of species generally associated with grasslands.

1755. Sieg, Carolyn Hull; Hodorff, Robert A.; Linder, Raymond L. 1984. Stand condition as a variable influencing wildlife use of green ash woodlands. *In:* Wooded Draws: characteristics and values for the northern Great Plains. Symposium proceedings; 1984 June 12-13; Rapid City, SD. Great Plains Agricultural Council Publication No. 111. Rapid City, SD: South Dakota School of Mines and Technology: 36-39. 52 p.

Based on one season of data, degraded green ash woodlands in northwestern South Dakota supported only half as many birds and fewer numbers of certain mammal species than stands in "good" condition. Additional data and analysis will be used to evaluate these preliminary findings.

1756. Sieg, Carolyn Hull; Uresk, Daniel W.; Hansen, Richard M. 1987. Impact of bentonite mining on selecting arthropods. Journal of Range Management. 40(2): 128-130.

Arthropods were sampled in pitfall traps for 2 years on bentonite mine spoils and adjacent, unmined big sagebrush grasslands in southeastern Montana to assess the impacts of bentonite mining on selected arthropods, evaluate the success of early reclamation efforts in restoring arthropods to mined sites, and to identify limiting factors for colonization of spoils by arthropods. The most significant impacts on selected arthropods were an old, unreclaimed bentonite mine spoils, where after nearly 30 years, numbers of 7 arthropod groups remained lower than on unmined sagebrush grasslands.

1757. Sieg, Carolyn Hull; Uresk, Daniel W.; Hansen, Richard M. 1984. Natural growth of *Atriplex suckleyi* ((Torrey) Rydb.) on bentonite mine spoils in southeastern Montana. *In:* Tiedemann, Arthur R. [and others], compilers. Proceedings of the symposium on the biology of atriplex and related chenopods; 1983 May 2-6; Provo, UT. Ogden, UT: Intermountain Forest and Range Experiment Station: 53-58. 309 p.

The success of rillscale (*Atriplex suckleyi* ((Torrey) Rydb.) on the mine spoils was attributed to its adaptation to the climatic and edaphic conditions of the area, an adequate seed source, and the absence (or near absence) of competing vegetation. Soil compaction, high sodium concentrations, and acidic soils limited growth of rillscale on some mine sites.

1758. **Sieg, Carolyn Hull; Uresk, Daniel W.; Hansen, Richard M. 1983. Plant-soil relationships on bentonite mine spoils and sagebrush-grassland in the northern High Plains. Journal of Range Management. 36(3): 289-294.**

Plant canopy cover, standing crop, and soils were sampled on (1) old (unreclaimed), (2) reclaimed, (3) semireclaimed (newly mined) bentonite mine spoils, and (4) native sagebrush-grass rangelands in southeastern Montana. Soil chemical analyses indicated that low ph, excessive salinity and sodium, plus soil compaction were limiting for plant growth and establishment on bentonite spoils.

1759. **Sieg, Carolyn Hull; Uresk, Daniel W.; Hansen, Richard M. 1986. Seasonal diets of deer mice on bentonite mine spoils and sagebrush grasslands in southeastern Montana. Northwest Science. 60(2): 81-89.**

Deer mice captured on bentonite mine spoils and sagebrush grasslands consumed mainly arthropods and seeds. Arthropod consumption was negatively correlated with availability and positively correlated with precipitation, indicating that deer mice apparently do not seek arthropods as a source of moisture. However, forb consumption was positively correlated with availability and negatively correlated with precipitation, indicating that deer mice eat forbs when available, but in increased amounts during periods of drought. Deer mice selected for specific types of arthropods and plants, but their selectivity may be partly an expression of the habitat.

1760. **Sieg, Carolyn Hull; Uresk, Daniel W.; Hansen, Richard M. 1986. The value of bentonite mine spoils in southeastern Montana as small mammal habitat. Northwest Science. 60(4): 218-224.**

Bentonite mine spoils in southeastern Montana provided foraging sites for some species of small mammals, but failed to provide cover or burrow sites. Habitat conversions resulting from bentonite mining favored foraging by the pioneering species, deer mice and Plains pocket mice, but apparently precluded permanent establishment of any small mammal species. These results indicate the importance of inspecting some study sites for burrows before drawing conclusions on small mammal densities.

1761. **Sieg, Carolyn Hull; Wright, Henry A.; Bjugstad, Ardell J. 1988. Influence of prescribed burning on bur oak woodlands in the Black Hills, South Dakota.** *In:* **Research highlights noxious brush and weed control range and wildlife management. Lubbock, TX: Texas Tech. University: 44.**

1762. **Silvey, William; Rinne, John N.; Sorenson, Roger. 1984. RUN WILD. Wildlife/habitat relationships. Index to the natural drainage systems of Arizona—a computer compatible digital identification of perennial lotic waters. Wildlife Unit Technical Report. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 36 p.**

A computer compatible digitalized listing of all naturally occurring perennial waters in the state of Arizona is provided. The approach utilizes the Arizona resources inventory and RUN WILD systems of storage and retrieval and includes bibliographic references and listings of fishes for all streams where data are available.

1763. **Simpson, C. David, editor. 1980. Proceedings of the symposium on ecology and management of barbary sheep. Lubbock, TX: Department of Range and Wildlife Management, Texas Tech. University. 112 p.**

Since the first release of barbary sheep to the wild, in the United States, in the late 1930's, this exotic ungulate has shown considerable ability to adapt to varying local conditions. Their rapid spread represents a problem to planned resource management. This symposium was organized to synthesize existing biological knowledge on this species, as well as to develop guidelines for future management-oriented research on barbary sheep.

1764. **Simpson, C. David; Bolen, Eric G.; Moore, Richard L.; Stormer, Fred A. 1981. Significance of playas to migratory wildlife.** *In:* **Playa Lakes symposium proceedings; 1979 December 4-5; Arlington, TX. FWS/OBS-81/07. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 35-45.**

1765. **Simpson, C. David; Krysl, Leslie J.; Dickinson, Tony G. 1980. Food habits of barbary sheep in the Guadalupe Mountains, New Mexico.** *In:* **Simpson, C. David, editor. Proceedings of the symposium on ecology and management of barbary sheep; 1979 November 19-21; Texas Tech. University, Lubbock, TX. Lubbock, TX: Department of Range and Wildlife Management, Texas Tech. University: 87-91.**

1766. Smego, James H.; Switzer, William E.; Betters, David R.; Donnelly, Dennis M.; Worth, Harold E. 1984. Timber utilization and marketing alternatives for Colorado and Wyoming. Resource Bulletin RM-7. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.

Profitable wood product mill operation in Colorado and Wyoming depends on market area, product, mill capacity, and characteristics of the available timber. This study shows how these factors affect timber marginal value and makes the connection between profitable wood products operations and the opportunities to manage woodlands.

1767. Smith, Federick W.; Schuler, Thomas M. 1988. Yields of southwestern pinyon-juniper woodlands. Western Journal of Applied Forestry. 3(3): 70-74.

1768. Smith, Frederick W.; Schuler, Thomas M. 1987. Assessment of site quality in pinyon-juniper woodlands. *In:* Everett, Richard L., compiler. Proceedings, pinyon-juniper conference. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 260-265.

1769. Smith, H. Dwain; Stormer, Fred A.; Godfrey, Ralph D. 1981. A collapsible quail trap. Research Note RM-400. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.

The trap is made of 14-gage, galvanized, welded, wire fabric. The hinged design of the sides with the top allows disassembly into a light weight, flat, compact unit, which can be easily transported in quantity.

1770. Smith, J. A.; Tzeu, Lie; Ranson, K. J. 1980. The lambertain assumption and LANDSAT data. Photogrammetric Engineering and Remote Sensing. 46(9): 1183-1189.

1771. Smith, Mark A.; Baltensperger, Arden A. 1983. Agronomic and acetylene reduction evaluation of three annual medics. Journal of Range Management. 36(1): 55-57.

1772. Smith, Mark A.; Baltensperger, Arden A. 1984. Field performance of three annual medics. Research Report 525. Las Cruces, NM: New Mexico Agriculture Experiment Station. 4 p.

1773. Smith, Mark A.; Baltensperger, Arden A. 1984. Productivity and nitrogen content of tall fescue grown in association with legumes. Research Report 544. Las Cruces, NM: New Mexico Agriculture Experiment Station. 4 p.

1774. Smith, V. Kerry. 1988. Intrinsic values in benefits cost analysis. *In:* Toward the measurement of total economic value. General Technical Report RM-148. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 27-35. 44 p.

1775. Snook, Paul W.; Winterberger, Kenneth C.; Merritt, Norman E.; Czaplewski, Raymond L. 1987. Comparison between digital and manual interpretation of high altitude aerial photographs. Photographic Engineering and Remote Sensing. 53(5): 531-534.

Second generation color infrared transparencies of the Tanana River Basin in Alaska were digitized using a scanning microdensitometer. Unsupervised clustering was performed independently on each of the 20 digital images. Area estimates from 208-hectare sample plots were obtained by manual and computer aided interpretations. Manual interpretation of large-scale (L:3,000) photographs and ground truth served as reference. Computer-aided interpretation was consistently more accurate than the manual interpretation when compared to reference. However, the time and cost for digital processing was much higher than manual interpretation if information for only a small portion (e.g., and 8-ha plot) of the digital image is required.

1776. Snyder, Dale E. 1982. Soil measurements for multiresource inventories. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 333-338. 1101 p.

1777. Sommerfeld, Richard A. 1980. Acoustic emissions from unstable snow slopes. *In:* Hardy, H. Reginold, Jr.; Leighton, Frederick W., editors. Proceedings of the second conference on acoustic emission/microseismic activity in geologic structures and materials; 1978 November 13-15; University Park, PA. Rockport, MA: Trans. Technical Publication: 319-329.

Acoustic emissions in the 5- to 125-hz range can be used to predict larger snow avalanches. If interference

from extraneous noises can be suppressed, the noises emanating from snow could be used to predict most avalanches.

1778. Sommerfeld, Richard A. 1980. An alternate statistical interpretation of the strength of snow: comments on the paper by H. Gubler. Journal of Glaciology. 22(88): 560-561.

Theoretical models for the strength of snow, in some circumstances, may cease to be adequate. Further progress in finding the most appropriate model and its range of applicability seems most likely to be achieved by experimental work.

1779. Sommerfeld, Richard A. 1982. The big shear frame. Avalanche Review. 1(2): 3.

1780. Sommerfeld, Richard A. 1983. A branch grain theory of temperature gradient metamorphism. Journal of Geophysical Research. 88(2): 1484-1494.

The major features of temperature gradient metamorphism of snow can be explained by a branch grain theory which assumes (1) at growth sites the thermal gradient is a function of crystal separation and (2) vapor flux is a function of local thermal gradient. A comparison of theory and experiment shows very good, but not perfect, agreement.

1781. Sommerfeld, Richard A. 1984. Comments of "Theory of metamorphism of dry snow" by S. C. Colbeck. Journal of Geophysical Research. 89(D3): 4963-4964.

This paper refers to an apparent logical contradiction in Colbeck's formulation of crystal growth under a thermal gradient.

1782. Sommerfeld, Richard A. 1986. Impurities on the surface of ice. *In:* Pielke, Roger A., editor. Acid deposition in Colorado—a potential or current problem; local versus long-distance transport into the state: proceedings of a Cooperative Institute for Research in the Atmosphere; 1986 August 13-15; Fort Collins, CO. Fort Collins, CO: Colorado State University: 133-139.

1783. Sommerfeld, Richard A. 1984. Instructions for using the 250 cm² shear frame to evaluate the strength of a buried snow surface. Research Note RM-446. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Proper use of the shear frame following the instructions presented here will give accurate measurements of the strength of a weak surface within the snowpack. The method requires the use of the 250 cm² shear frame. It also requires a minimum of 21 measurements on each surface and a calculation that estimates the large-surface strength from the small-surface tests.

1784. Sommerfeld, Richard A. 1982. A review of snow acoustics. Reviews of Geophysics and Space Physics. 20(1): 62-66.

Snow acoustics can be divided into two major areas: (1) the attempt to understand the acoustic properties of snow and to relate them to other material properties, and (2) acoustic emissions. High-frequency acoustic emissions have aided in the development of a texture-oriented consecutive relationship. Low-frequency acoustic emissions have been shown to have the potential for predicting avalanches, at least under some conditions.

1785. Sommerfeld, Richard A. 1984. The solunar tides and avalanche hazard. Avalanche Review. 2(5): 5.

1786. Sommerfeld, Richard A. 1980. Statistical models of snow strength. Journal of Glaciology. 26(94): 217-223.

Because snow is variable in both time and space, a complete understanding of snow strength must include statistical strength analysis. Two types of statistical strength theories are the series-element, or weakest-link theories, and the parallel-element theories. In each case, large-volume, low-stress-rate strengths are predicted using small-volume, high-stress-rate data.

1787. Sommerfeld, Richard A. 1985. Temperature gradient weakening in snow. Research Note RM-449. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

When snow of densities lower than about 250 kg/m³ metamorphoses under a temperature gradient, large crystals form, and the snow becomes weaker. These crystals form at selected sites as branch grains, because the local temperature gradient is increased at such sites. Calculations using a simple one-dimensional model of the process show that the geometrical relationships of the snow grains can explain the major features of temperature gradient metamorphism.

1788. **Sommerfeld, Richard A. 1987. Temperature gradient driven vapor transport in snow. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 231-234. 253 p.**

Snow is a good insulator. The first snow layer of the season traps the heat that has been stored in the ground during the summer. This heat is slowly released to flow through the snow to the colder, upper surface of the snowpack. Part of the heat flow is carried by water molecules that move from the warmer to the colder grains. This temperature driven vapor flow causes extensive recrystallization in a process called temperature gradient metamorphism. Normal temperature fluctuations, and the snow's layered structure complicate the process. However, a simple system with a constant difference across a uniform snow layer can provide the information necessary for understanding the more complex system. Such a simple system is easily maintained in a cold laboratory.

1789. **Sommerfeld, Richard A. 1983. Texture and temperature. Avalanche Review. 1(4): 1, 8.**

1790. **Sommerfeld, Richard A.; Freeman, Tara L. 1988. Making artificial snow for laboratory use. Research Note RM-486. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 3 p.**

Ice spheres with a mean radius of 100 micrometers can be produced using a sonic nebulizer at 20 khz. A collection of these spheres makes a very uniform type of artificial snow that is useful for laboratory experiments.

1791. **Sommerfeld, Richard A.; Friedman, Irving; Nilles, M. A. 1987. The fractionation of natural isotopes during temperature gradient metamorphism of snow. *In:* Jones, H. G.; Orville-Thomas, W. J., editors. Seasonal snowcovers: physics, chemistry, hydrology. NATO ASI Series C: Mathematical and Physical Sciences (211). D. Reidel Publishing Company: 95-105.**

Changes in the ratios of the naturally occurring isotopes HDO and H_2 18° occur when a layer of snow gains or loses mass. These changes can be used to measure the mass transport across a horizon. Measurement of the temperature gradient across the horizon allows one to calculate the effective diffusion coefficient. Preliminary experiments indicate that the effective diffusion coefficient is approximately twice that of water vapor in air. The enhancement is probably the result of the geometry of the ice network.

1792. **Sommerfeld, Richard A.; Gubler, Hans. 1983. Snow avalanches and acoustic emissions. Annals of Glaciology. 4: 271-276. (Proceedings of the second symposium on applied glaciology, 1982 August 23-27, Hanover, NH. Sponsored by the International Glaciological Society, Cambridge, England).**

Analysis of several years of data show that acoustic emission activity is higher from unstable snow packs than from stable snow packs. A foam-mounted geophone set into the snow near active layers appears to be the best sensor now available.

1793. **Sommerfeld, Richard A.; King, Rudy M.; Bowles, J. R. 1984. Avalanche hazard and the solunar cycle. *In:* Proceedings of the international snow science workshop; 1984 October 24-27; Aspen, CO. P.O. Box 4446, Aspen, CO: ISSW Workshop Committee: 133-142. 218 p.**

A statistical analysis of avalanche accidents in North America indicated that there is a strong relationship between accidents and time of day because of variations in the exposure of people to potential avalanches with time of day. No relationship of solunar tidal forces was found.

1794. **Sommerfeld, Richard A.; Lamb, D. 1986. Comment on Cadle, S. H.; Dasch, J. M.; Mulawa, P. A. "Atmospheric concentrations and the deposition velocity to snow of nitric acid, sulfur dioxide and various particulate species. Atmospheric Environment. 21(1): 260-261.**

1795. **Sommerfeld, Richard A.; Lamb, D.; Blumenstein, R. 1986. Laboratory studies of the interactions of SO_2 and ice. *In:* Proceedings of the 23rd conference on radar meteorology and the conference on cloud physics; 1986 September 22-26; Snowmass, CO. Boston, MA: American Meteorological Society.**

Snow on the ground and much liquid precipitation begins as ice crystals formed in the atmosphere. The ability to quantify the amounts of such substances acquired and transported by ice under different conditions is very important in understanding the effects of pollutant source levels on receptor areas in climates

where ice processes are important in the atmosphere. This understanding is crucial to the ability to set rational standards for pollution emissions.

1796. Sommerfeld, Richard A.; Lamb, D. 1986. Preliminary measurements of SO_2 absorbed on ice. Geophysical Research Letters. 13(4): 349-351.

Three absorption isotherms of sulfur dioxide on ice were measured at -3°, -11°, and -30° C in the sulfur dioxide concentration range of 0.3 to 6 ppmv. The isotherms indicated that there is a strong increase of adsorption as the temperature rises toward the melting point. This behavior may correlate with the presence of a "quasi-liquid" layer on the surface of ice. If this behavior is typical of impurity adsorption on ice, it is important in the processes that govern the acquisition, transport, and storage of atmospheric pollutants by snow.

1797. Sommerfeld, Richard A.; Vertucci, Frank A.; Wooldridge, Gene L. 1989. An estimate of the snow input to a small alpine catchment. *In:* Ninth Annual American Geophysical Union, Front Range Branch, Hydrology Days; 1989 April 18-21; Fort Collins, CO. 101-106.

1798. Sorensen, Darwin L.; Fresquez, Philip R. 1985. Patterns of denitrification in reclaimed minespoils in the arid Southwest. *In:* Williams, Dean; Fisher, Scott E., Jr., editors. Proceedings of the second annual meeting of the American Society for Surface Mining and Reclamation; 1985 October 8-10; Denver, CO. Princeton, WV: American Society for Surface Mining and Reclamation: 227-331. 412 p.

Irrigation and occasional heavy rains or snowmelt may lead to anaerobic conditions in replaced and revegetated soils or spoils providing opportunities for nitrogen loss through denitrification. Using the acetylene block technique, samples of spoil and replaced topsoil from a surface coal mine in northwestern New Mexico were assayed for denitrification potential by enriching the sample with nitrate nitrogen and glucose. Apparently denitrification is highest where levels of nitrate are high and the spoil material is less permeable.

1799. Sorg, Cindy F.; Donnelly, Dennis M.; Loomis, John B.; Peterson, George L. 1984. Implications of economics as applied to wild trout fisheries management in Idaho. *In:* Richardson, Frank; Hamre, Robert H., editors. Wild Trout III. Proceedings of the symposium; 1984 September 24-25; Yellowstone National Park, WY. Vienna, VA: Trout Unlimited: 187-191. 192 p.

The economics of resource allocation is explored especially as it applied to the wild trout fisheries in Idaho. Values associated with wild trout fishing are identified and explained, as well as methods to derive these values. These concepts and methods are then applied to a case study based on data collected in Idaho in 1983. A hypothetical management situation is developed to show appropriate use of the values derived.

1800. Sorg, Cindy F.; Loomis, John B. 1986. Economic value of Idaho sport fisheries—an update. North American Journal of Fisheries Management. 6: 494-503.

Improvements in nonmarket valuation techniques were explored, especially as they apply to sportfishing in Idaho. Definitions and appropriate use of the terms expenditures, consumer surplus, net value, and maximum net revenue were clarified. Advancement in the travel cost and contingent value methods are outlined. The results of the 1983 angler survey of net values for cold-water, warm-water, and steelhead fishing were $42.93, $42.18, and $27.87 per day, respectively, according to the travel cost method. By the contingent value method, net cold-water, warm-water, and steelhead fishing values per day were $22.52, $16.35, and $31.45, respectively.

1801. Sorg, Cindy F.; Loomis, John B. 1984. Empirical estimates of amenity forest values: a comparative review. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.

Comparisons of empirical estimates of the values of wildlife, wilderness, and general recreation require that the values are based on comparable methodologies and comparable units of measurement. Adjustments necessary to allow such comparisons are outlined and are applied to an extensive database of valuation studies.

1802. Sorg, Cindy F.; Loomis, John B. 1985. An introduction to wildlife valuation techniques. Wildlife Society Bulletin. 13: 38-46.

This paper explains the difference between the efficiency measure of the value of wildlife and traditional expenditure measures, in the context of hunting. It discusses techniques for emperically estimating net willingness to pay and outlines methodological adjustments necessary to allow comparisons of wildlife values across studies. To illustrate the process, these adjustments are applied to past big game hunting studies; then, possible hypotheses to explain remaining value discrepencies are presented.

1803. **Sorg, Cindy F.; Loomis, John B.; Donnelly, Dennis M.; Peterson, George L.; Nelson, Louis J. 1985. Net economic value of cold and warm water fishing in Idaho. Resource Bulletin RM-11. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p.**

Net willingness to pay for cold and warm water fishing in Idaho was estimated at $42.93 and $42.18 per trip, respectively, with the travel cost method, and at $22.52 and $16.35 per trip, respectively, with the contingent value method. Willingness to pay was greater for increased catch or fish size.

1804. **Sorg, Cindy F.; Nelson, Louis J. 1986. Net economic value of elk hunting in Idaho. Resource Bulletin RM-12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 21 p.**

Net willingness to pay in addition to actual expenditure for elk hunting in Idaho was estimated at $63.17 per trip and $99.82 per trip using a standard cost per mile travel cost method and a reported cost per mile travel cost method, respectively. Using the contingent value method, the values for the 1982 and 83 elk hunting seasons were $51.84 per trip and $92.54 per trip, respectively. Willingness to pay was greater for double number of elk seen on a trip. Methods, results, and applications are fully described.

1805. **Sorg, Cindy F.; Nelson, Louis J. 1987. Net economic value of waterfowl hunting in Idaho. Resource Bulletin RM-14. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 18 p.**

Average net willingness to pay for waterfowl hunting in Idaho was estimated at $22.25 per trip and $32.79 per trip, using the travel cost method with a standard cost per mile and a reported cost per mile, respectively. Using the contingent value method, a net value of $16.87 was estimated for the last trip of the season. Willingness to pay was greater for double the number of opportunities to shoot. methods, results, and applications are fully described.

1806. **Sorg, Cindy F.; Thomas, Michael; Donnelly, Dennis M. 1989. Economic value of big game hunting in southeast Alaska. Resource Bulletin RM-16. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.**

Surveys in southeast Alaska in 1984 and 1985 were the basis for estimating net willingness to pay of hunters. Net willingness to pay was highest for resident deer hunters ($331) and lowest for nonresident moose hunters ($55). Relationship between willingness to pay and expenditures is discussed.

1807. **Spreitzer, Patricia N. 1985. Transitory range: a new frontier. Rangelands. 7(1): 33-34.**

This article summarizes the findings of transitory range research in the South. This research serves to support the biological and economic feasibility of livestock and timber production on the same land. The biological concerns addressed include tree canopy influences, livestock and wildlife interactions, and livestock influences on seedlings. The economic feasibility is evaluated by rates of return and other indirect benefits.

1808. **Squillace, A. E.; Schreuder, Hans T.; Bhattacharyya, Helen T. 1980. Identification of seed origin of slash pine plantations. Silvae Genetica. 29(3-4): 152-154.**

Likelihood analysis of monoterpene composition in slash pine is shown to be a useful tool for ranking possible geographic origins of slash pine plantations. The procedure could also be used to check suspected errors in provenance study plots and in seed certification. Additional information such as morphological traits and historical records should also be used when available.

1809. **Stack, Robert W.; Riffle, Jerry W. 1986. Mycosphaerella leaf spots of ash. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 14-15. 149 p.**

1810. **Staley, John M.; Nicholls, Thomas H. 1989. Lophordermium needle cast. Agriculture Handbook 680. Washington, DC: U.S. Department of Agriculture. 1184 p.**

1811. Staley, John M.; Raymond, Gerry; Harvey, George M. [and others]. 1981. Control of *Lophodermium* needlecast in Pacific Northwestern Scotch pine. Northwest Lookout. 14(2): 36-40.

In the Pacific Northwest, three *Lophodermium* species cause foliar damage to Scotch pine Christmas trees. Of several chemicals tested, maneb was most cost effective. The presence of one species *(L. seditiosum)* in plantings is clearly related to sanitary conditions in the source nursery. For the other two species, this same relation is probable, but not so easily evaluated.

1812. Stednick, John D. 1987. The potential of subalpine forest management practices on sediment production. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 95-100. 253 p.

1813. Steuter, Allen E. 1980. Wildlife response to prescribed burning in the Rio Grande Plains. *In:* Proceedings, prescribed range burning in the Rio Grande Plains of Texas; 1979 November 7; Carrinzo Springs, TX. College Station, TX: Texas Agricultural Extension Service: 34-43.

1814. Stevens, Robert E. 1986. Life history and habits of *Exoteleia anomala* Hodges, a ponderosa pine needle miner in the southwestern United States (Gelechiidae). Journal of the Lepidopterists' Society. 40(1): 23-26.

Exoteleia anomala, the larvae of which mine needles of ponderosa pine in Arizona and New Mexico, has a one-year life cycle similar to that of several species of needle-mining Coleotechnites. Each larva requires two needles to complete development. when numerous, larvae can cause highly visible foliage damage, but outbreaks do not appear to persist.

1815. Stevens, Robert E.; Brewer, J. Wayne; Leatherman, David A. 1980. Insects associated with ponderosa pine in Colorado. General Technical Report RM-75. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 42 p.

Ponderosa pine serves as a host for a wide variety of insects. Many of these, including all the particularly destructive ones in Colorado, are discussed in this report. Included are a key to the major insect groups, an annotated list of the major groups, a glossary, and a list of references.

1816. Stevens, Robert E.; Brewer, J. Wayne; Leatherman, David A. 1982. Insects associated with ponderosa pine in the Rocky Mountains and the Southwest. General Technical Report RM-94. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.

Ponderosa pine serves as a host for a wide variety of insects. Many of these, including all the particularly destructive ones in the area, are discussed in this booklet. Included are a key to the major insect groups, an annotated list of the major groups, a glossary, and a list of references. This report supersedes USDA Forest Service General Technical Report RM-75.

1817. Stevens, Robert E.; Carolin, V. M., Jr.; Stein, Catherine. 1983. *Lepidoptera* associated with western spruce budworm in the southwestern United States. Journal of the Lepidopterists' Society. 37(2): 129-139.

Western spruce budworm, *Choristoneura occidentalis* Freeman (Tortricidae), is an important pest of Douglas-fir and white fir in the southwestern United States. Notes are presented on species' life history and field identifying features in late larval and adult stages.

1818. Stevens, Robert E.; Carolin, V. M., Jr.; Markin, George P. 1985. *Lepidoptera* associated with western spruce budworm. Agriculture Handbook 622. Washington, DC: U.S. Department of Agriculture, Forest Service. 63 p.

1819. Stevens, Robert E.; Hawksworth, Frank G. 1984. Insect-dwarf mistletoe associations: an update. *In:* Hawksworth, Frank G.; Scharpf, Robert F., technical coordinators. Biology of dwarf mistletoes: proceedings of the symposium; 1984 August 8; Fort Collins, CO. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 94-101. 131 p.

Many insects of dwarf mistletoes have been identified but much more research will be needed before their potential as practical biological control agents can be assessed.

1820. Stevens, Robert E.; Leatherman, David A. 1982. Implants and sprays for control of ponderosa pine needle miner in foliage of individual trees. Research Note RM-420. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Acephate implants and acephate and permethrin foliar sprays all reduced numbers of ponderosa pine needle miners to acceptable levels. Implant-treated trees also remained relatively free of infestation the second year after treatment.

1821. Stevens, Robert E.; Leatherman, David A.; Brewer, J. Wayne. 1983. Ponderosa pine needle miners. Service in Action Leaflet 5.544. Fort Collins, CO: Colorado State University, Extension Service. 2 p.

1822. Stevens, Robert E.; McCambridge, William F.; Edminster, Carleton B. 1980. Risk rating guide for mountain pine beetle in Black Hills ponderosa pine. Research Note RM-385. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 2 p.

Average tree diameter, stand density, and stand structure are key elements used in the rating. Single storied stands are most susceptible to heavy mountain pine beetle damage. Risk increases with d.b.h., reaching a maximum when trees are 12 inches d.b.h. and larger. During buildup of an outbreak, denser stands within a given mean diameter are more susceptible to invasion.

1823. Stevens, Robert E.; Merrill, L. D.; Brewer, J. Wayne. 1989. *Dioryctria albovittella* (Hulst) (Lep., Pyralidae) in shoots and cones of pinyon (*Pinus edulis* Engelm.) in Colorado. Journal of Applied Entomology. 105: 387-392.

1824. Stevens, Robert E.; Sartwell, Charles Jr; Koerber, Thomas W.; Powell, Jerry A.; Daterman, Gary E.; Sower, Lonne L. 1985. Forest tortricids trapped using *Eucosma* and *Rhyacionia* synthetic sex attractants. Journal of the Lepidopterists' Society. 39(1): 26-32.

Moths of 31 non-target species of Tortricidae (30 Olethreutinae, 1 Tortricinae) were lured to synthetic *Eucosma* and *Rhyacionia* sex attractants deployed in pine forests throughout 12 states in the western United States. Genera represented include *Petrova, Barbara, Phaneta, Eucosma, Epiblema, Epinotia, Ancylis, Dichrorampha, Sereda, Grapholita, Cydia,* and *Decodes,* as well as new genus near *Rhyactonia.*

1825. Stevens, Robert E.; Sartwell, Charles Jr; Koerber, Thomas W.; Daterman, Gary E.; Sower, Lonne L.; Powell, Jerry A. 1980. Western *Rhyacionia* (Lepidoptera: Tortricidae, Olethreutinae) pine tip moths trapped using synthetic sex attractants. Canadian Entomologist. 112: 591-603.

Synthetic sex attractants were used to trap *Rhyacionia* pine tip moths throughout the western United States, in spring and early summer 1977 and 1978. Some species were shown to have much wider distributions than previously known. Species trapped included *Zozana, Neomexicana, Salmonicolor, Monophylliana, Jenningsi, Multilineata, Busckana,* and *Fumosana.*

1826. Stocker, David W.; Stedman, Donald H.; Massman, William J.; Zeller, Karl F.; Fox, Douglas G. 1989. Measurement of the dry deposition of nitrogen oxides to a prairie ecosystem by eddy correlation. *In:* 82nd annual meeting of AWMA; 1989 June 25-30; Anaheim, CA. 16 p.

1827. Stoecker, Arthur; Mathia, Gene A.; Cardwell, Harlan T.; Knight, Alan. 1981. Economic considerations of Playa Lake enhancements for wildlife. *In:* Playa Lakes symposium proceedings. FWS/OBS-81/07. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 112-123.

1828. Stokes, Marvin A.; Dieterich, John H. 1980. Proceedings of the fire history workshop; 1980 October 20-24; Tucson, AZ. General Technical Report RM-81. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 142 p.

The purpose of the workshop was to exchange information on sampling procedures, research methodologies, preparation and interpretation of specimen material, terminology, and the application and significance of findings, emphasizing the relationship of dendrochronology procedures to fire history interpretations.

1829. Stoll, John R.; Gregory, Robin. 1988. Overview. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 3-6.

1830. Stormer, Fred A. 1981. Characteristics of scaled quail loafing coverts in northwest Texas. Research Note RM-395. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Cholla cactus *(Opuntia imbricata)* provided cover in 85 percent of scaled quail *(Callipepla squamata)* loafing coverts during winter and spring. All coverts had a band of lateral cover within the canopy of the overhead shrub. Two to five paths through the lateral cover led to a central, vegetation-free area.

1831. Stormer, Fred A. 1984. Night-roosting habitat of scaled quail. Journal of Wildlife Management. 48(1): 192-197.

This paper describes the floristic and structural features of roost habitat used by scaled quail during winter and spring, a period when cover frequently is limited.

1832. Stormer, Fred A.; Bolen, Eric G.; Simpson, C. David. 1981. Management of Playas for migratory birds—information needs. *In:* Playa Lakes symposium proceedings. FWS/OBS-81/07. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 52-61.

1833. Stormer, Fred A.; Guthery, Fred S. 1982. Irrigation and wildlife in the southern and central Great Plains. *In:* Proceedings of the Great Plains Agricultural Council; 1982 June 7-9; North Platte, NE. Lincoln, NE: Great Plains Agricultural Council: 41-48. 81 p.

Because irrigation has and still is encouraging conversion of native ranges to cropland, it leads to a loss of or reduction in many native wildlife species, which are replaced by species better adapted to using crops and crop residues. Drafting of groundwater has been implicated in the loss of riparian habitats on the southern high Plains; Sandhill Wetlands of Nebraska also are sensitive to groundwater removal.

1834. Stormer, Fred A.; Valentine, Gary L. 1981. Management of shelterbelts for wildlife. *In:* Windbreaks—agriculture: a new beginning: proceedings of the 33rd annual meeting of the forestry committee; 1981 June 16-18; Lubbock, TX. Publication 102. Lincoln, NE: Great Plains Agricultural Council: 169-181.

1835. Stottlemyer, Robert. 1987. Natural and anthropic factors as determinants of long-term stream chemistry. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 86-94. 253 p.

1836. Stottlemyer, Robert; Hanson, D. Jr. 1989. Atmospheric deposition and ionic concentrations in forest soils of Isle Royale National Park, Michigan. Soil Science Society of America Journal. 53(1): 270-274.

1837. Stottlemyer, Robert; Troendle, Charles A. 1989. Factors responsible for long-term trends in stream water chemistry, Fraser Experimental Forest, Colorado. *In:* Poppoff, I. G.; Goldman, G. R.; Loeb, Stanford L.; Lunapold, L. G., editors. International mountain watershed symposium; 1988 June 8-10; Lake Tahoe, CA. Lake Tahoe, CA: Tahoe Resource Conservation District: 111-136.

1838. Stottlemyer, Robert; Troendle, Charles A. 1987. Trends in streamwater chemistry and input-output balances, Fraser Experimental Forest, Colorado. Research Paper RM-275. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.

Precipitation chemistry on the Fraser Experimental Forest is some of the least altered in Colorado. Volume weighted mean pH is 5.32 (4.8 eq/l, nitrate concentration is 9.7 eq/l, and sulfate l6.6 eq/l. Calcium and sulfate are the dominant ionic inputs; calcium and bicarbonate are the dominant stream outputs. Calcium and sulfate show a significant (p 0.01, Kendall's TAU) increase in stream concentration (unweighted) from 1965 to 1984.

1839. Stottlemyer, Robert; Troendle, Charles A. 1988. Trends in streamwater chemistry and input-output balances, alpine and subalpine forests, Fraser Experimental Forest, Colorado. Research program for 1987. Houghton, MI: U.S. Department of Interior, National Park Service, Great Lakes Area, Resource Studies Unit; in cooperation with Department of Biological Sciences, Michigan Technological University: 15-17.

1840. Strauss, Charles H. 1986. Scheduling whitewater boating usage on the Lehigh River. *In:* Proceedings 1984 national river recreation symposium; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 316-326.

1841. Strauss, Charles H.; Lord, Roger G. 1989. An application of FORPLAN for regional timber projections. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 101-109. 278 p.

1842. Streeter, Robert G.; Chalk, David E.; Thomas, Carl H.; Krohn, William B. 1983. National appraisal for wildlife habitat: from inventory to management. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference, renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 674-677.

1843. Stroo, Hans F.; Reich, Peter B.; Schoettle, Anna W.; Amundson, Robert G. 1988. Effects of ozone and acid rain on white pine *(Pinus strobus)* seedlings grown in five soils. II. Mycorrhizal infection. Canadian Journal of Botany. 66(8): 1510-1516.

1844. Sturges, David L. 1986. Benefits of snow management and N fertilization on sagebrush range. *In:* Steppuhn, H.; Nicholaichuk, W., editors. Proceedings of the symposium on snow management for agriculture. Great Plains Agricultural Council Publication No. 120. Lincoln, NE: University of Nebraska: 403-430. 716 p.

Crested wheatgrass planted in 3-m wide strips spaced at 3-m intervals significantly increased snow retention on a windswept sagebrush rangeland site in Wyoming. Each additional centimeter of soil water recharge from snow increased production of sagebrush vegetation by 59 kg/ha. Productivity increased about 25 kg/ha per 1 kg/ha addition of nitrogen for both vegetation types; water-use efficiency also increased linearly with increasing fertilization. Total herbaceous productivity of grass strips was significantly greater than that of sagebrush strips at similar fertilization levels. Forage production of unfertilized sagebrush vegetation within the stripped area, and 4.2 times greater than on adjacent rangeland.

1845. Sturges, David L. 1984. Comparison of precipitation as measured in gages protected by an alter shield, Wyoming shield, and stand of trees. *In:* Proceedings of the Western Snow Conference, 52nd annual meeting; 1984 April 17-19; Sun Valley, ID. Spokane, WA: Executive Secretary of the Conference: 57-67. 192 p.

This study compared monthly precipitation recorded at gages protected by a Wyoming shield, and by a modified alter shield, with precipitation measured in nearby forest stands which provided protection from wind. A relationship to predict undermeasurement of precipitation at the gage protected by the wyoming shield in relation to wind-speed also was developed.

1846. Sturges, David L. 1983. Establishment and growth of shelterbelts species and grass barriers on windswept Wyoming rangeland. Transportation Research Record. 913: 4-11.

Survival and growth of six traditional shelterbelt species and three rangeland shrubs were evaluated for 6 years at a windswept site adjacent to Interstate-80 in south-central Wyoming. The effect of creating grass strips to increase on-site snow retention and reduce snow relocation on sagebrush rangeland was also investigated. The grass stand caused on-site snow retention to double. Winter snow accumulation behind a snow fence decreased about 20 percent because of reduced snow relocation.

1847. Sturges, David L. 1989. Evaporation and seepage from a livestock reservoir equipped with a snow fence for water recharge. *In:* 57th western snow conference: proceedings of the conference; 1989 April 18-20; Fort Collins, CO. Fort Collins, CO: Colorado State University: 9-20.

Net evaporation and seepage accounted for 9% and 91% of seasonal water loss at a small livestock reservoir equipped with a snow fence for water supply. Losses at a second snow-fenced reservoir attributable to cattle consumption, new evaporation, and seepage were 2%, 9%, and 89%, respectively.

1848. Sturges, David L. 1983. Long-term effects of big sagebrush control on vegetation and soil water. Journal of Range Management. 36(6): 760-765.

Soil water and vegetation responses of mountain big sagebrush rangeland sprayed with 2,4-D are presented through 11 years after treatment. Herbaceous productivity of treated areas remained high. Mathematical relationships relating seasonal water depletion to number of years since sagebrush control are presented.

1849. Sturges, David L. 1986. Precipitation measured by dual gages, Wyoming-shielded gages, and in a forest opening. *In:* **Kane, Douglas L., editor. Proceedings of the symposium: cold regions hydrology. Bethesda, MD: American Water Resources Association: 387-396.**

Wyoming-shielded gages undermeasured precipitation received as snow, but not as rain. Dual gages provided precipitation estimates similar to measurements in a forest opening in 8 of 12 months. Relationships were developed to predict precipitation undermeasurement by a Wyoming-shielded gage based on storm wind speed, or day number.

1850. Sturges, David L. 1986. Responses of vegetation and ground cover to spraying a high elevation, big sagebrush watershed with 2,4-D. Journal of Range Management. 39(2): 141-146.

Total production of aboveground biomass on a 238-ha watershed was not affected when big sagebrush was controlled by aerial application of 2,4-D. Grass production increased in the 5 years following treatment, but forb production was not affected by treatment because forbs were in an early phenological stage when sprayed. Five years after treatment, there was a 37% decrease in bare ground and a 29% and 61% increase in letter and grass cover, respectively, on the treated watershed compared to an adjacent untreated watershed.

1851. Sturges, David L. 1989. Response of mountain big sagebrush to induced snow accumulation. Journal of Applied Ecology. 26: 1035-1041.

Mountain big sagebrush was eliminated downwind of a 3.8-m snow fence 3 years after fencing. A critical snow depth for sagebrush survival of 2.8 m was estimated for the study site. Snow deposition increased for 50 m upwind of the fence, but not enough to affect survival of mountain big sagebrush.

1852. Sturges, David L. 1983. Shelterbelt establishment and growth at a windswept Wyoming rangeland site. Research Paper RM-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

Survival and growth of six shelterbelt tree and shrub species and three rangeland shrubs were evaluated for 5 years at a planting site adjacent to Interstate 80 in south-central Wyoming. Depredation by rodents at the rangeland site limited establishment and growth of some species more severely than did the harsh climate.

1853. Sturges, David L. 1986. Snow fencing to increase streamflow: preliminary results. *In:* **54th annual meeting western snow conference; 1986 April 15-17; Phoenix, AZ. Spokane, WA: Western Snow Conference: 18-29. 198 p.**

This paper discusses results from a paired watershed study in which a large snow fence was placed on a sagebrush-covered watershed to trap drifting snow and increase water yield. Streamflow and sediment transport characteristics were measured 10 years preceding fence installation and the specific conductance of water was measured for 2 years. Study results are reported here for the first 2 years after fence construction.

1854. Sturges, David L. 1980. Soil water withdrawl and root distribution under grubbed, sprayed, and undisturbed big sagebrush vegetation. Great Basin Naturalist. 40(2): 157-164.

Seasonal depletion by vegetation where sagebrush was selectively removed by grubbing and where sagebrush was sprayed with 2,4-D was 33 and 12 percent less, respectively, than that for undisturbed big sagebrush vegetation, in the surface 122 cm of soil. Differences were located primarily below 61 cm in vegetation grubbed the previous fall, and below 91 cm in vegetation sprayed 3 years previously. Total root weights under grubbed and sprayed vegetation were 29 and 16 percent less, respectively, than for undisturbed big sagebrush vegetation. Total herbaceous production by grubbed and sprayed vegetation was 69 and 43 percent less, respectively, than production by undisturbed vegetation.

1855. Sturges, David L. 1988. Water potential from blowing snow management. *In:* **Thirty-ninth Annual Meeting Great Plains Agricultural Council Forestry Committee; 1987 June 22-25; Cheyenne, WY. GPAC Publication 122. Cheyenne, WY: Wyoming State Forestry Division: 40-56.**

1856. Sturges, David L.; Nelson, David L. 1986. Snow depth and incidence of a snowmold disease on mountain big sagebrush. *In:* **Proceedings—symposium on the biology of *Artemisia* and *Chryothamnus*; 1984 July 9-13; Provo, UT. General Technical Report INT-200. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 215-221. 398 p.**

A snowmold disease of mountain big sagebrush induced by an unidentified fungus, was discovered in Wyoming in 1973. Snowmold was present on 2% of sagebrush plants where maximum snow accumula-

tion was less than 16 inches (40 cm), and 93% of plants where maximum accumulation exceeded 47 inches (119 cm). The disease reduces the canopy area or kills mountain big sagebrush plants in areas of deeper snow accumulation.

1857. **Sturges, David L.; Tabler, Ronald D. 1981. Management of blowing snow on sagebrush rangelands: three case studies. Journal of Soil and Water Conservation. 36(5): 287-292.**

Wind-transported snow can be managed to increase water supplies for livestock, wildlife, and irrigation, and to improve forage production. This paper presents case studies illustrating the design and performance of snow fencing, snow harvesting, and snow retention treatments on sagebrush rangelands.

1858. **Sturges, David L.; Winter, C. James. 1989. Automated collection of water quality and discharge data on streams. *In:* 57th western snow conference: proceedings of the conference; 1989 April 18-20; Fort Collins, CO. Fort Collins, CO: Colorado State University: 122-125.**

Water-related information can now be collected at remote sites and transferred directly into a computer for analysis using battery-operated electronic data loggers, thus bypassing hand-reduction of hydrologic data from charts. A system to collect data on water stage, conductivity, pH, and temperature and on air temperature is described.

1859. **Stynes, Daniel J.; Donnelly, Dennis M. 1987. Simplifying the travel cost method. Transactions of the American Fisheries Society. 116: 432-440.**

This paper proposes a shortcut approach to travel cost analysis. Compared to unit-day value methods, the suggested procedures add only modest increases in data requirements and technical skills while capturing the price-quantity relationship and the influence of population distributions around the site. Substitute sites, quality variations, and other complexities of recreation demand must be handled in an ad hoc manner.

1860. **Stynes, Daniel J.; Peterson, George L. 1989. Information effects and biases in the travel cost method. *In:* Vining, Joanne, compiler, editor. Social science and natural resource recreation management: a partnership for the future. Boulder, CO: Westview Press: 247-256.**

1861. **Stynes, Daniel J.; Peterson, George L.; Rosenthal, Donald H. 1986. Log transformation bias in estimating travel cost models. Land Economics. 62(1): 94-103.**

1862. **Stynes, Daniel J.; Peterson, George L. 1984. A review of logit models with implications for modeling recreation choices. Journal of Leisure Research. 16(4): 295-310.**

1863. **Sutton, Roy F.; Tinus, Richard W. 1983. Root and root systems terminology. Forest Science Monograph 24. Washington, DC: Society of American Foresters. 137 p.**

This compendium contains more than 2,200 terms relating either directly or indirectly by involvement, to roots and root systems. The terminology should be useful to anyone working with the roots of plants, in anatomy, ecology, morphogenesis, morphology, nutrition, pathology, physiology, propagation, and silviculture.

1864. **Swank, Wayne T.; DeBano, Leonard F.; Nelson, DeVon. 1989. Effects of timber management practices on soil and water. *In:* Burns, Russell M., technical compiler. The scientific basis for silviculture and management decisions in the National Forest System. General Technical Report WO-55. Washington, DC: U.S. Department of Agriculture, Forest Service: 79-106.**

1865. **Swanson, Cindy Sorg; Peterson, George L. 1989. Wilderness recreation demand and value: An assessment of existing knowledge and research needs. Outdoor recreation benchmark 1988. *In:* National outdoor recreation forum; Asheville, NC. General Technical Report SE-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 368-384.**

1866. **Swetnam, Thomas W.; Lynch, Ann M. 1989. A tree-ring reconstruction of western spruce budworm history in the southern Rocky Mountains. Forest Science. 35(4): 962-986.**

Tree-ring width chronologies from 10 mixed-conifer stands in the Colorado Front Range and New Mexico Sangre de Cristo Mountains were used to reconstruct the timing, duration, and radial growth impacts of past outbreaks of western spruce budworm. At least nine outbreaks were identified in the stands from 1700 to 1983. There was a relatively long period of reduced budworm activity in the first few decades of the

twentieth century, and since that time outbreaks have been markedly more synchronous among sampled stands.

1867. Swift, Lloyd W., Jr.; Schreuder, Hans T. 1981. Fitting daily precipitation amounts using the SB distribution. Monthly Weather Review. 109(12): 2535-2541.

The SBB distribution, a simple bivariate extension of the SB, showed low correlations between amounts of precipitation on consecutive wet days and between amounts on the first and third days of three consecutive days with precipitation. The cumulative amounts of precipitation over n days are normally distributed for large n with mean 0.53n cm and standard deviation 1.55n to the 1/2 power cm.

1868. Szaro, Robert C. 1981. Bird population responses to converting chaparral to grassland and riparian habitats. The Southwestern Naturalist. 26(3): 251-256.

Twenty-one years after chaparral was converted to grassland and riparian habitat in central Arizona, bird population density ranged from a high of 321 pairs per 40 ha in the riparian stringer to a low of 24 pairs per 40 ha on the grassland, compared to 103 pairs per 40 ha in the chaparral. Although population density, species richness, and diversity were higher in the riparian area when contrasted with the chaparral, there was an overall net difference of 66 fewer pairs per ha in the converted area.

1869. Szaro, Robert C. 1980. Factors influencing bird populations in southwestern riparian forests. *In:* Workshop proceedings: management of western forests and grasslands for nongame birds; 1980 February 11-14; Salt Lake City, UT. General Technical Report INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 403-418. 535 p.

Riparian forests comprise only a minor portion of the available habitat in the arid Southwest, but support extremely high bird populations. Bird communities in riparian forests are affected by vegetation type, structure, density, temporal fluctuations, adjacent habitat, recreational use, grazing, and location.

1870. Szaro, Robert C. 1986. Guild management: an evaluation of avian guilds as a predictive tool. Environmental Management. 10(5): 681-688.

The use and applicability of the guild concept to management is evaluated and questioned. Ecological problems are never as simple as implied in using one or two guild axes. A close examination of bird communities in a ponderosa pine forest reveals little relationship between guilds or guild blocks in the responses exhibited by individual bird species or bird species groups. The whole concept of guild management needs much more research and development before it can be recommended as a management tool.

1871. Szaro, Robert C. 1988. The management of amphibians, reptiles, and small mammals in North America: historical perspective and objectives. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-3. 458 p.

This paper introduces the symposium and gives historical perspective on the conception and organization of the meeting. We need to use an approach where ecological landscapes are considered as units, and land management practices incorporate all elements into an integrated policy. This includes examining the impacts of proposed land uses on amphibian, reptile, and small mammal populations. These populations may prove to be the ultimate indicators of habitat quality and health because of their sedentary characteristics that make them much more susceptible to management activities.

1872. Szaro, Robert C. 1989. Riparian forest and scrubland types of Arizona and New Mexico. Desert Plants. 9(3-4): 70-138.

This publication separates and characterizes the riparian forest and scrubland communities indicated in the title. It makes is possible for anyone to identify each of 28 vegetation types, characteristics of the plants which typify each community, distribution of each community in Arizona and New Mexico, The vegetational parameters of each community, relationships to other types, and pertinent studies that have been previously published. Appendices rank each riparian tree or shrub species by (a) elevation in meters, (b) stream gradient, and (c) compass directions of streamflow in degrees.

1873. Szaro, Robert C.; Balda, Russell P. 1986. Relationships among weather, habitat structure, and ponderosa pine forest birds. Journal of Wildlife Management. 50(2): 253-260.

Avian community structure during the breeding season in a ponderosa pine forest of northern Arizona was influenced by weather and a series of timber harvest treatments. Fewer birds and bird species

were present after a winter with the heaviest snowfall on record and low temperatures than after milder winters. Bird density was greater on the light and medium cut plots than on the untreated plot. A cluster analysis of bird densities over plots and the 3-year study period indicated treatment effects were more important in determining bird community composition than weather effects.

1874. Szaro, Robert C.; Balda, Russell P. 1982. Selection and monitoring of avian indicator species: an example from a ponderosa pine forest in the Southwest. General Technical Report RM-89. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

A critical discussion of the factors involved in selecting an indicator species is highlighted by the examination of a case study. The pygmy nuthatch and violet-green swallow are suggested as indicator species for lightly cut to old growth southwestern ponderosa pine. The monitoring of avian species could best be accomplished by the variable circular-plot method.

1875. Szaro, Robert C.; Belfit, Scott C. 1986. Herpetofaunal use of a desert riparian island and its adjacent scrub habitat. Journal of Wildlife Management. 50(4): 752-761.

The restriction of water flow in 1959 in Queen Creek in Whitlow Ranch Dam, Pinal County, Arizona, has caused the development of a 15-ha riparian island upstream behind the dam. The herpetofaunas of the riparian interior, riparian edge, desert wash, and upland habitats were sampled to assess the value of this type of development for mitigating continued losses of riparian habitat. Total species richness was 4 in the riparian interior, 7 in the riparian edge, 14 in the desert wash, and 15 in the desert upland. Many of the locally expected riparian species were absent. The lack of invasion by typical riparian species probably results more from biogeographic considerations and flooding patterns than from structural and physical conditions of this newly formed riparian habitat. Regression models for species abundance emphasize the importance of using floristic information rather than summary variables in developing animal-habitat relationships.

1876. Szaro, Robert C.; Belfit, Scott C.; Aitkin, J. Kevin; Rinne, John N. 1985. Impact of grazing on a riparian garter snake. *In:* Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 359-363. 523 p.

Numbers of wandering garter snakes were significantly higher where cattle grazing was excluded than along grazed portions of Rio de Las Vacas, a high elevation thin-leaf alder-willow riparian community in northern New Mexico. Differences can be attributed to the regeneration of streamside vegetation and the increased amount of organic debris.

1877. Szaro, Robert C.; Belfit, Scott C. 1987. Small mammal use of a desert riparian island and its adjacent scrub habitat. Research Note RM-473. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

The restriction of water flow in 1959 in Queen Creek by Whitlow Ranch Dam, Pinal County, Arizona, created a 15 ha riparian island upstream, behind the dam. Small mammal populations in the riparian interior and edge, desert wash, and upland habitats were sampled to assess the value of this type of development for mitigating continued loss of riparian habitat. The riparian island had few small mammals; more were recorded in the adjacent desert washes and desert upland habitats.

1878. Szaro, Robert C.; Belfit, Scott C.; Aitkin, J. Kevin; Babb, Randall D. 1988. The use of timed fixed-area plots and a mark-recapture technique in assessing riparian garter snake populations. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 239-246. 458 p.

Wandering garter snake *(Thamnophis elegans vagrans)* populations along a thin-leaf alder *(Alnus tenuifolia)* riparian community in northern New Mexico were sampled using timed fixed-area plots and a mark-recapture method. Both methods served to determine yearly differences and relative magnitude of snake

density between years. But populations estimates determined by timed fixed-area plots were inconsistent between study plots in the same year.

1879. Szaro, Robert C.; Coon, Nancy C.; Stout, William. 1980. Weathered petroleum: effects on mallard egg hatchability. Journal of Wildlife Management. 44(3): 709-713.

The toxicity of both crude and refined oils are ameliorated after 2-3 weeks of weathering. Weathering can lessen the impact of oil contamination on the eggs of aquatic bird species. However, oil remains a direct and persistent threat to embryo survival.

1880. Szaro, Robert C.; DeBano, Leonard F. 1985. The effects of streamflow modification on the development of a riparian ecosystem. *In:* **Riparian ecosystems and their management: reconciling conflicting uses. Proceedings of the symposium. General Technical Report RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 211-215. 523 p.**

The interrelationships between riparian vegetation development and hydrologic regimes in a ephemeral desert stream were examined at whitlow ranch dam along queen creek in Pinal County, Arizona. Our data indicates that a flood control structure can have a positive impact on riparian ecosystem development and could be used as a mitigation tool to restore this critically threatened habitat.

1881. Szaro, Robert C.; Hensler, Gary; Heinz, Gary H. 1981. Effects of chronic ingestion of no. 2 fuel oil on mallard ducklings. Journal of Toxicology and Environmental Health. 7: 789-799.

1882. Szaro, Robert C.; Jakle, Martin D. 1985. Avian use of a desert riparian island and its adjacent scrub habitats. The Condor. 87: 511-519.

A riparian bird community in central Arizona contributed from 23% to 33% of the birds along the adjacent desert washes, and from 7 to 15% of the birds in the adjacent desert upland. Conversely, the desert bird community contributed only from 1% to 1.5% of the birds in the riparian island. Bird density ranged from 336 to 446 birds/49 ha in the riparian core and edge in 1981 and 1982. Bird density in the adjacent desert decreased with distance from the edge of the riparian island to a low of 101 birds/40 ha in 1981, to 137/40 ha in 1982, in the segment 600 to 1,000 m from the riparian edge.

1883. Szaro, Robert C.; Jakle, Martin D. 1982. Comparison of variable circular-plot and spot-map methods in desert riparian and scrub habitats. Wilson Bulletin. 94(4): 546-550.

Breeding bird density and richness estimates for a goodding willow-salt cedar riparian association and an adjacent Paloverde-Saguaro desert scrub association were estimated by both the spot-map and variable circular-plot methods. All spot-map density estimates fell within the 95 percent confidence limits of the variable circular-plot estimates except for white-winged dove density on the riparian plot.

1884. Szaro, Robert C.; Pase, Charles P. 1983. Short-term changes in a cottonwood-ash-willow association on a grazed and an ungrazed portion of Little Ash Creek in central Arizona. Journal of Range Management. 36(3): 382-384.

Recovery of a cottonwood-ash-willow association from overgrazing has been extremely limited over a 4-year period. Seedling reproduction and herbaceous cover has increased however, overstory tree species composition has not changed. Tree growth was not affected by grazing. The younger, associated, codominant tree species differed in composition between the grazed and ungrazed plots.

1885. Szaro, Robert C.; Patton, David R. 1986. Riparian habitat classification in the southwestern United States. *In:* **Transactions, 51st North American wildlife and natural resources conference; 1986 March 21-26; Reno, NV. Washington, DC: Wildlife Management Institute: 215-221.**

1886. Szaro, Robert C.; Rinne, John N. 1988. Ecosystems approach to management of southwestern riparian communities. Transactions, 53rd North American wildlife and natural resources conference. 502-511.

The ecosystem approach to management of riparian systems requires the continued monitoring of population levels over many years in order to fully assess the effects of environmental perturbations. several such studies are in progress or nearing completion. This paper discusses examples, suggests potential management guidelines, and proposes recommendations for the development of future work.

1887. Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. 1988. Management of amphibians, reptiles, and small mammals in North America; proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 458 p.

This is a state-of-the-science summary of habitats and habitat requirements of species of amphibians, reptiles, and small mammals. Included are papers emphasizing habitat models, sampling techniques, community dynamics, and management recommendations.

1888. Szaro, Robert C.; Simons, Lee H.; Belfit, Scott C. 1988. Comparative effectiveness of pitfalls and live-traps in measuring small mammal community structure. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 282-288. 458 p.

The effectiveness of pitfalls and live-traps for assessing small mammal community structure was compared in burned and unburned upland Sonoran Desert and in an elevational series of sycamore riparian and adjacent habitats in Arizona. Although live-traps were more effective in recapturing previously captured small mammals and usually resulted in more total captures of new individuals, neither method gave a complete assessment of small mammal community structure.

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1889. Tabler, Ronald D. 1985. Ablation rates of snow fence drifts at 2300-meters elevation in Wyoming. *In:* 53rd western snow conference proceedings; 1985 April 16-18; Boulder, CO. Spokane, WA: Western Snow Conference: 1-12. 183 p.

Objections of this study were to monitor ablation of several snow fence drifts throughout the melt season, and to relate ablation rates and changes in drift geometry to air temperatures. The relationships presented here should be useful for designing water augmentation projects, hydraulic structures, conveyance systems, and culverts; for preducting snowmelt duration for both ecological and hydrological analyses; for assessing erosion potential; and for estimating evaporation losses. They also provide insight into how snow fence design and placement affect melt rates, and the critical snow depth needed to initiate perennial snow fields.

1890. Tabler, Ronald D. 1982. Frequency distribution of annual peak water-equivalent on Wyoming snow courses. *In:* Proceedings of the 50th western snow conference; 1982 April 19-23; Reno, NV. Fort Collins, CO: Colorado State University: 139-148. 225 p.

An empirical sample frequency distribution of annual peak water-equivalent, expressed as a modular coefficient, was developed using all snow courses having 30 or more years of records. This variable was found to be approximately normally distributed, with mean 1.0 and variance 0.0888. A table of exceedance probabilities is provided.

1891. Tabler, Ronald D. 1980. Geometry and density of drifts formed by snow fences. Journal of Glaciology. 26(94): 405-419.

This paper presents results from studies of snowdrifts formed by vertical-slat "Canadian" and horizontal-slat "Wyoming" snow fences having 50 percent porosity and heights from 0.8 m to 3.8 m, on nearly level terrain. Relationships are presented for the effects of wind orientation and curvature of drifts near fence ends, as well as empirical equations describing pre-equilibrium geometry relative to degree of saturation.

1892. Tabler, Ronald D. 1980. Self-similarity of wind profiles in blowing snow allows outdoor modeling. Journal of Glaciology. 26(94): 421-434.

Drifts formed by snow fences appear to be scaled in proportion to fence height over a range of nearly two orders of magnitude. This paper examines natural scaling in terms of commonly accepted similitude criteria.

1893. Tabler, Ronald D. 1983. Snow control and engineering in Japan. Report 81. Sapporo, Japan: Civil Engineering Research Institute, Hokkaido Development Bureau. 26 p.

1894. **Tabler, Ronald D. 1983. Using visual range data for highway operations in blowing snow.** *In:* **Aitken, George W., chairman and editor. Optical engineering for cold environments; 1983 April 7-8; Arlington, VA. Bellingham, WA: SPIE—the International Society for Optical Engineering: 68-77. 225 p.**

This paper discusses characteristics of light attenuation by blowing snow in relation to motorist visual range, and describes the computerized visual range monitor system used for traffic operations on Interstate Highway 80 in Wyoming.

1895. **Tabler, Ronald D.; Furnish, Richard P. 1982. Benefits and costs of snow fences on Wyoming Interstate-80. Transportation Research Record. 860: 13-20.**

Snow fence protection along a 100-km of Wyoming Interstate Highway-80 has gradually been increased from 0 percent to 50 percent since 1970. This presents a unique opportunity to identify effects of the snow fences on snow removal expenditures, accident frequency and road closure. This information is needed for economic analyses to determine the feasibility of future snow control projects.

1896. **Tabler, Ronald D.; Furnish, Richard P. 1982. In-depth study of snow fences. Public Works. 113(4): 42-44.**

Snow fence protection along a 60-mile section of Wyoming Interstate-80 has gradually been increased from 0 percent to 50 percent since 1970. The present system has reduced snow removal costs by more than a third, and "blowing snow" accidents by about 70 percent.

1897. **Tabler, Ronald D.; Jairell, Robert L. 1980. Studying snowdrifting problems with small-scale models outdoors.** *In:* **Western Snow Conference proceedings; 1980 April 15-17; Laramie, WY. 48: 1-13.**

Because drifts formed by snow fences are geometrically scaled in proportion to fence height, small-scale models can be used outdoors to study snowdrifting problems. This paper summarizes the theory and practical aspects of outdoor modeling, and presents results from model studies of topographic features, guard rails, buildings, surface roughness, and snow fences.

1898. **Tabler, Ronald D.; Schmidt, Ralph A. 1986. Snow Erosion, transport, and deposition in relation to agriculture.** *In:* **Steppuhn, H.; Nicholaichuk, W., editors. Proceedings of the symposium on snow management for agriculture; Swift Current, Saskatchewan, Canada. Great Plains Agricultural Council Publication No. 120. Linoln, NE: University of Nebraska: 11-58. 716 p.**

This presentation covers four topics: the mechanics of snow transport; the theory of drag forces in relation to surface roughness and snow accumulation; the aerodynamics of wind barriers and snowdrift formation; the application of this knowledge for agricultural benefit. Together, these topics define a turbulent mixing theory which explains snowcover erosion, snow transport by wind, and snowdrift deposition.

1899. **Tabler, Ronald D.; Sturges, David L. 1986. Watershed test of a snow fence to increase streamflow: preliminary results.** *In:* **Kane, Douglas L., editor. Proceedings of the symposium: cold regions hydrology. Bethesda, MD: American Water Resources Association: 53-61.**

Although snow fences have long been proposed as a method to increase water yield, the feasibility of this practice has not been established. This paper reports hydrologic changes the first 2 years after construction of an 800-m long snow fence, 3.78-m tall, on a 307-ha paired watershed having 10 years of pretreatment data. Snow accumulation increased about 58%, and streamflow averaged 237% of that predicted by the pretreatment calibration with the control watershed. Flow duration on the ephemeral stream increased about 18 days. To amortize the fence construction cost over a 25-year physical project life, the value of the new water would have to be about $0.06721 per cubic meter.

1900. **Tainter, Joseph A.; Hamre, Robert H., editors. 1988. Tools to manage the past: research priorities for cultural resources management in the Southwest; 1988 May 2-6; Grand Canyon, AZ. General Technical Report RM-164. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 214 p.**

These proceedings contain 13 solicited papers, plus 9 papers generated during the Grand Canyon workshop, designed to establish what knowledge and technology is needed to make possible more effective management of cultural resources in the Southwest. Workshops were organized around the topics: management impacts, native American heritage, protection and preservation, site discovery and definition,

public interpretation and education, key prehistoric research, key historic research, and integrated research designs.

1901. Tarbet, D.; Cordell, H. Ken; Schreuder, Hans T. 1982. An evaluation of the double sampling techniques for estimation of recreation use. *In:* Proceedings of southeastern recreation research conference; 1981 February 19-20; Ashville, NC. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 85-96.

1902. Tauer, C. G.; Harris, K. D.; Van Haverbeke, David F. 1987. Seed source influences juniper seedling survival under severe drought trees. Research Note RM-470. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Thirty-nine sources of eastern redcedar *(Juniperus virginiana)* and 15 sources of Rocky Mountain juniper *(Juniperus scopulorum)* representing collections from throughout the Great Plains, were planted in 1980 as 2+0 stock in south-central Oklahoma. Extremely droughty conditions during 1980 resulted in 77% first-year mortality. Percent survival of seedlings, by source, showed a low and negative but statistically significant correlation with mean nursery height. Survival of Rocky Mountain juniper was greater than survival of eastern redcedar.

1903. Taylor, Cathy A.; Raphael, Martin G. 1988. Identification of mammal tracks from sooted track stations in the Pacific Northwest. California Fish and Game. 74(1): 4-15.

Sooted aluminum tracking stations were used to investigate distribution patterns of medium and large mammals in Douglas-fir forest in northwestern California. Track stations consisted of two adjacent aluminum sheets covered by a thin layer of kerosene soot with a central bait. Stations were located at 166 sites and monitored for 8-day periods between 1 July and 15 September in 1981, 1982, and 1983. Tracks from 23 species were preserved with transparent tape and up to seven measurements were recorded. Track impressions on the hard surface were found to be much smaller and more detailed than those in soil or snow; available measurements and drawings in field guides were useless for identification purposes. Therefore, a standard method of measurement and a key to distinguish the tracks of medium to large sized mammals from sooted track stations in the Pacific Northwest are presented.

1904. Taylor, Maple A.; Guthery, Fred S. 1980. Status, ecology and management of the lesser prairie chicken. General Technical Report RM-77. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 15 p.

This report assesses past and recent distribution of the lesser prairie chicken; summarizes knowledge of its life history, ecology, and management; and identifies research needs.

1905. Tecle, Aregai; Covington, W. Wallace; Hamre, Robert H., technical coordinators. 1989. Multiresource management of ponderosa pine forests: proceedings of the symposium; 1989 November 14-16 1989; Flagstaff, AZ. General Technical Report RM-185. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 282 p.

The conference served as a forum for discussing current issues, concerns, opportunities, and procedures in multiresource management of ponderosa pine forests. The papers in these proceedings are grouped into six themes: (1) areal distribution and growth of ponderosa pine forests; (2) factors affecting ponderosa pine forest resource outputs; (3) forest diseases, environmental pollutants, and other stresses; (4) wildlife habitat concerns; (5) modeling and integrating environmental and public concerns in ponderosa pine forest resource management; and (6) multiresource management, decision support systems, and expert systems.

1906. Thilenius, John F.; Brown, Gary R. 1987. Herded versus unherded sheep grazing systems on an alpine range in Wyoming: effects on plant composition, ground cover, forage utilization, and lamb weight gains. General Technical Report RM-147. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

The influence of sheep grazing on plant composition, canopy coverage, and forage utilization was studied on an alpine range in northwestern Wyoming grazed by an unherded band of sheep and on an adjacent range where the sheep were grazed under the usual herded system. Under both systems, total canopy coverage did not change appreciably over the 10 years of study. Alpine mat clovers, graminoids, and grasses were the preferred forages. Overall forage utilization was low; 6.1% on the range where the sheep were herded and 8.1% on the range grazed by the unherded sheep. Protecting range from sheep grazing influ-

enced plant composition, but not total canopy coverage. The major response to protection from grazing was a decline in the coverage of alpine mat clovers, accompanied by an increase in the coverage of other forbs, especially noncushion plant forbs. Lamb weight gains were similar under both grazing systems.

1907. Thilenius, John F.; Smith, Dixie R. 1985. Vegetation and soils of an alpine range in the Absaroka Mountains, Wyoming. General Technical Report RM-121. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 18 p.

Alpine vegetation on Carter Mountain in the Absaroka Range of northwestrn Wyoming was classified into eight community types. Community type differences are due mainly to shifts in the standing crop and constancy of a few species. Floristic differences among community types are not marked, and very few species are confined to a single community type. Soils associated with each community type were classified to soil subgroup level. No consistent relationships were found between the vegetation and soil classification. Exposure to prevailing wind, elevation, soil particle size distribution, available water content, and snow accumulation were statistically significant environment factors determining community type distribution.

1908. Thill, Ronald E.; Ffolliott, Peter F.; Patton, David R. 1983. Deer and elk forage production in Arizona mixed conifer forests. Research Paper RM-248. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p.

Mean forage production levels were closely associated with overstory basal area (BA), diminishing rapidly with increasing stand densities. Overstory-understory relationships were generally best described by log or log-log regression equations. Estimated total deer and elk forage on unlogged sites in mid-August is 82 pounds per acre (ovendry weight) at ba 50, versus 4 pounds per acre at BA 400. Forage benefits derived from clearcutting may be long-lived because of slow natural or artificial regeneration.

1909. Thomas, Carl H.; Streeter, Robert G.; Chalk, David E.; Sroufe, Barry D. 1983. Computerized national appraisal of wildlife habitat—1985. *In:* Proceedings of a national workshop on computer uses in fish and wildlife programs; 1983 December 5-7; Blacksburg, VA. Blacksburg, VA: Virginia Polytechnic Institute and State University; 1: 69-74.

1910. Thompson, James S.; Peterson, George L.; Turnquist, Mark. 1984. Simulation analysis of the stochastic behavior of a discrete time migration process. *In:* Proceedings, 15th annual Pittsburgh conference on modeling and simulation; 1984 April 19-20; Pittsburgh, PA. Research Triangle Park, NC: Instrument Society of America: 1303-1308.

1911. Tiedeman, J. A.; Francis, Richard E.; Terwillinger, C. Jr; Carpenter, Len H. 1987. Shrub-steppe habitat types of Middle Park, Colorado. Research Paper RM-273. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 20 p.

Shrub-steppe vegetation was classified into 17 habitat types in relation to plant species canopy cover, and physical characteristics. Grazing and browsing by wildlife and livestock are expected to continue to influence the development and maintenance of stable plant communities in Middle Park. The habitat types emphasize critical mule deer winter range and are considered climax, each modified by zootic, edaphic, climatic, and/or landform factors. phyto-edaphic characteristics, ground photos, and a habitat type key are presented and discussed. This classification and associated descriptions of habitat types provide the basic ecological information necessary to aid in land management planning and monitoring of the shrub-steppe plant communities in Middle Park and similar environs.

1912. Timmer, Michael J.; Ffolliott, Peter F.; Baker, Malchus B., Jr. 1984. Snowpack dynamics in aspen stands near the San Francisco Mountains, Arizona. *In:* Hydrology and water resources in Arizona and the Southwest. Proceedings, 1984 meetings of the Arizona Section, American Water Resources Association, and Hydrology Section Arizona-Nevada Academy of Science; 1984 April 7; Tucson, AZ. Tucson, AZ: Water Resources Research Center: 51-55.

1913. Tinnin, Robert O.; Hawksworth, Frank G.; Knutson, Donald M. 1982. Witches' broom formation in conifers infected by *Arceuthobium* spp. an example of parasitic impact upon community dynamics. American Midland Naturalist. 107: 351-359.

This article discusses witches' broom formation by the parasitic angiosperm, *Arceuthobium* spp., and the potential contribution of those brooms to shaping the structure of the coniferous forest communities in which they are found. Brooms are of adaptive advan-

tage to the parasite populations, and, in some ways, to the host populations as well. Broomed trees represent a unique resource in forested ecosystems.

1914. Tinsley, Howard E. A.; Driver, B. L.; Bay, Steven B.; Manfredo, Michael J. 1986. Stability of recreation experience preference (REP) ratings for samples and individuals across three measurement periods. Education and Psychological Measurements. 46(4): 1105-1111.

This study investigated the stability of rep items measuring the likelihood and importance of possible psychological outcomes of a recreational experience across the time and location of measurement and the instructional set used with the items. Adequate stability was observed for the total sample of respondents but the stability of individuals' responses was marginal.

1915. Tinsley, Howard E. A.; Kass, Richard A.; Driver, B. L. 1981. Reliability and concurrent validity of the recreation experience preference scales. Educational and Psychological Measurement. 41(3): 897-907.

Two procedures for scoring the recreation experience preference scales were investigated by using data obtained from respondents engaged in outdoor recreational activities in Pennsylvania and Michigan. Both scoring procedures were judged to yield acceptable levels of reliability and concurrent validity.

1916. Tinus, Richard W. 1981. Developing concepts for seedling production and handling in New Zealand. *In:* Proceedings of the symposium on engineering systems for forest regeneration; 1981 March 2-6; Raleigh, NC. Publication 10-81. St. Joseph, MO: American Society of Agricultural Engineers: 56-60.

1917. Tinus, Richard W. 1982. Effect of dewinging, soaking, stratification, and growth regulators on germination of green ash seed. Canadian Journal of Forest Research. 12(4): 931-935.

Dewinging stored seed of green ash increased speed of and total germination. Fresh seed germinated best with a 4-day warm-water soak followed by 3-day stratification at 3°C. Best procedures for stored seed were a 4-day soak in 100 ppm giberellic acid or a 2-day soak in 1-10 ppm 6-benzyladenine, followed by 30-day stratification at 3°C.

1918. Tinus, Richard W. 1981. Effects of extended photoperiod on southern Rocky Mountain Engelmann spruce and Douglas-fir. Tree Planters' Notes. 32(4): 9-12.

Four sources of Engelmann spruce (*Picea engelmannii* Parry) and two of Douglas-fir (*Pseudotsuga menziesii* var. *glauca* Beissn. Franco) were grown from seed under eight different extended photoperiod regimes. Incandescent light 1 minute of every 15 at night at 270 lux was more effective than continuous incandescent light at 1,200 lux or intermittent flourescent at 950 lux in preventing bud dormancy and maintaining continuous height growth. Even the southernmost sources responded to extended photoperiod, although response of northern sources was much stronger.

1919. Tinus, Richard W. 1982. Environmental control of seedling physiology. *In:* Scarratt, J. B.; Glerum, C.; Plexman, C. A., editors. Proceedings of the Canadian containerized tree seedling symposium; 1981 September 14-16; Toronto, Canada. Sault Ste, Marie, Ontario: Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre: 75-82. 460 p.

The greenhouse container nursery offers a degree of control of seedling physiology that the outdoor bareroot nursery cannot match, but this potential can be realized only by a thorough understanding of seedling environmental requirements and the procedures for providing them.

1920. Tinus, Richard W. 1980. Forestation concepts and practices developing in New Zealand. *In:* Proceedings of the Intermountain Nurserymen's Association and Western Forest Nursery Association combined meeting; 1980 August 12-14; Boise, ID. General Technical Report INT-109. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 11-16.

Radiata pine is precision sown and thinned, permitting "box pruning." Seedlings can be lifted and packed in the field, because almost every tree is shippable. Reduction in exposure and handling of seedlings increases plantation survival and initial growth, and promises to reduce rotation age by 1 year and decrease nursery costs.

1921. Tinus, Richard W. 1982. Future of greenhouse container nursery systems in the South. *In:* Proceedings, Southern containerized forest tree seedling conference; 1981 August 25-27; Savannah, GA. General Technical Report SO-37. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 149-152

1922. Tinus, Richard W. 1988. How hardy trees survive winter. The World & I. January 1988: 198-199.

In the temperate zone, a tree in summer pulses with life, yet in winter the same tree may have to endure for months in a frozen world. To survive through a cold winter, the tree's cells must be modified so they are not damaged with the onset of freezing temperatures. Except for extreme and unusual situations, however, winter causes little damage to well-adapted trees. In the spring, slightly damaged cells are repaired, extensively damaged ones are bypassed, and new growth starts again.

1923. Tinus, Richard W. 1986. In-bed herbaceous windbarrier produced more ponderosa pine seedlings. *In:* Proceedings, Intermountain Nurserymen's Association meeting; 1985 August 13-15; Fort Collins, CO. General Technical Report RM-125. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 3-6. 111 p.

There are currently no windbreaks at the Albuquerque tree nursery, but experience at other nurseries indicates windbreaks can be highly beneficial. With the windbarrier, increases in seedling fresh weight and epicotyl height, and greener color were observed, but variability was too great for the differences to be significant. Windbarriers in adjacent beds across a section had no significant cumulative effect.

1924. Tinus, Richard W. 1987. Modification of seed covering yields more and larger pine seedlings. Tree Planter's Notes. 38(1): 11-13.

Pondersoda pine (*Pinus ponderosa* Dougl. ex Laws.) seed, sown in a soil with a high composition of calcium carbonate that tends to crust, was covered with either soil, soil treated with phosphoric acid, light colored sand, or dark volcanic cinder. After two seasons, seedling density and size were greatest with cinder covering, second best with sand, and poorest with soil. phosphoric acid was ineffective.

1925. Tinus, Richard W. 1980. Nature and management of soil pH and salinity. *In:* Proceedings of the North American forest tree nursery soils workshop; 1980 July 28-August 1; Syracuse, NY. Syracuse, NY: State University of New York: 72-86.

Acid soils usually develop in wet climates under long-term leaching and tend to be low in mineral nutrients. Alkaline and salty soils usually develop in dry climates because of high evaporation rates and lack of leaching. The pH may be reduced with sulfur, organic matter, acid-forming fertilizers, and acidification of irrigation water. Salt can be removed by leaching, but excess sodium must first be replaced by calcium.

1926. Tinus, Richard W. 1984. Optimum temperatures for growth of southern Rocky Mountain Engelmann spruce and Douglas-fir seedlings. Research Note RM-442. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Because requirements of the two species are similar to each other and to that of coastal Douglas-fir, they all can be grown together. However, requirements are sufficiently different from ponderosa pine to warrant a separate greenhouse.

1927. Tinus, Richard W. 1986. Principles of container seedling production. *In:* Proceedings: 18th IUFRO World Congress, Divison 3, Forest operations and techniques; 1986; Ljubljana, Yugoslavia. Vienna, Austria: Yugoslav IUFRO World Congress Organizing Committee: 292-297.

Despite the wide variety of species grown in many different climates in a vast array of economic situations, container-grown tree seedlings have many common characteristics. These include consistent differences from bare-root seedlings and similarities regarding container, growing medium, growing schedule, irrigation and mineral nutrition, and protection requirements.

1928. Tinus, Richard W. 1989. Processes and systems analysis for reducing variability in nursery stock. Forestry Supplement. 62: 131-141.

In nurseries, seedling uniformity can best be increased: (1) by using seed that germinates completely and promptly; (2) by sowing the seed with precise spacing; (3) if the seed or sowing is deficient, thinning to a desirable, uniform spacing; and (4) by achieving near-optimal levels of other critical environmental factors.

1929. Tinus, Richard W. 1983. Prospects for a new energy-efficient system for greenhouse container tree nurseries. *In:* Proceedings, 7th North American forest biology workshop; 1982 July; Lexington, KY. 26-28.

1930. Tinus, Richard W. 1980. Raising bur oak in containers in greenhouses. Research Note RM-384. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Under optimum conditions, two crops of bur oak *(Quercus macrocarpa)* can be grown per year. Because bur oak requires high temperature for rapid growth, the most economical approach is to grow both crops during the spring and summer by starting early and hardening the first crop in a shadehouse and the second crop in the greenhouse. Procedures are given for seed handling, regulating climate, watering and fertilizing, and hardening.

1931. Tinus, Richard W. 1981. Root system configuration is important to long tree life. Plants and the Landscape. 4(1): 1-5.

The development of girdling roots is one of the principal long-range problems facing producers of containerized plants and those who use these plants in landscaping. The problem may not become apparent until many years after the plants have been transplanted out, but the pattern of root growth can be traced back directly to the period when the plants were grown in containers.

1932. Tinus, Richard W. 1984. Salt tolerance of 10 deciduous shrub and tree species. *In:* The challenge of producing native plants for the Intermountain area. Proceedings: Intermountain Nurserymen's Association; 1983 August 8-11; Las Vegas, NV. General Technical Report INT-168. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 44-49. 96 p.

Ten species of deciduous shrubs and trees were grown in a greenhouse and irrigated with nutrient solution plus sodium sulfate, chloride, and bicarbonate to yield salt concentrations with conductivity of 1.6, 4.5, 7.2, 12.1, and 16.6 mmhos/cm. Honeysuckle, crabapple, lilac, and american plum were salt sensitive. Buffaloberry, Russian olive, and chokecherry were moderately sensitive. Green ash, juneberry, and caragana were tolerant.

1933. Tinus, Richard W. 1983. Sand and hydrogel seed covering improves germination of several hardwoods in a soil that crusts. *In:* Proceedings, 1982 western nurseryman's conference; 1982 August 10-12; Medford, OR. 21-26.

1934. Tinus, Richard W. 1982. Successful overwintering of container-grown seedlings. *In:* Proceedings, Intermountain Nurseryman's annual meeting; 1981 August 11-13; Edmonton, Alberta. Information Report NOR-X-241. Canadian Forest Service: 26-41.

Ponderosa pine, Scots pine, bur oak, green ash, and seven other hardwood species were successfully overwintered at Bottineau, N. Dak., buried under snow or moderately dry peat, in unheated white plastic or snow fence covered structures. Several other environments were intermittently successful or failed. Measurements of temperature and water stress to determine cause of success or failure were inconclusive.

1935. Tinus, Richard W. 1984. Summary of country statements on tree planting and nursery practices. *In:* Seminar on machines and techniques for forest plant production; 1983 June 20-24; Tatranska Lomnica, Hautes Tatras, Czechoslovakia. U.N. ILO and FAO Joint Committee on Forest Working Techniques and Training of Forest Workers; 1: 47-55.

A survey questionnaire was sent to IUFRO members requesting statistics and some technical detail about tree planting and nursery practices in their country. This paper summarizes and interprets their responses.

1936. Tinus, Richard W.; Bourque, J. E.; Wallner, Steven J. 1985. Estimation of cold hardiness of Douglas-fir and Engelmann spruce seedlings by differential thermal analysis of buds. Annals of Applied Biology. 106: 393-397.

Low temperature freezing points of conifer buds were determined by differential thermal analysis and were compared to results obtained in whole plant freezing tests of the same seedlings. To obtain well-defined, meaningful exotherms, it was necessary to nucleate buds externally. The low temperature exotherms for buds occurred at temperatures very close to the lowest which seedlings tolerate with no visible injury. Thus, for Engelmann spruce and Douglas-fir, differential thermal analysis may provide a convenient prediction of containerized tree seedling hardiness.

1937. Tinus, Richard W.; Burr, Karen E.; Wallner, Steven J.; King, Rudy M. 1986. Relation between cold hardiness, root growth capacity, and bud dormancy in three western conifers. *In:* Proceedings: Combined Western Forest Nursery Council and Intermountain Nursery Association meeting; 1986 August 12-15; Tumwater, WA. General Technical Report RM-137. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 80-86. 164 p.

Ponderosa pine, Douglas-fir, and Engelmann spruce seedlings were greenhouse container grown, then cold acclimated and deacclimated in growth chambers over 19 weeks. Stem cold hardiness, new root length at 14 days, and days to budbreak were measured weekly. During acclimation, root growth capacity had doubled when stem cold hardiness reached

-22° C. During deacclimation, root growth capacity was not lost when two-thirds of maximum cold hardiness was lost. At Budbreak, both cold hardiness and root growth capacity were minimum.

1938. **Tinus, Richard W.; Burr, Karen E.; Wallner, Steven J.; King, Rudy M. 1987. Relation between cold hardiness, root growth capacity, and bud dormancy in three western conifers. Plant Physiology. 83(4): 71. (Abstract).**

1939. **Tinus, Richard W.; Cleary, Brian. 1980. Preservation of nursery stock quality through packaging, storage, transport, and planting. New Zealand Journal of Forestry Science. 10(1): 293-300.**

Nurseries ensure quality during growing and conditioning of the seedlings. That quality must be maintained through the processes of packaging, storage, transportation, and planting.

1940. **Tinus, Richard W.; Owston, Peyton W. 1984. Chapter 7. Physiology research made forestation with container-grown seedlings successful.** *In:* **Duryea, M. L.; Brown, G. N., editors. Seedling physiology and reforestation success. The Hague, The Netherlands: Martinus Nijhoff/Dr. W. Junk Publishers.**

Seedlings physiology research in the past 15 years has improved production and performance of container seedlings. Ongoing research with great promise includes precise spacing of seedlings through sowing germinated seed, stress testing to determine planting stock quality, relating different growth aspects to each other to develop the best"balanced"seedling, and seeking growth control mechanisms at the cellular and biochemical levels.

1941. **Tischendorf, J.; Frazer, C.; Grubb, Teryl G. 1987. Interactions between bald eagles (*Haliaeetus leucocephalus*: Accipitridae) and river otters (*Lutra canadensis*: Mustelidiae). Southwestern Naturalist. 32(2): 286-287.**

Bald eagles *(Haliaeetus leucocephalus)* obtain food by hunting, scavenging, and piracy. here, further evidence is presented showing that eagles occasionally interact with river otters *(Lutra canadensis)* to enhance their foraging success.

1942. **Troendle, Charles A. 1985. Chapter 12. Variable source area models.** *In:* **Anderson, M. G.; Burt, T. P., editors. Hydrological forecasting. New York, NY: John Wiley and Sons: 347-403.**

Hydrology has developed to the point where what may have been called the traditional or"classical"concepts for processes are no longer accepted as the norm for studying environments. This chapter discusses the nature of the flow-generating processes from forest and wildland, and the degree to which we are able to model this dynamic and variable response.

1943. **Troendle, Charles A. 1983. The Deadhorse experiment: a field verification of the subalpine water balance model. Research Note RM-425. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Thirty-six percent of a small, 41-ha, subalpine watershed on the Fraser Experimental Forest was harvested using a system of small 5-h circular clearcuts. Simulations, using the subalpine water balance model, indicated that a 4.3-cm increase in flow could be expected in an average year following the proposed treatment. Predictive techniques also indicated 30 percent more snow would be deposited in the openings. Annual water yield was increased an average of 4.6-cm during the first 4 years after treatment with no detectable effect on peak flow rates. Significantly more snow was found in the openings than in the forest, but mean peak water equivalent for the watershed was not significantly altered.

1944. **Troendle, Charles A. 1985. The effect of timber harvest on the water balance of the subalpine forests.** *In:* **Foresters future: leaders of followers? Proceedings of the 1985 Society of American Foresters national convention; 1985 July 28-31; Fort Collins, CO. Bethesda, MD: Society of American Foresters: 148-152. 445 p.**

Timber harvest in the subalpine zone of the central Rocky Mountains can significantly affect streamflow, regardless of whether the harvesting is done by clearcutting or partial cutting. Experiments at Wagon Wheel Gap, Fool Creek, and Deadhorse Creek all resulted in significant increases in both stramflow volume and peak discharge rates. The effect of harvest on timing of peak and peak water equivalent in the snowpack varied by watershed and harvesting practice. Long-term streamflow and climatic recorders were useful in further refining the definition of hydrologic recovery and the positive correlation of precipitation and flow increase.

1945. **Troendle, Charles A. 1987. Effect of clearcutting on streamflow generating processes from a subalpine forest slope. *In:* IAHS symposium proceedings, forest hydrology and watershed management; 1987 August; Vancouver, BC. 545-552.**

The flow producing mechanisms on two forested plots (17 x 210 m and 36 x 210 m) were monitored for 7 years. Surface, shallow subsurface (0-1 m), and deep subsurface (1-4 m) lateral flows were intercepted and measured, as were the fluctuation of perched water tables and soil moisture content on the two hillslopes. After the fifth season, one plot was clearcut. Peak water equivalent in the snowpack, total flow, and peak discharge rate increased during the first full year following harvest. The timing of the peak was not affected. Observations of water movement on both study plots appear to define the streamflow generating processes representative of the subalpine environment.

1946. **Troendle, Charles A. 1988. Effect of partial cutting and thinning on the water balance of the subalpine forest. *In:* Schmidt, Wyman C., compiler. Proceedings—future forests of the Mountain West: a stand culture symposium; 1986 September 29-October 3; Missoula, MT. 108-116.**

Increases in streamflow have been demonstrated on watersheds in Colorado and South Dakota where 30-40% of the basal area has been removed in shelterwood cuts. Process studies on young lodgepole pine stands in Colorado and Wyoming indicate that thinning significantly reduces winter interception loss and increases net precipitation to the ground or to the snowpack. Soil water depletion is reduced and water available for streamflow is increased in direct proportion to the basal area reduced. However, the effect of basal area reductions on soil water depletion is eliminated in dry years. This paper presents several linear models that describe the interaction between growing stock level or stand basal area, precipitation, and site differences on the water balance of the subalpine forest.

1947. **Troendle, Charles A. 1980. Effects of timber harvest on water yield and timing—snow region. *In:* Proceedings of a workshop on scheduling timber harvest for hydrologic concerns. Portland, OR: U.S Department of Agriculture, Forest Service, Pacific Northwest Region and Pacific Northwest Forest and Range Experiment Station: 1-25.**

1948. **Troendle, Charles A. 1982. The effects of small clearcuts on water yield from the Deadhorse Watershed, Fraser, Colorado. *In:* Proceedings of the 50th western snow conference; 1982 April 19-23; Reno, NV. Fort Collins, CO: Colorado State University: 76-83. 225 p.**

Thirty-six percent of a small, 41-ha, subalpine watershed on the Fraser Experimental Forest was harvested using a system of small 5-h circular clearcuts. Annual water yield has increased an average of 4.6 cm during the first 4 years after treatment with no detectable effect on peak flow rates. Significantly more snow was found in the openings than in the forest, but mean peak water equivalent for the watershed was not significantly altered.

1949. **Troendle, Charles A. 1983. The potential for water yield augmentation from forest management in the Rocky Mountain Region. Water Resources Bulletin. 19(3): 359-373.**

Opportunities for increasing flow through forest manipulation are discussed, and research on the influence of snowpack and vegetation management water yield is summarized. The optimal harvest design appears to consist of small openings, irregularly shaped, and about 3 to 8 tree heights in width, parallel to the wind.

1950. **Troendle, Charles A. 1987. The potential effect of partial cutting and thinning on streamflow from the subalpine forest. Research Paper RM-274. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.**

Process studies suggest that thinning young lodgepole pine stands in Colorado and Wyoming significantly reduces winter interception loss. Soil moisture studies in lodgepole pine stands that range in basal area from 32 ft^2 per acre show that soil water depletion (and ET loss) is reduced and water available for streamflow is increased in direct proportion to the basal area reduced. However, because the subalpine environment is so precipitation limiting rather than energy limiting, the effect of basal area reductions on soil water depletion is eliminated in dry years.

1951. **Troendle, Charles A. 1985. Streamflow generation from subalpine forests. *In:* Jones, Bruce E.; Ward, Timothy J., editors. Watershed management in the eighties: symposium proceedings; 1985 April 30-May 1; Denver, CO. New York, NY: American Society of Civil Engineers: 240-246.**

1952. Troendle, Charles A. 1980. Watershed management in the Rocky Mountains. *In:* Meeting the challenge of the 80's—proceedings: Rocky Mountain forest industries conference; 1980 May 7-10; Jackson, WY. 24-45.

Changes in the aerodynamics of the forest canopy after harvesting can significantly increase snow accumulations in the opening and decrease it in the surrounding forest. All harvesting practices have the potential for increasing water yield, and may do so at the expense of some other resources and to the benefit of others.

1953. Troendle, Charles A.; Kaufmann, Merrill R. 1987. Influence of forests on the hydrology of the subalpine forest. *In:* Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 68-78. 253 p.

Forest vegetation is important in the hydrology of subalpine ecosystems. First, leaf surface area of the canopy presents a massive intercepting surface to both rain and snowfall, much of which subsequently is evaporated back to the atmosphere. The same canopy biomass also transpires significant amounts of water, thereby depleting soil water reserves and increasing storage capacity for subsequent rain or snowmelt that reaches the soil. Reducing the canopy biomass by either partial or clearcutting decreases the interception loss, decreases overstory transpiration, increases understory water use, decreases soil water depletion, and may increase total streamflow, peak flow, and base flow. Increasing stand density has the reverse effect. This paper describes the processes influenced as the forest vegetation is manipulated.

1954. Troendle, Charles A.; Kaufmann, Merrill R.; Hamre, Robert H.; Winokur, Robert P., technical coordinators. 1987. Management of subalpine forests: building on 50 years of research: proceedings of a technical conference; 1987 July 6-9; Silver Creek, CO. General Technical Report RM-149. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 253 p.

These proceedings contain 43 papers (18 formal papers and 25 poster papers), which are the product of the technical conference called to summarize, discuss, and transfer the knowledge learned at the Fraser Experimental Forest over the past 50 years. The formal papers describe the status of our knowledge about the interactions among timber, water, and wildlife. To broaden the scope of the conference, poster papers were presented to describe research in the subalpine environment in other ecosystems or for other resources.

1955. Troendle, Charles A.; King, Rudy M. 1985. The effect of timber harvest on the Fool Creek Watershed, 30 years later. Water Resources Research. 21(12): 1915-1922.

The Fool Creek Watershed at the Fraser Experimental Forest, Colorado, was harvested using a pattern of alternating clearcut and forested strips in 1956. Today, with almost 30 years of postharvest record, subtle impacts in the hydrology of the watershed can be detected that were not significant in the past. Peak discharges, advanced 7.5 days following harvest, have also been increased 20%, with the largest effect occurring in the wettest years. Increases in peak water equivalent, annual flow, and date of peak flow occurrence will appear to be returning to preharvest levels at a very slow rate.

1956. Troendle, Charles A.; King, Rudy M. 1987. The effect of partial and clearcutting on streamflow at Deadhorse Creek, Colorado. Journal of Hydrology. 90: 145-157.

Two subalpine forest subdrainages of Deadhorse Creek, Colorado, USA, were used to demonstrate the comparable impact on water yield of two tree-harvesting practices. Of the 40-ha north fork subdrainage, 36% was clearcut commercially using five-tree height circular openings. In contrast, 40% of the basal area on the 41-ha unit 8 was removed by partial cutting in the first step of a three-step shelterwood cut. Annual flow and peak flow from the clearcut watershed were increased significantly. The Partial cut resulted in a significant increase in total water equivalent in the winter snowpack and an apparent increase in total annual streamflow that was comparable to the clearcut. Timber harvest, however, represented only 10% of the total basal area of the larger Deadhorse Creek Watershed in which they are located. Annual flow at the mainstream gage was not significantly increased as a result of harvest.

1957. Troendle, Charles A.; Leaf, Charles F. 1980. Chapter 3, Hydrology. *In:* An approach to water resources evaluation of non-point silvicultural sources (a procedural handbook). EPA 60018-80-012. Athens, GA: U.S. Environmental Protection Agency, Environmental Research Laboratory: III.1-III.173.

The handbook provides an analysis methodology that can be used to describe and evaluate changes to the water resource resulting from non-point silvicultural activities. Chapter 3 presents regionalized methodologies for predicting the effect.

1958. Troendle, Charles A.; Leaf, Charles F. 1981. Effects of timber harvest in the snow zone on volume and timing of water yield. *In:* Proceedings of the Interior West watershed management symposium; 1980 April 8-10; Spokane, WA. Pullman, WA: Washington State University, Extension Service: 231-243. 288 p.

Changes in the aerodynamics of the forest canopy after harvesting can significantly increase snow accumulations in the opening and decrease it in the surrounding forest. Increased accumulations after harvesting usually can be attributed to both a reduction in interception loss and a redistribution of snow by wind during and after the event.

1959. Troendle, Charles A.; Meiman, James R. 1986. The effect of patch clearcutting on snowpack accumulation and subsequent snowmelt and soil water storage on a subalpine forest slope in Colorado. *In:* 54th annual meeting western snow conference; 1986 April 15-17; Phoenix, AZ. Spokane, WA: Western Snow Conference: 93-100. 198 p.

This paper describes a replicated plot study designed (1) to investigate the effect of a forest opening on the accumulation and melt of the snowpack in both the opening and in the surrounding forest, (2) to determine if any differences in soil moisture recharge between the forest and opening resulted from creation of the opening, and (3) to quantify the evaporative components of the hydrologic cycle for a specific site, to determine how the creation of a small opening altered the water balance.

1960. Troendle, Charles A.; Meiman, James R. 1984. Options for harvesting timber to control snowpack accumulation. *In:* Proceedings of the western snow conference, 52nd annual meeting; 1984 April 17-19; Sun Valley, ID. Spokane, WA: Executive Secretary of the Conference: 86-97. 192 p.

Timber harvest has been demonstrated to have a significant effect on snowpack accumulation and melt. This paper reports the results of several recent studies on the Fraser Experimental Forest in Colorado that look at what other options may be available to harvest the forest and still optimize the impact on the snowpack, reduce interception loss, and subsequently impact the water resource.

1961. Troendle, Charles A.; Nilles, M. A. 1987. The effect of clearcutting on chemical exports in lateral flow from differing soil depths on a subalpine forested slope. *In:* IAHS symposium proceedings, forest hydrology and watershed management; 1987 August; Vancouver, BC. 423-431.

Chemistry of lateral flow from the surface and subsurface depths on two study plots at the Fraser Experimental Forest has been measured for 5 years. Following the third year, one plot was clearcut. The calibration period data were useful in refining the definition of the dominant flow mechanisms and pathways of travel during the snowmelt season. Clearcutting the smaller plot increased chemical export, both because two elements, NO^3- and Cl-, increased in concentration and because the greater flow following harvest "flushed" more material from the system. Users may request copies of these through that system.

1962. Troendle, Charles A.; Schmidt, Ralph A.; Martinez, Manuel H. 1988. Snow deposition processes in a forest stand with a clearing. *In:* Proceedings, 56th western snow conference; 1988 April 19-21; Kalispell, MT. Fort Collins, CO: Colorado State University: 78-86.

Electronic sensors supported on towers simultaneously measured the flux of snow falling into a forest and a clearing in experiments to compare fluxes during storms with those occurring when wind redistributed intercepted snow after snowfall ceased. The latter process was intermittent and showed very low fluxes compared to those during storms.

1963. Troxell, Harry E.; Tang, Jung Lei; Sampson, George R.; Worth, Harold E. 1980. Suitability of beetle-killed pine in Colorado's Front Range for wood and fiber products. Resource Bulletin RM-2. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.

Beetle-killed wood is suitable for most traditional uses. Differences are: the beetle-killed timber is drier, usually blue-stained, and may contain wood borers and decay. Mechanical properties may be affected.

1964. Tunnicliff, Brock; Brickler, Stanley K. 1984. Recreational water quality analyses of the Colorado River corridor in Grand Canyon. Applied and Environmental Microbiology. 48(5): 909-917.

1965. Turkowski, Frank J. 1980. Carnivora food habits and habitat use in ponderosa pine forests. Research Paper RM-215. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p.

Major food items of carnivores on the Beaver Creek Watershed (with percentage of scats in which each was found) were mammals 50 percent, birds 6 percent, reptiles 3 percent, arthropods 37 percent, and plants 60 percent. Although habitat manipulation influenced carnivore use of the treated watersheds, the modifications were not harmful to most carnivore species.

1966. Turner, Matthew T.; Betters, David R. 1989. Concave vs. convex singular path solutions for optimal economic thinning schedules in even-aged stands. *In:* The 1988 symposium on systems analysis in forest resources; 1988 March 29-April 1; Pacific Grove, CA. General Technical Report RM-161. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 163-165. 278 p.

1967. Turner, Raymond M.; Applegate, Lee H.; Bergthold, Patricia M.; Gallizioli, Steve; Martin, S. Clark. 1980. Arizona range reference areas. General Technical Report RM-79. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 34 p.

Range reference areas (exclosures and remote areas) provide a historical record of vegetation that has not been influenced by livestock grazing. In Arizona, 380 exclosures can be used for research and management. Location, controlling agency, year of establishment, and vegetation information are provided for each reference area.

1968. U.S. Department of Agriculture, Forest Service. 1980. Regional directory—leafy spurge control. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Addresses of those interested or involved in controlling leafy spurge, a rapidly spreading, noxious weed, are listed alphabetically, and alphabetically by state.

1969. U.S. Department of Agriculture, Forest Service. 1989. An analysis of the land base situation in the United States: 1989-2040: a technical document supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-181. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 76 p.

1970. U.S. Department of Agriculture, Forest Service. 1989. An analysis of the minerals situation in the United States: 1989-2040: a technical document supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-179. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 p.

1971. U.S. Department of Agriculture, Forest Service. 1989. Basic assumptions: a technical document supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-174. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.

1972. U.S. Department of Agriculture, Forest Service. 1989. A description of USDA programs and responsibilties: a technical document supporting the 1989 USDA Forest Service RPA Assessment. General Technical Report RM-176. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 45 p.

1973. Ulrich, Roger S. 1988. Toward integrated valuations of amenity resources using nonverbal measures. *In:* Peterson, George L.; Driver, B. L.; Gregory, Robin, compilers and editors. Amenity resource valuation: Integrating economics with other disciplines. State College, PA: Venture Publishing, Inc. 87-100.

1974. Uresk, Daniel W. 1984. Black-tailed prairie dog food habits and forage relationships in western South Dakota. Journal of Range Management. 37(4): 325-329.

Four plants made up 65% of items in fecal pellets of the black-tailed prairie dog in western South Dakota. These important forages in order of significance were sand dropseed, sun sedge, blue grama, and wheatgrasses. Relationships of diets to available forage was weak, having an average similarity of 25%; rank-order correlations were nonsignificant, indicating that black-tailed prairie dogs were selective feeders.

1975. Uresk, Daniel W. 1987. Diets of cattle in the Black Hills of South Dakota. *In:* Fisser, Herbert G., editor. Wyoming shrublands: proceedings of the 16th Wyoming shrub ecology workshop; 1987 May 26-27; Sundance, WY. Laramie, WY: Wyoming Shrub Ecology Workshop: 33-35.

Cattle diets were studied in the northern and central Black Hills of South Dakota and Wyoming. In the northern Black Hills, grasses in cattle feces averaged 54%, forbs 17%, and shrubs-trees 28% over the grazing season. For the central Black Hills, grasses made up 69% of the cattle diet, followed by shrubs and trees (20%), and forbs (11%). Seasonal trends of grasses, forbs, shrubs, and trees are presented.

1976. Uresk, Daniel W. 1985. Effects of controlling black-tailed prairie dogs on plant production. Journal of Range Management. 38(5): 466-468.

Production of 43 plant species was evaluated for three treatments (control, prairie dogs only, cattle plus prairie dogs) after poisoning black-tailed prairie dogs (*Cynomys ludovidianus*) on rangelands. Western wheatgrass (*Agropyron smithii*), buffalograss (*Buchloe dactyloides*), and needleleaf sedge (*Carex eleocharis*) were the only plant species that responded to poisoning of prairie dogs.

1977. Uresk, Daniel W. 1987. Effects of livestock grazing and thinning of overstory trees on understory woody plants. *In:* Proceedings—symposium on plant-herbivore interactions; 1985 August 7-9; Snowbird, UT. General Technical Report INT-222. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 168-171.

Two cultural treatments were employed and evaluated over 7 years to determine their effect on height increases of woody plants in decadent woodlands of southwestern North Dakota. Cultural treatments included exclusion of livestock and removing 40% of low-vigor trees. Shrub heights varied with species and cultural treatment. The response of woody plants to these cultural treatments was slow for some species and nonexistent for others.

1978. Uresk, Daniel W. 1982. Importance of woodlands to wildlife and livestock use on the northern Great Plains. *In:* Proceedings of Great Plains Agricultural Council; 1982 June 7-9; North Platte, NE. 7-12. 81 p.

The importance of woodlands to rodents, birds, big game and livestock use on the northern High Plains as compared is presented. Woody riparian habitats which make up less than 8 percent of the Plains receive much use by wildlife and livestock. Management implications for maintaining or enhancing woodlands are given.

1979. Uresk, Daniel W. 1987. Relation of black-tailed prairie dogs and control programs to vegetaion, livestock, and wildlife. Integrated pest management on rangeland. 312-323.

Black-tailed prairie dogs (*Cynomys ludovicianus*) have long been considered pests on shortgrass and mixedgrass prairies of central North America. Because prairie dogs compete for forage with livestock, massive prairie dog control programs were initiated. Prairie dog control also has been justified to reduce reservoirs of contagious diseases. Throughout these control programs, little attention has been given to economic benefits from increased forage, comparison of effectiveness of rodenticides used for prairie dog control, secondary impacts on nontarget animals, livestock-prairie dog forage relationships and wildlife utilizing prairie dog colonies. This chapter presents an overview of these aspects as related to black-tailed prairie dogs on western rangelands.

1980. Uresk, Daniel W.; Bjugstad, Ardell J. 1981. Effects of prairie dogs and cattle on vegetation of the northern High Plains. South Dakota Stockgrower. May 1981: 10, 27.

Plant production where the prairie dogs only grazed was approximately 24 percent higher than under cattle only grazing. Plant production on sites grazed by cattle and prairie dogs together was 13 percent higher than under cattle grazing alone. Under no grazing, the average production was about the same as the cattle treatment.

1981. **Uresk, Daniel W.; Bjugstad, Ardell J. 1984. Prairie dogs as ecosystem regulators on the northern High Plains.** *In:* **Proceedings of the seventh North American prairie conference; 1980 August 4-6; Springfield, MO. 91-94.**

1982. **Uresk, Daniel W.; Boldt, Charles E. 1986. Effect of cultural treatments on regeneration of native woodlands on the northern High Plains. Prairie Naturalist. 18(4): 193-202.**

Two cultural treatments were evaluated over a 6-year post-treatment period to determine their effect on regeneration of native woodlands in southwestern North Dakota. Cultural treatments included livestock exclusion and the combination of felling and removal of low-vigor trees and transplanting of woody plants. Shrub density varied by species when grazed and ungrazed treatments were compared. transplanting of woody plants was successful, and when grazing was excluded, survival of plants improved by about 36%.

1983. **Uresk, Daniel W.; Charps, Jon C. 1986. Denning habitat and diet of the swift fox in western South Dakota. Great Basin Naturalist. 46(2): 249-253.**

Swift fox were investigated in western South Dakota to determine food habits and denning site characteristics. Over a 3-year period, food habitat consisted of mammals, followed by insects, plants, and birds. Dens were located near hilltops within two habitat types, shortgrass and midgrass prairie; each type is characterized by differing plant species. Soil type was not a selective factor for den sites of swift fox. Management considerations for enhancing swift fox populations were presented.

1984. **Uresk, Daniel W.; Dietz, Donald R. 1981. White-tailed deer habitat studies in the Black Hills—An Overview.** *In:* **Proceedings, Black Hills deer management workshop; 1980 January 20-21; Rapid City, SD. Custer, SD: U.S. Department of Agriculture, Forest Service, Black Hills National Forest: 20-21. 39 p.**

1985. **Uresk, Daniel W.; Fager, Leon. 1981. Proceedings, Black Hills deer management workshop; 1980 January 20-21; Rapid City, SD. Custer, SD: U.S. Department of Agriculture, Forest Service, Black Hills National Forest. 39 p.**

1986. **Uresk, Daniel W.; King, Rudy M.; Apa, Anthony D.; Linder, Raymond L. 1986. Efficacy of zinc phosphide and strychnine for black-tailed prairie dog control. Journal of Range Management. 39(4): 298-299.**

Three rodenticide treatments, zinc phosphide (prebaited) and strychinine (both with and without prebait), were evaluated immediately following treatment for efficacy of controlling black-tailed prairie dogs in western South Dakota. Active prairie dog burrows were reduced 95% with zinc phosphide, 83% with strychnine (prebaited), and 45% with strychnine without prebait. zinc phosphide was the most effective in reducing active burrows of prairie dogs.

1987. **Uresk, Daniel W.; King, Rudy M.; Apa, Anthony D.; Deisch, Michele S.; Linder, Raymond L. 1988. Rodenticidal effects of zinc phosphide and strychnine on nontarget species.** *In:* **Uresk, Daniel W.; Schenbeck, Greg L.; Cefkin, Rose, technical coordinators. Eighth Great Plains wildlife damage control workshop proceedings; 1987 April 28-30; Rapid City, SD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 57-63. 231 p.**

When three rodenticide treatments—zinc phosphide (prebaited) and strychnine (both with and without prebait)— were evaluated, zinc phosphide was the most effective in reducing active burrows of prairie dogs; but, it also resulted in a reduction in deer mouse densities. One month after treatment, counts of fecal pellets of eastern cottontails were greater on areas treated with strychnine without prebait than on sites treated with zinc phosphide. Eight months after treatment, no differences could be detected among rodenticides for either leporid. Horned lark densities were reduced 61% on sites treated with strychnine only.

1988. **Uresk, Daniel W.; Lowrey, Dennis G. 1984. Cattle diets in the central Black Hills of South Dakota.** *In:* **Wooded draws: characteristics and values for the northern Great Plains. Symposium proceedings; 1984 June 12-14; Rapid City, SD. Great Plains Agricultural Council Publication No. 111. Rapid City, SD: South Dakota School of Mines and Technology: 50-52. 52 p.**

Cattle diets were determined using fecal analysis. Grasses made up 69% of the diet, followed by shrub and tree category (20%), and forbs (11%). Wheatgrasses and sedges were major diet components throughout the grazing season. Forbs were less abundant in diets, ranging from 6% to 14%. Bur oak and snowberry were important woody species during the fall. All woody plants made up 35% of the diets during September and October.

1989. Uresk, Daniel W.; MacCracken, James G.; Bjugstad, Ardell J. 1982. Prairie dog density and cattle grazing relationships. *In:* Timm, Robert M.; Johnson, Ron J., editors. Proceedings of the fifth Great Plains wildlife damage control workshop; 1981 October 12-15; Lincoln, NE. Lincoln, NE: Institute of Agriculture and Natural Resources, University of Nebraska: 199-201. 299 p.

Blacktail prairie dogs were more abundant in areas of southwestern South Dakota heavily grazed by cattle than in areas where cattle were excluded. Results suggest that periodic exclusions or reduced cattle stocking rates, in combination with control programs, help regulate prairie dog population increase and expansion as indexed by burrow counts.

1990. Uresk, Daniel W.; Paintner, Wayne W. 1985. Cattle diets in a ponderosa pine forest in the northern Black Hills. Journal of Range Management. 38(5): 440-442.

1991. Uresk, Daniel W.; Paulson, Deborah D. 1988. Estimated carrying capacity for cattle competing with prairie dogs and forage utilization in western South Dakota. *In:* Szaro, Robert C.; Severson, Kieth E.; Patton, David R., technical coordinators. Management of amphibians, reptiles, and small mammals in North America: proceedings of the symposium; 1988 July 19-21; Flagstaff, AZ. General Technical Report RM-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 387-390. 458 p.

Carrying capacities for cattle in competition with black-tailed prairie dogs was estimated by linear programming techniques for management of cool-season grasses in western South Dakota. Forage utilization ranged from 20% to 80%. Needlegrasses and needleleaf sedge were key forage species in estimating carrying capacities.

1992. Uresk, Daniel W.; Rickard, W. H.; Cline, J. F. 1980. Perennial grasses and their response to a wildfire in south-central Washington. Journal of Range Management. 33(2): 111-114.

The average leaf length of cusick bluegrass and thurber needlegrass was shortened by burning in all 3 years, but leaf shortening was inconsistent for bluebunch wheatgrass. Cusick bluegrass and thurber needlegrass generally responded to burning with shortened culms and spikes. The basal area of cusick bluegrass and thurber needlegrass was reduced by burning. Phytomass production of bluebunch wheatgrass showed an increase during the 3 years of postburning, whereas cusick bluegrass and thurber needlegrass showed a reduction in phytomass production. No single measurement provided a way to evaluate overall plant responses.

1993. Uresk, Daniel W.; Schenbeck, Greg L. 1987. Effect of zinc phosphide rodenticide on prairie dog colony expansion as determined from aerial photography. Prairie Naturalist. 19(1): 57-61.

Aerial photography was used to evaluate the effectiveness of zinc phosphide in reducing area expansion of black-tailed prairie dog colonies over a 5-year period in western South Dakota. Untreated prairie dog colonies increased 65% in area, compared to a 1% increase on treated colonies. Zinc phosphide, applied at 3-year intervals, was effective in restricting prairie dog colonies to their original size.

1994. Uresk, Daniel W.; Schenbeck, Greg L.; Cefkin, Rose. 1988. Eighth Great Plains wildlife damage control workshop proceedings; 1987 April 28-30; Rapid City, SD. General Technical Report RM-154. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 231 p.

These proceedings consist of more than 40 presented papers on damage caused by many different animals. Panel presentation that followed two special sessions—one on prairie dogs and related small mammals and another on ways to enhance waterfowl production—are also included. In addition to information on mechanical and chemical control methods, the ecosystem processes involved are considered.

1995. Uresk, Daniel W.; Severson, Kieth E. 1989. Understory-overstory relationships in ponderosa pine forest, Black Hills, South Dakota. Journal of Range Management. 42(3): 203-208.

1996. Uresk, Daniel W.; Severson, Kieth E. 1988. Waterfowl and shorebird use of surface-mined and livestock water impoundments on the northern Great Plains. Great Basin Naturalist. 48(3): 353-357.

Cluster analysis and stepwise discriminant analysis were used to group waterfowl and shorebird use on water impoundments (bentonite, coal, livestock) on the northern Great Plains. Three bird use categories—high, medium, and low—were delineated and related to pond characteristics.

1997. Uresk, Daniel W.; Uresk, Virginia A. 1981. Diets and habitat analyses of mule deer on the 200 areas of the hanford site in south-central Washington. PNL-2461. Richland, WA: Pacific Northwest Laboratory, Battelle. 89 p.

1998. Uresk, Daniel W.; Uresk, Virginia A. 1982. Diets and habitats of mule deer in south-central Washington. Northwest Science. 56(2): 138-147.

1999. Uresk, Daniel W.; Yamamoto, Teruo. 1986. Growth of forbs, shrubs, and trees on bentonite mine spoil under greenhouse conditions. Journal of Range Management. 39(2): 113-117.

Revegetation on raw bentonite spoil with or without treatments is often more practical than replacing topsoil in areas where it is scarce or nonexistent. The effect of raw bentonite spoil treated with ponderosa pine sawdust on plant survival and growth was compared to other treatments including perlite, gypsum, straw, vermiculite, and no treatment. The growth promoting effect of sawdust is particularly promising; it is readily available and cost is minimal.

2000. Umess, Phillip J. 1981. Desert and chaparral habitats. *In:* Wallmo, Olof C., editor. Mule and black-tailed deer in North America. Lincoln, NE: Wildlife Management Institute and U.S. Department of Agriculture, Forest Service. University of Nebraska Press: 347-365.

2001. Utter, Jack. 1985. Some legal considerations in water quality management for wildland recreation. College of Agriculture Paper 536. Tucson, AZ: University of Arizona. 46 p.

V

2002. Vahle, J. Robert; Patton, David R. 1983. Red squirrel cover requirements in Arizona mixed conifer forests. Journal of Forestry. 81(1): 14-15, 22.

Seven species of coniferous trees provide red squirrels nesting cover as well as shade for cones stored in a food cache. The best habitat consists of multi-storied stands of mixed conifers with trees from 12-14 inches d.b.h. in dense groups of one tenth acre or less. At least one tree in the group is 18 inches in d.b.h. and is generally a Douglas-fir. Centered within the group is a live tree, snag, or downed log (20 inches or more in d.b.h.) which is the nucleus of the food cache.

2003. Van Der Kamp, Bart J.; Hawksworth, Frank G. 1985. Damage and control of the major diseases of lodgepole pine. *In:* Baumgartner, David M.; Krebill, Richard G.; Arnott, James T.; Weetman, Gordon F., compilers and editors. Lodgepole pine, the species and its management: symposium proceedings; 1984 May 8-10 and May 14-16; Spokane, WA, and Vancouver, BC. Pullman, WA: Washington State University, Cooperative Extension Service: 125-131.

2004. Van Deusen, James L. 1982. Comparison of tree heights in the greenhouse with early height growth in the field for progeny of control-pollinated scotch pine. *In:* Proceedings, 1982 North Dakota Academy of Science; 1982 April 22-24; Bismarck, ND. Grand Forks, ND: North Dakota Academy of Science; 36: 49.

2005. Van Deusen, James L. 1980. Ponderosa pine provenances for the northern Great Plains. Research Paper RM-223. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Ponderosa pine trees representing 79 provenances were tested near Towner, N. Dak. Eight provenances can be recommended for planting in the northern Great Plains, based on 10 years in the plantation: 721 (Valentine, Nebr.); 720 (Ainsworth, Nebr.); 811 (Jordan, Mont.); 722 (Chadron, Nebr.); 703 (Cave Hills, S. Dak.); 816 (York, Mont.); 704 (Slim Buttes, S. Dak.); and 757 (Rosebud, S. Dak.).

2006. Van Deusen, James L. 1980. Windbreak inventories. *In:* Windbreak management: a collection of papers presented at a workshop; 1979 October 23-25; Norfolk, NE. Great Plains Agricultural Council Publication 92. Forestry Committee, Great Plains Agricultural Council: 11-18.

Eleven major categories are proposed for gathering management information: species, age, and row spacing; length, configuration, and spacing; density; vigor; competition; reproduction; insects; diseases; soils; animal and weather damage; and products. Detail with which data are collected will depend on the use for the inventory.

2007. Van Deusen, James L.; Cunningham, Richard A. 1982. Green ash seed sources for North Dakota. Research Paper RM-236. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p.

Based on survival and height after eight field seasons, seed from the following provenances is recommended for use in growing planting stock for use in North Dakota: Aten, Nebr.; Gettysburg, S. Dak.; Fairth, S. Dak.; Lisco, Nebr.; Beaver Crossing, Nebr.; Belfield, N. Dak.; Prairie City, S. Dak.; Bismarck, N. Dak.; and Redfield, S. Dak.

2008. Van Deusen, James L.; Dix, Mary Ellen. 1980. Survey of a *Petrova metallica* Busck in a South Dakota ponderosa pine provenance test plantation. Journal of the Kansas Entomological Society. 53(3): 662-668.

Infestation levels (mean 4.6 pitch blisters per tree), in crowns of 8-year-old trees, at Watertown, S. Dak., varied significantly among geographical clusters, with tree height, and with crown bushiness. Needle angle did not influence infestation. Average number of attacks per leader did not vary significantly among provenances.

2009. Van Devender, Thomas R.; Hawksworth, Frank G. 1986. Fossil mistletoes in packrat middens from the southwestern United States. Madrono. 33(2): 85-99.

2010. Van Haverbeke, David F. 1984. Clonal and sexual variation in initial graft-take of *Juniperus virginiana* L. Canadian Journal of Forest Research. 14(3): 473-474.

Graftings of 44 *Juniperus virginiana* L. clones revealed significant differences in initial graft take among clones and between ovulate and staminate clones. Consistent year to year successes of individual clones indicate the presence of clonal variability in *J. virginiana*.

2011. Van Haverbeke, David F. 1986. Crown shape in a *Pinus sylvestris* L. clonal seed orchard. Silvae Genetica. 35(5-6): 236-240.

Ninety-eight percent of 800 ramets in a 15-year-old *Pinus sylvestris* L. clonal seed orchard in Nebraska have developed short, wide, bushy, and ovately shaped crowns. This condition, manifested by the presence of multiple lateral branches of ramets competing with terminal shoots for dominance, could be a result of topophysis. Wide spacing of ramets in the orchard and climatic conditions unique to the Great Plains also may have contributed to crown ovateness. There were significant differences in ovateness among clones within provenances, but not among provenances.

2012. Van Haverbeke, David F. 1984. Genetic variation in blue spruce: a test of populations in Nebraska. Research Paper RM-253. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Analyses of 43 blue spruce populations, at age 12 (9 years in the field) revealed significant differences among populations for survival, height, vigor, crown diameter, frost injury, and foliage color. Use of regions increases the probability of locating better seed sources; but high variability among individual populations within regions limits their value in specifying where better seed sources can be collected. Phenotypes should be selected in best stands within regions.

2013. Van Haverbeke, David F. 1986. Genetic variation in ponderosa pine: a 15-year test of provenance in the Great Plains. Research Paper RM-265. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 16 p.

Survival was highest and height growth greatest in ponderosa pine provenances from north-central Nebraska, southwest South Dakota, and the High Plains region. Genotype X environment interaction was minimal in central and northern Great Plains plantations. Age/age correlations indicate provenances expressing superior height growth can be identified after 5 or 10 years.

2014. Van Haverbeke, David F. 1987. Genetic variation in Douglas-fir: a 20-year test of provenances in eastern Nebraska. General Technical Report RM-141. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Twenty-year-old Douglas-fir trees in provenances from Arizona, New Mexico, and southern Colorado survived better and grew taller but incurred more winter injury in eastern Nebraska than trees from provenances from northern Colorado, southern and western Montana, northern Idaho, Canada, and eastern Washington. Surviving trees from Pacific Coast and northern and central Rocky Mountain provenances increased in percent of plantation mean height during the past 9 years, whereas trees from southern Rocky Mountain provenances decreased.

2015. Van Haverbeke, David F. 1988. Genetic variation in eastern white pine: a 15-year test of provenances in eastern Nebraska. Research Paper RM-279. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Provenances of eastern white pine from eastern Tennessee, northern Georgia, and western North Carolina produced trees of superior height, diameter, and volume. Height growth was inversely correlated with latitude, but with nonclinal ecotypes. Trees and provenances of superior height are identifiable by age 11. Height differences between original and replacement seedlings persisted throughout the 15-year period.

2016. Van Haverbeke, David F. 1984. Machine-planting seedlings with neat checkerboard precision. Tree Planters' Notes. 35(4): 25-26.

Trees machine-planted on cultivated sites can be aligned in checkerboard pattern by (1) setting several guide flags in each row to be planted, (2) setting three rows of baseline flags outside the plantation at within-row spacings parallel to the first row to be planted, and (3) advancing three rows of baseline flags across the plantation in leap-frog fashion every five rows as planting proceeds.

2017. Van Haverbeke, David F. 1988. Ponderosa pine: use and management in shelterbelts. *In:* Ponderosa pine: the species and its management; 1987 September 19-October 1; Spokane, WA. 47 p.

2018. Van Haverbeke, David F. 1984. Progeny testing—nursery techniques. *In:* Progeny testing: proceedings of servicewide genetics workshop; 1983 December 5-9; Charleston, SC. Washington, DC: U.S. Department of Agriculture, Forest Service, Timber Management: 275-291. 595 p.

Quality seedlings for progeny testing can be produced bare-root or in containers. Progeny testing is a necessary component of a successful tree improvement program. Careful attention to lifting, sorting, and packing insures maintenance of quality seedlings.

2019. Van Haverbeke, David F. 1980. Rocky Mountain juniper. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 99-100.

2020. Van Haverbeke, David F. 1981. Seed orchards—a way to better Christmas trees. I—Establishment. American Christmas Tree Journal. 25(2): 16-19.

Seed orchards promise to supply the Christmas tree industry with genetically improved trees. Principles, techniques and procedures of seed orchard establishment, including selection of material through provenance testing of scotch pine, followed by individual tree selection, vegetative propagation, orchard design, site preparation, field-planting and ground cover management, are discussed.

2021. Van Haverbeke, David F. 1981. Seed orchards—a way to better Christmas trees. Part II—Management. American Christmas Tree Journal. 25(3): 22-25.

Some of the principles and techniques of seed orchard management are discussed, using Nebraska scotch pine seed orchard as an example. Topics include protection of the trees, irrigation and fertilization, crown pruning and shaping, diseases and insects, cone and seed harvesting, and progeny testing and seed certification.

2022. Van Haverbeke, David F. 1983. Seventeen-year performance of *Pinus flexilis* and *P. strobiformis* progenies in eastern Nebraska. Silvae Genetica. 32: 71-76.

2023. Van Haverbeke, David F. 1980. Short note: winter injury in a scotch pine (*Pinus sylvestris* L.) clonal seed orchard. Silvae Genetica. 28(4): 167-169.

Scotch pine clonal seed orchard trees, 3 to 6 years old, sustained varying amounts of crown damage follow-

ing prolonged drought stress and severe winter conditions in eastern Nebraska. Damage was greatest in the northwestern portion of the orchard, direction of prevailing winter winds. Primary branch tips and secondary branchlets of trees, which were killed by desiccation, in the North and Northwest, were detected among clones and provenances. Provenances from the most northerly and southerly regions incurred most damage. Age of trees was not significant.

2024. Van Haverbeke, David F. 1984. Survival and height growth of Norway spruce in a south-central Nebraska provenance trial. Research Note RM-439. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Among five Romanian provenances of norway spruce tested in south-central Nebraska, a source from pojoriata survived best and grew tallest during an 8-year test period. Shading seedlings during field establishment significantly increased survival.

2025. Van Haverbeke, David F. 1980. Trees in urban energy conservation. *In:* Proceedings of the national urban forestry conference; 1978 November 13-16; Washington, DC. ESF Publication 80-003. Syracuse, NY: State University of New York: 183-191. 874 p.

Knowledge of windbreak influences of trees from Plains research can be useful in quantifying protective influences of trees in urban energy conservation. Guidelines are being formulated for effective use of trees to enhance human comfort outdoors, and to reduce energy consumption for space conditioning.

2026. Van Haverbeke, David F. 1986. Twenty-year performances of scotch, European black (Austrian), red, and jack pines in eastern Nebraska. Research Paper RM-267. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

Sources of scotch, European black (Austrian), red, and jack pines were identified that produce trees, at age 20, which are well-adapted to eastern Nebraska in terms of survival, height and diameter growth, crown and stem characteristics, cone production and disease resistance. Age/age correlations indicate that provenances of superior height growth can be identified by age 10.

2027. Van Haverbeke, David F. 1987. Windbreaks in Pakistan for optimum production of annual crops and week. *In:* Society of American Foresters Annual Convention; 1987 October 18-21. Section D-4. Windbreak Technology. 1 p.

2028. Van Haverbeke, David F. 1987. Windbreaks in the People's Republic of China. *In:* 5th North Central tree improvement conference; 1987 August 10-12; Fargo, ND. 1 p.

2029. Van Haverbeke, David F.; Bagley, Walter T.; Brandle, James R.; Lovett, William R. 1984. A quarter century of tree improvement research in Nebraska. *In:* 36th annual meeting of the Forestry Committee. Tree improvement in the Great Plains proceedings; 1984 June 26-28; Watertown, SD. Great Plains Agricultural Council Publication 112. Lincoln, NE: University of Nebraska: 63-83. 230 p.

Evaluations of provenance and other tests have revealed seed sources which are rapid-growing, well-adapted, resistant to disease, and tolerant to insects in the Nebraska environment.

2030. Van Haverbeke, David F.; Comer, C. W. 1985. Effects of treatment and seed source on germination of eastern redcedar seed. Research Paper RM-263. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Germination of eastern redcedar (*Juniperus virginiana* L.) seeds was best with a 96-hour soak in citric acid (10,000 ppm.), with 6 weeks of moist-cold (24° C) stratification, and 10 weeks of moist-cold (5°C) Stratification. Geographic seed sources responded differently to treatment. Use of fresh seeds could reduce the time in moist-warm stratification, would improve germination, and would reduce interaction between seed source and treatment.

2031. Van Haverbeke, David F.; Peterson, Glenn W. 1989. Effect of storage temperature on germination of seeds of twenty sources of ponderosa pine. Research Note RM-490. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Seeds of 20 sources of ponderosa pine, stored for 22 years at 5°C in glass jars and for 22 years at -16°C in paper sacks, attained 64% germination. viability ranged from 22-80% and from 34-83%, respectively. Rate of germination was higher through days 4-6 for seeds stored at -16°C, but similar thereafter. Differences in

germination between storage treatments were not consistent among sources; for some sources, storage at -16°C would be better; for other sources, storage at 5°C would be better. Consistency in germination response and the relationship of storage at -16°C compared to storage at 5°C did not appear to be related to latitude.

2032. Van Haverbeke, David F.; Probasco, George E. 1980. Eastern redcedar. *In:* Eyre, F. H., editor. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 50-51.

2033. Van Haverbeke, David F.; Sprackling, John A.; Hovland, Ted L. 1982. Care and handling of experimental tree material from seed identification to outplanting. Tree Planters' Notes. 33(3): 9-12.

2034. Vertucci, Frank A. 1988. The reflectance and fluorescence properties of Adirondack Mountain region lakes applied to the remote sensing of lake chemistry. Ithaca, NY: Cornell University. 365 p. Ph.D. dissertation.

2035. Vertucci, Frank A.; Likens, Gene E. 1989. Spectral reflectance and water quality of Adirondack Mountain Region lakes. Limnology and Oceanography. 34(8): 1656-1672.

2036. Vertucci, Frank A.; Likens, Gene E. 1989. Spectral reflectance and water quality of Adirondack mountain region lakes. Limnology Oceanography. 34(8): 1656-1672.

2037. Vining, Joanne; Orland, B. O. 1989. The video advantage: a comparison of two environmental representation techniques. Journal of Environmental Management. 29: 275-283.

2038. Voorhees, Marguerite E. 1986. Infiltration rate of bentonite mine spoil as affected by amendments of gypsum, sawdust and inorganic fertilizer. Reclamation and Revegetation Research. 5: 483-490.

Amendment of bentonite mine spoil with sawdust increased the infiltration rate and total cumulative infiltration rate and total cumulative infiltration of water in laboratory tests. Spoil that had been amended with sawdust had absorbed 41%, 74%, and 75% more water at 2, 24 and 48 h after initial wetting, respectively, than spoil that had not been amended with sawdust. Water had infiltrated sawdust-amended spoil at a rate that was 92%, 259% and 300% greater than the rate of penetration for spoil that had not been so amended during the period of time from 0 to 1 h, from 1 to 2 h and from 2 to 24 h after wetting, respectively. Gypsum or fertilizer amendments (alone or in combination with other amendments) had no significant effect on infiltration.

2039. Voorhees, Marguerite E.; Trlica, M. J.; Uresk, Daniel W. 1987. Growth of rillscale on bentonite mine spoil as influenced by amendments. Journal of Environmental Quality. 16(4): 411-416.

Application of amendments in the fall had a greater positive effect on growth of rillscale than application of amendments in the spring. Amendment with sawdust, alone or in combination with other amendments, increased growth of rillscale through at least two growing seasons. Amendments of gypsum and inorganic fertilizer alone had little effect on plant growth, but the highest production of rillscale (3500 kg/ha) was achieved on spoil that had been treated in the fall with a combination of gypsum, sawdust (With N), and fertilizer (N, P, and K) amendments. High production capabilities and degree of response to spoil treatment support the hypothesis that rillscale could be useful for early revegetation of bentonite mine spoil.

2040. Voorhees, Marguerite E.; Uresk, Daniel W.; Hansen, Richard M. 1984. *Atriplex suckleyi* (Torrey) Rydb. a native annual plant for revegetating bentonite mine spoils. *In:* Tiedemann, Arthur R. [and others], compilers. Proceedings of the symposium on the biology of *Atriplex* and related chenopods; 1983 May 2-6; Provo, UT. Ogden, UT: Intermountain Forest and Range Experiment Station: 306-309. 309 p.

Rillscale is a plant that may have potential for revegetating bentonite mine spoils following spoil modifications. Sawdust and gypsum amendments were effective for improving spoils as a plant growth medium when applied in the fall. Spring applications of sawdust were less effective and spring applications of gypsum were ineffective. Fertilizers generally had no effect on plant growth.

2041. Wagner, Michael R.; Clancy, Karen M.; Tinus, Richard W. 1989. Maturational variation in needle essential oils from *Pseudotsuga menziesii, Abies concolor* and *Picea engelmannii*. Phytochemistry. 28(3): 765-770.

The maturational variation in current year needle essential oils of Douglas-fir, white fir, and Engelmann spruce was determined. Strong Seasonal And Between-species Differences Were Found. Most compounds increased in concentration through the season. White fir foliage had the highest essential oil concentration and Engelmann spruce foliage has the lowest concentration.

2042. Wagner, Michael R.; Clancy, Karen M.; Kirkbride, Dale M. 1987. Predicting number of oocytes in adult western spruce budworm, *Choristoneura occidentalis* (Lepidoptera: Tortricidae). Environmental Entomology. 16: 551-555.

2043. Wagner, Michael R.; Koerber, Thomas W.; Schmid, John M. 1987. Insects affecting seed production of ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) in the southwestern United States. *In:* Roques, Allian, compiler and editor. Cone and seed insects working party S2.07-01: Proceedings of the second conference; 1986 September 3-5; Briancon, France. Paris, France: IUFRO: 69-81.

2044. Wagner, Michael R.; Tinus, Richard W. 1985. Mechanism of tree resistance to spruce budworms—is there a terpene connection? *In:* Mullins, E. G., editor. Proceedings, CANUSA spruce budworms research symposium; 1984 September 16-20; Bangor, ME. Ottawa, Ontario: Canadian Forestry Service: 578-580.

2045. Walla, James A.; Riffle, Jerry W. 1981. *Fomes fraxinophilus* on green ash in North Dakota windbreaks. Plant Disease. 65: 669-670.

Incidence of *Fomes fraxinophilus* stem decay on green ash, in North Dakota State Forestry Project Windbreaks was determined using a 0.9-percent random sample of windbreaks. From the survey, it is estimated that 8,700 trees of an estimated population of 3 million living green ash trees in North Dakota have sporocarps.

2046. Walla, James A.; Riffle, Jerry W. 1986. Gymnosporangium rusts on junipers. *In:* Riffle, Jerry W.; Peterson, Glenn W., technical coordinators. Diseases of trees in the Great Plains. General Technical Report RM-129. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 136-137. 149 p.

2047. Walsh, Richard G.; Gilliam, Lynda O. 1982. Benefits of wilderness expansion with excess demand for Indian Peaks. Western Journal of Agricultural Economics. 7: 1-12.

2048. Walsh, Richard G.; Loomis, John B. 1986. The contribution of recreation to national economic development. *In:* Driver, B. L.; Peterson, George L., compilers and editors. A literature review, the President's Commission on Americans Outdoors. Washington DC: U.S. Government Printing Office: 35-46.

2049. Walsh, Richard G.; Miller, Nicole P.; Gilliam, Lynda O. 1983. Conjestion and willingness to pay for expansion of skiing capacity. Land Economics. 59(2): 195-210.

2050. Walsh, Richard G.; Peterson, George L.; McKean, John R. 1989. The discriminatory impact of recreation price. Journal of Leisure Research. 21(4): 327-347.

2051. Walsh, Richard G.; Sanders, Larry D.; Loomis, John B. 1986. Measuring the economic benefits of proposed wildland scenic rivers. *In:* Proceedings 1984 national river recreation; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 301-315.

2052. Walters, James W.; Hinds, Thomas E.; Johnson, David W. 1982. Effects of partial cutting on diseases, mortality, and regeneration of Rocky Mountain aspen stands. Research Paper RM-240. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 12 p.

Logging wounds on residual aspen, in partially cut stands, predisposed wounded trees to attack by insects and diseases. Five to 7 years after cutting, aspen mortality amounted to 20 percent; 41 percent of the live trees were infected with canker diseases; and 30

percent were infested with wood borers. Adequate sprouting occurred even though only 60-80 percent of the basal area was wounded.

2053. Wang, Y. S. 1989. Turbulence structure, momentum and heat transport in the edge of broad leaf tree stands. Storrs, CT: University of Connecticut; Progress Report No. 15. 137 p.

2054. Wang, Y. S.; Miller, D. R.; Anderson, D. E.; Thistle, H. W.; Lin, J. D. 1989. Spatial variability of turbulence in an almond orchard during phase IV project WIND. *In:* 19th conference on agriculture and forest meteorology; 1989 March 7-10; Charleston, SC. Boston, MA: American Meteorological Society.

2055. Ward, A. Lorin. 1985. Displacement of elk related to seismograph activity in south-central Wyoming. *In:* Issues and technology in the management of impacted western wildlife: proceedings of a national symposium; 1985 February 4-6; Glenwood Springs, CO. Boulder, CO: Thorne Ecological Institute: 246-254.

A hunted elk population on winter range was monitored by visual observation and telemetry during seismographic activity, including above ground explosions, truck vibrators, and drill and shoot. Elk were displaced by all three forms of seismograph activity. The most extreme response was to people walking. The distance depended on whether the elk would be out of sight of seismic crews. Within a few days after human activity stopped, elk returned to the seismograph use areas.

2056. Ward, A. Lorin. 1982. Mule deer behavior in relations to fencing and underpasses of Interstate 80 in Wyoming. Transportation Research Record. 859: 8-13.

Big game fencing 8 feet high was used successfully to force approximately 1,000 mule deer *(Odocoileus hemionus)* to use three machinery and four box-type underpasses to cross under interstate 80 during their migrations. Deer-vehicle accidents have been reduced by more than 95 percent in the area.

2057. Ward, A. Lorin. 1980. Multiple use of timbered areas: views of a wildlife manager specifically for elk and mule deer. *In:* Meeting the challenge of the 80's. Proceedings: Rocky Mountain forest industries conference; 1980 May 7-10; Jackson, WY. 1-24. 170 p.

Timber management is compatible with hunted populations of elk *(Cervus canadensis)* and mule deer *(Odocoileus hemionus)* management if animal habitat requirements are considered. Foraging areas, preferably 9- to 32-ha openings such as parks, meadows, riparian zones, clearcuts, and burns, must be protected from human disturbances such as vehicles and pedestrians. Elk prefer a "buffer zone" of 800 m from pedestrians and 400 m from moving traffic; mule deer prefer 180 m from pedestrians and 90 m from moving traffic.

2058. Ward, A. Lorin. 1983. Multiple use of timbered areas: views of a wildlife manager specifically for deer and elk. *In:* Timber harvesting in the central Rockies: problems and opportunities; 1983 January 4-6; Fort Collins, CO. Publication XCM-87. Fort Collins, CO: Cooperative Extension Service, Colorado State University: 269-291.

2059. Ward, A. Lorin. 1985. The response of elk and mule deer to firewood gathering on the Medicine Bow Range in south-central Wyoming. *In:* Proceedings of the 1984 western states and provinces elk workshop; 1984 April 17-19; Edmonton, Alberta, Canada. Edmonton, Alberta: Wildlife Branch, Fish and Wildlife Division: 28-40.

More than 1,000 cords of firewood were removed by the public from the North Fork and Rock Creek Park area of the Medicine Bow National Forest during the summer and fall of 1980. Telemetered elk and their associates were disturbed by the presence of humans and preferred a buffer area of 800 m. Telemetered mule deer were more tolerant of the disturbance and continued to use the area although they generally stayed in the trees.

2060. Ward, A. Lorin. 1981. Telemetered heart rate of three elk as affected by activity and human disturbance. *In:* Planning for trailbike recreation, part 2. Washington, DC: U.S. Department of the Interior, Heritage Conservation and Recreation Service: 28-33.

2061. Ward, A. Lorin; Fornwalt, Nevin E.; Henry, Stephen E.; Hodorff, Robert A. 1980. Effects of highway operation practices and facilities on elk, mule deer, and pronghorn antelope. Final report. FHWA-RD-79-143. Washington, DC: Federal Highway Administration.

Describes effectiveness of 8-foot-high wildlife fencing to guide deer through underpasses under Interstate 80 to avoid collisions, and how all three species respond to roads, vehicular traffic, and people.

2062. Ward, Frank A. 1986. Optimally managing wild rivers for instream benefits. *In:* Proceedings 1984 national river recreation symposium; 1984 October 31-November 3; Baton Rouge, LA. Baton Rouge, LA: Louisiana State University: 285-300.

2063. Ward, Timothy J. 1986. A study of runoff and erosion processes using large and small rainfall simulators. New Mexico Water Resources Research Institute Report 215. Las Cruces, NM: New Mexico State Univesity. 71 p.

2064. Ward, Timothy J.; Baker, Malchus B., Jr. 1984. Sediment from managed pine watershed in northern central Arizona. *In:* Proceedings of the specialty conference sponsored by the irrigation and drainage division; 1984 July 24-26; Flagstaff, AZ. New York, NY: American Society of Civil Engineers: 552-558. 731 p.

These data from the last 20 years indicate an initial, marked increase in sediment yield following treatment which is related to the degree of management activity and the intensity of runoff.

2065. Ward, Timothy J.; Bolin, Susan B. 1989. Determination of hydrologic parameters for selected soils in Arizona and New Mexico utilizing rainfall simulation. Tech. Compl. Rep. WRRI 243. Las Cruses, NM: New Mexico State University, New Mexico Water Resources Institute. 84 p.

2066. Ward, Timothy J.; Bolin, Susan B. 1989. A study of rainfall simulators, runoff and erosion processes, and nutrient yield on selected sites in Arizona and New Mexico. Tech. Compl. Rep. WRRI 241. Las Cruses, NM: New Mexico State University, New Mexico Water Resources Institute. 68 p.

2067. Waring, R. H.; Rogers, James J.; Swank, Wayne T. 1981. Water relations and hydrologic cycles. *In:* Reichle, D. E., editor. Dynamic properties of forest ecosystems. Cambridge, MA: Cambridge University Press: 205-264.

2068. Weiss, A.; Lukens, Donald L.; Norman, J. M.; Steadman, J. R. 1989. Leaf wetness in dry beans under semi-arid conditions. Agricultural and Forest Meteorology. 48: 149-162.

2069. Weiss, A.; Lukens, Donald L.; Steadman, J. R. 1988. A sensor for the direct measurement of leaf wetness: construction techniques and testing under controlled conditions. Agricultural and Forest Meteorology. 43(3-4): 241-249.

2070. Wellman, J. D.; Dawson, M. S.; Roggenbuck, J. W. 1982. Park managers' predictions of the motivations of visitors to two National Park Service areas. Journal of Leisure Research. First Quarter 1982: 1-15.

2071. Wengert, Eugene M.; Donnelly, Dennis M. 1980. Lumber yield potential of aspen in the Rocky Mountains. Research Paper RM-227. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

The yield of sawn products from aspen (*Populus tremuloides* Michx.) trees from northern New Mexico and eastern Utah, both in terms of volume and dollar value, was related to trial tree and log grades. Trial grading systems generally allowed separation of trees and logs into different levels of volume and dollar value recovery.

2072. Wengert, Eugene M.; Donnelly, Dennis M.; Markstrom, Donald C.; Worth, Harold E. 1986. Wood utilization. *In:* DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: ecology and mangement in the western United States. General Technical Report RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 169-180. 283 p.

2073. Werth, Lee F. 1983. Remote sensing for forest land change detection—an approach for national assessment. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 330-333. 737 p.

This paper reviews past studies using remote sensing techniques for detecting abrupt changes in forest land. An operational technique that combines good aspects of aerial photography and landsat and multispectral scanner data is presented.

2074. Wesche, Thomas A.; Rechard, Paul A. 1980. A summary of instream flow methods for fisheries and related research needs. Eisenhower Consortium Bulletin 9. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest And range Experiment Station. 122 p.

2075. Whelan, James B. 1982. Interagency coordination of wildlife and fish resource inventories. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 588-591. 1101 p.

2076. Whisenant, Steven G.; Uresk, Daniel W. 1989. Burning upland, mixed prairie in Badlands National Park. Prairie Naturalist. 21(4): 221-227.

The effects of burning in either April or October were measured on a droughty, upland site in west-central South Dakota. Spring burning reduced blue grama and western wheatgrass production for 1-2 seasons. Threadleaf sedge productivity was increased when precipitation was above average, but was reduced when postburn precipitation was low. Needle-and-thread production was generally reduced for 2-3 years. Recovery of needle-and-thread, western wheatgrass, and threadleaf sedge on an upland site of below average productivity required 1-3 years longer compared to more productive sites.

2077. Whiteside, Richard W.; Guthery, Fred S. 1981. Coyote use of playas in the Texas High Plains. Prairie Naturalist. 13: 42-44.

2078. Whitford, Walter G.; Aldon, Earl F.; Freckman, Diana W.; Steinberger, Yosef; Parker, Lawrence W. 1989. Effects of organic amendments on soil biota on a degraded rangeland. Journal of Range Management. 42(1): 56-60.

Rehabilitation of degraded rangeland requires rebuilding the soil, including soil biota. In this study, wheat straw, bark and wood chips, and dried municiple sludge were placed on native range plots in north-central New Mexico. There may be long-term benefits from application of recalcitrant mulches like wood chips and bark, but the less recalcitrant mulching materials like straw and low application rates of sludge produce no measurable benefit.

2079. Wicker, Ed F. 1989. Public involvement in forest health - who will speak. *In:* 36th western international forest disease work conference; 1988 September 19-23; Park City, UT. Vancouver, BC, Canada: University of British Columbia Department of Forest Science: 58-66.

2080. Wicker, Ed F.; Hawksworth, Frank G. 1988. Relationships of dwarf mistletoes and intermediate stand cultural practices in the northern Rockies. *In:* Schmidt, Wyman C., compiler. Proceedings—future forests of the Mountain West: a stand culture symposium; 1986 September 29-October 3; Missoula, MT. General Technical Report INT-243. Ogden, UT: U.S. Department of Agriculture, Intermountain Research Station: 298-302.

The dwarf mistletoes have long been known as one of the most widespread and damaging disease agents of conifers in the West, including the northern Rockies. Although the basics for silvicultural control of these parasites are well established, these principles have been effectively applied only during the last decade or two. This paper discusses the ecological role of dwarf mistletoes in northern coniferous forests. Knowledge of weak links in the life cycle of dwarf mistletoes should be utilized to develop control strategies and tactics, and to incorporate them into management practices.

2081. Wiebe, Wayne L.; Peterson, Glenn W.; Wysong, David S. 1983. *Diplodia* tip blight of pines. Nebguide G83-646. Lincoln, NE: Cooperative Extension Service, Institute of Agriculture And Natural Resources, University of Nebraska: B-6.

This article discusses the symptoms and disease cycle of this common fungus, which generally infects older pine plantings, and recommends control measures.

2082. Wiens, Delbert; Calvin, Clyde L.; Wilson, C. A. 1987. Reproductive success, spontaneous embryo abortion, and genetic load in flowering plants. Oecologia. 71: 501-509.

2083. Wiens, Delbert; Nickrent, Daniel L.; Davern, C. I.; Calvin, C. L.; Vivrette, N. J. 1989. Developmental failure and loss of reproductive capacity in the rare palaeoendemic shrub *Dedeckera eurekensis*. Nature. 338: 65-67.

2084. Wikstrom, John H.; Hoekstra, Thomas W. 1981. The analytical basis for integrated forest and rangeland ecosystem inventory. *In:* Lund, H. Gyde [and others], technical coordinators. Arid land resource inventories: developing cost-efficient methods; 1980 November 30-December 6; La Paz, Mexico. General Technical Report WO-28. Washington, DC: U.S. Department of Agriculture, Forest Service: 56-60. 620 p.

2085. Wikstrom, John H.; Hoekstra, Thomas W. 1981. Forest ecosystem analysis and inventory in the United States. *In:* Proceedings, 17th IUFRO World Congress; 1981 September 6-12; Kyoto, Japan. Ikarashi, Niigata, Japan: Niigata University: 280-290.

2086. Wilkins, Scott D.; Klopatek, Jeffrey M. 1984. Moisture stress, *Atriplex* species, and reclamation at Black Mesa, Arizona. *In:* Tiedemann, Arthur R.; McArthur, E. Durant; Stutz, Howard C.; Stevens, Richard; Johnson, Kendall L., editors. Proceedings: symposium on the biology of *Atriplex* and related chenopods; 1983 May 2-6; Provo, UT. General Technical Report INT-172. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 97-107.

2087. Wilkins, Scott D.; Klopatek, Jeffrey M. 1987. Plant water relations in ecotonal areas of pinyon-juniper and semi-arid shrub ecosystems. *In:* Pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 412-417.

2088. Williams, Knox. 1980. Credibility in avalanche warnings. Journal of Glaciology. 26(94): 93-96.

Avalanche warnings can provide a valuable public service. To be effective, the warning program must inspire public confidence. The topics discussed are the requirements for a good forecaster, the working relationship between the forecaster and field observers, relations with the news media and the public, and forecast accuracy.

2089. Williams, Knox. 1980. Weather and avalanche forecasting: where do we stand? *In:* Proceedings, avalanche workshop; 1980 November 3-5; Vancouver, BC. Technical Memorandum No. 133. Ottawa, Canada: National Research Council: 31-41.

2090. Williams, Knox; Armstrong, Betsy R. 1984. The snowy torrents: avalanche accidents in the United States 1972-1979. Jackson, WY: Teton Bookshop Publishing Company. 221 p.

This compilation of 145 avalanche accidents reports will help those who spend time in the mountains in winter to avoid getting caught in an avalanche, or if caught, how to survive.

2091. Williams, R. E.; Shaw, Charles G., III; Wargo, P. M.; Sites, W. H. 1986. *Armillaria* root disease. Forest Service, FIDR Leaflet 78. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

2092. Williams, Tod B.; Francis, Richard E. 1989. A taxonomic field herbarium. Rangelands. 11(4): 156-157.

Field herbariums provided valuable reference for plant identification when taxonomic information was included. Taxonomic herbarium sheets (10 cm x 15 cm) included a floral vegetation specimen, line-drawing, and a descriptive key. An individual specimen sheet can be assembled for about $1 and takes 30 minutes.

2093. Wilson, C. L.; Catts, G. P. 1986. Determining conifer stand stocking percentages by sequential clustering and masking of thematic mapper digital data. *In:* Use of auxiliary information in natural resource inventories; 1985 October 1-2; Blacksburg, VA. SAF 86-01. Blacksburg, VA: Virginia Polytechnic University: 9-23.

2094. Wilson, Rodney L.; Schreuder, Hans T.; Ken, Brian. 1982. A comparison of survey sampling computing packages. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 976-984. 1101 p.

2095. Wilson, Rodney L.; Schreuder, Hans T. 1983. Some alternative estimators for mean tree diameter in even-aged stands. *In:* Bell, John F.; Atterbury, Toby, editors. Proceedings of an international conference on renewable resource inventories for monitoring changes and trends; 1983 August 15-19; Corvallis, OR. Corvallis, OR: Oregon State University, College of Forestry: 206-210. 737 p.

A computer simulation study is used to examine the performance of alternative estimators for mean tree

diameter at breast height in even-aged forest stands. The performance of six alternative estimators are compared to that of the traditional estimator, the sample mean. Cases are discussed where inventory specialists can increase their estimation efficiency by using knowledge about a population's distribution characteristics.

2096. Winter, C. James; Sturges, David L. 1989. Improved procedures for installing and operating precipitation gages on alter shields on windswept lands. Research Note RM-489. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

This note describes materials to speed the installation of a recording precipitation gage and a modified alter windshield, as well as techniques to improve the operating performance of gages in locations where blowing snow and cold temperatures are common. Materials cost about $110.

2097. Winterberger, Kenneth C.; Hegg, Karl M. 1982. A low-cost photo-scale protractor for small scale photography. Photogrammetric Engineering. 48: 941-943.

2098. Wisdom, C. S.; Crawford, C. S.; Aldon, Earl F. 1989. Influence of insect herbivory on photosynthetic area and reproduction in Gutierrezia species. Ecology. 77: 685-692.

Measurements were made on photosynthetic area and proximate reproduction of plants with both tied and control branches. In within-plant comparisons, tied branches had significantly less photosynthetic area than control branches. The number of flowers/branch, flowers/capitulum, seeds/branch, and seeds/capitulum were significantly greater for control than for tied branches. However, seeds produced by tied branches germinated more rapidly and at a higher percentage than seeds from control branches over the same time period.

2099. Wolters, Gale L.; Aldon, Earl F.; Donart, Gary B. 1989. Response of reseeded coal mine spoils to season and intensity of defoliation: preliminary findings. *In:* **Walker, D. G.; Powter, C. B.; Pole, M. W., editors. Reclamation, a global perspective: proceedings of the conference; 1989 August 28-30; Calgary, Alberta, Canada. Report No. RRTAC 89-2. Calgary, Alberta, Canada: Alberta Land Conservation and Reclamation Council: 289-298. 854 p. (2 volumes).**

Preliminary findings indicate that revegetated coal mine sites in western New Mexico can be defoliated any of five seasons without significantly influencing production of wheatgrasses. Plant response to defoliation intensity was variable but, generally, defoliation at 7.5 cm was more detrimental to production than defoliation at 15-cm stubble height.

2100. Wood, Geoff B.; Schreuder, Hans T.; Brink, Glen E. 1985. Comparison of a model-based sampling strategy with point-Poisson sampling on a timber management area in the Arapahoe-Roosevelt National Forest. Canadian Journal of Forest Research. 15: 83-86.

Field procedures, incorporating model-based (MB) sampling, were developed to estimate the volume of timber in a 20-ha coniferous forest, in the Arapahoe-Roosevelt National Forest of Colorado. Estimates derived for two point-MB, two point-Poisson (PP), and a large (20%) Poisson sample confirm that point-MB sampling is as efficient as the pp procedure. Point-MB sampling has the advantage that the size of the second-stage sample can be rigidly controlled. It practically guarantees a good sample, whereas poor samples occasionally are selected with PP sampling.

2101. Wood, Geoff B.; Schreuder, Hans T. 1986. Implementing point-poisson and point-model based sampling in forest inventory. Forest Ecology and Management. 14: 141-156.

Office and field procedures are described for planning and implementing point-poisson and point-model based sampling strategies for forest inventory.

2102. Wood, M. C.; Fox, Douglas G.; Marlatt, William E. 1981. Energy development planning and air quality: a modeling assessment of northwestern Colorado. *In:* **Proceedings of the second conference on mountain meteorology; Steamboat Springs, CO. Boston, MA: American Meteorological Society: 157-160.**

Paper presents results of a study of the air pollution potential for the vicinity of Craig, CO The analysis of pollution potential is based upon a combined wind model and air pollution model. Results are in the form of qualitative maps of the relative potential for air pollution in the area.

2103. Woodward, D. F.; Farag, A. M.; Mueller, M. E.; Little, E. E.; Vertucci, Frank A. 1989. Sensitivity of endemic snake river cutthroat trout to acidity and elevated aluminum. Transactions of the American Fisheries Society. 118: 630-643.

2104. **Wooldridge, Gene L. 1986. The dynamics of the planetary boundary layer over a heated slope. Geofizika. 3: 3-21.**

2105. **Wooldridge, Gene L.; Fox, Douglas G. 1981. Airflow Trajectories and eddy diffusivities in the vicinity of Crested Butte, Colorado: implications for modeling. *In:* Proceedings of the second conference on mountain meteorology; Steamboat Springs, CO. Boston, MA: American Meteorological Society: 301-308.**

Doople theodolite tracking of constant volume balloons with and without temperature sonde equipment shows the general behavior of airflow in the vicinity of Crested Butte, CO Eddy diffusivities and trajectories are presented. Trajectories show fair agreement with calculations for flow around isolated topography.

2106. **Wooldridge, Gene L.; Fox, Douglas G.; Furman, R. William. 1987. Airflow patterns over and around a large three-dimensional hill. Meteorology and Atmospheric Physics. 37: 258-270.**

Surface wind patterns and air flows within the planetary boundary layer over a large three-dimensional hill of moderate slope are grouped according to froude number classes. An evolution of flow patterns is shown to occur as the froude number increases. The concept of a critical height for the approach flow is generally supported. The integral form of the froude number does not appear to be superior to a bulk froude calculation in representing a particular airflow pattern.

2107. **Wooldridge, Gene L.; Furman, R. William. 1984. The use of froude numbers to represent airflow patterns around an isolated mountain. *In:* Third conference on mountain meteorology; 1984 October 16-19; Portland, OR. Boston, MA: American Meteorological Society: 46-48.**

Evidence of the wind flow characteristics is derived here from surface wind stations on an isolated mountain in northern New Mexico, sonde-equipped pilot balloon flights near the mountain and superpressured balloon trajectories over and around it. A change in the wake characteristics corresponding to a change in froude numbers is noted.

2108. **Wooldridge, Gene L.; Thorson, P. A.; Furman, R. William. 1982. Airflow patterns and momentum flux profiles around an isolated mountain. *In:* Proceedings, 17th international conference for alpine meteorology; 1982 September 21-25; Berchtesgaden, German Federal Republic. 140-142. (Preprint).**

2109. **Wysong, David S.; Riffle, Jerry W. 1982. *Cytospora* canker of poplars and willows. Nebguide G75-257. Lincoln, NE: Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska. (Revised).**

Cytospora chrysoperma is one of several fungal pathogens that cause cankers on hardwood trees. This fungus is most damaging to poplars, willows, and mountain ash, but can also attack other trees, such as silver maple and Siberian elm. *Cytospora* canker is considered one of the principal limiting factors in the establishment and growth of siouxland cottonwood, lombardy poplar, and weeping willow.

2110. **Yamamoto, Teruo. 1982. A review of uranium spoil and mill tailings revegetation in the western United States. General Technical Report RM-92. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 20 p.**

The following aspects of uranium mine and mill tailings management are reviewed and discussed: (1) the history of the uranium remedial action program, (2) magnitude of the uranium spoils problem, (3) uranium deposits, mining, and milling, (4) status of reclamation, (5) problems in revegetation of uranium spoils and tailings, and (6) health and safety considerations.

2111. **Yancik, Richard F.; Roussopoulos, Peter J. 1982. User's guide to the National Fire Occurrence Data Library. Unnumbered publication. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 25 p.**

The National Fire Occurrence Data Library is an automated system for the collection, retrieval, and analysis of historical wildfire information from federal and state agencies. Instructions, including runstreams, example inputs, and example outputs, are provided for using library computer software maintained at the USDA Fort Collins Computer Center.

2112. Yandle, David A. 1982. Binomial sampling in forest populations. *In:* Brann, Thomas B.; House, Louis O., IV; Lund, H. Gyde, editors. In-place resource inventories: principles and practices. Proceedings of a national workshop; 1981 August 9-14; Orono, ME. Publication 82-02. Washington, DC: Society of American Foresters: 362-370. 1101 p.

2113. Young, John S.; Donnelly, Dennis M.; Sorg, Cindy F.; Loomis, John B.; Nelson, Louis J. 1987. Net economic value of upland game hunting in Idaho. Resource Bulletin RM-15. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.

Net willingness to pay in addition to actual expenditure for upland game hunting in idaho was estimated with the travel cost method and the contingent value method. Net differences between methods result in part from their long-run and short-run orientations in this study.

2114. Young, Michael K.; Hubert, Wayne A.; Wesche, Thomas A. 1989. An evaluation of variation in permeability measurements when using the MARK IV standpipe. Canadian Journal of Fisheries and Aquatic Sciences. 46: 447-450.

2115. Young, Michael K.; Hubert, Wayne A.; Wesche, Thomas A. 1989. From laboratory to field: potential application of a survival to emergence model for Colorado River cutthroat trout. *In:* The Annual Meeting of the Colorado-Wyoming Chapter of the American Fisheries Society; 1989 March 1-2; Laramie, WY. 24: 41-49.

2116. Young, Michael K.; Hubert, Wayne A.; Wesche, Thomas A. 1989. Substrate modification by spawning brook trout in a southeastern Wyoming stream. Transactions of the American Fisheries Society. 118: 379-385.

2117. Younglove, Theodore; Smith, Elaine D.; McCool, Patrick M.; Musselman, Robert C. 1988. The use of transfer function models to describe the relationship between pollutant exposure and leaf stomatal opening. Environmental and Experimental Botany. 28(3): 239-248.

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2118. Zeller, Karl F. 1987. Avoid the jolt from a bolt. Flying Magazine. 43(2): 2-7.

2119. Zeller, Karl F.; Hazlett, Donald L. 1989. Ozone deposition and leaf area index at the Pawnee National Grassland for the 1988 growing season. *In:* APCA annual conference; 1989 June 25-30; Anaheim, CA. 177-192.

2120. Zeller, Karl F.; Massman, William J.; Stocker, David W.; Fox, Douglas G.; Stedman, Donald H.; Hazlett, Donald L. 1989. Initial results from the Pawnee eddy correlation system for acid deposition research. General Technical Report RM-282. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 30 p.

The Pawnee Grassland eddy correlation dry deposition project is described. Instumentation, methods of analysis, and initial data and research findings are presented. Data from this eddy correlation system show agreement with (a) previous observations of deposition velocities for atmospheric ozone, NO_2, and NO X; (b) micrometeorological theory; and (c) micrometeorological site characteristics.

2121. Zentz, W. R. 1984. Risk rating lodgepole pine stands for comandra blister rust. *In:* Hunt, R. S., compiler. Proceedings, 32nd western international forest disease work conference; 1984 September 25-28; Taos, NM. Victoria, BC: British Columbia Forest Service, Pacific Forest Research Center: 61. 37 p.

2122. Zentz, W. R.; Jacobi, William R. 1989. Ecology of *Comandra umbellata* (Santalaceae) in western Wyoming. Great Basin Naturalist. 49: 650-655.

2123. Zentz, W. R.; Jacobi, William R. 1984. Risk rating lodgepole pine for *Cronartium comandrae*. *In:* Proceedings, 31st annual western international forest disease work conference; 1983 August 22-26; Coeur d'Alene, ID. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region: 71.

2124. Zimmerman, G. Thomas; Laven, Richard D. 1984. Ecological interrelationships of dwarf mistletoe and fire in lodgepole pine forests. *In:* Hawksworth, Frank G.; Scharpf, Robert F., technical coordinators. Biology of dwarf mistletoes: proceedings of the symposium; 1984 August 8; Fort Collins, CO. General Technical Report RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 123-131. 131 p.

2125. Zimmerman, G. Thomas; Laven, Richard D. 1987. Effects of smoke on dwarf mistletoe seed germination. Great Basin Naturalist. 47: 652-659.

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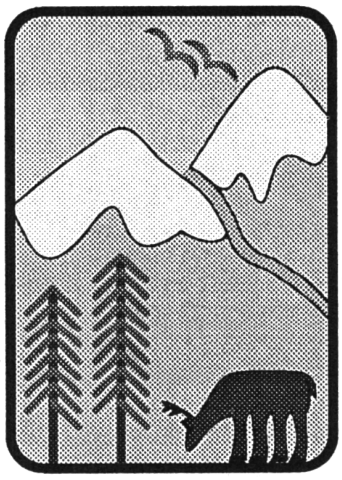

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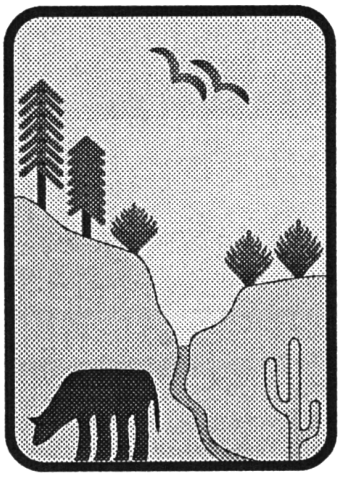

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