This file was created by scanning the printed publication.
Errors identified by the software have been corrected;
however, some errors may remain.

United States
Department
of Agriculture

Forest Service

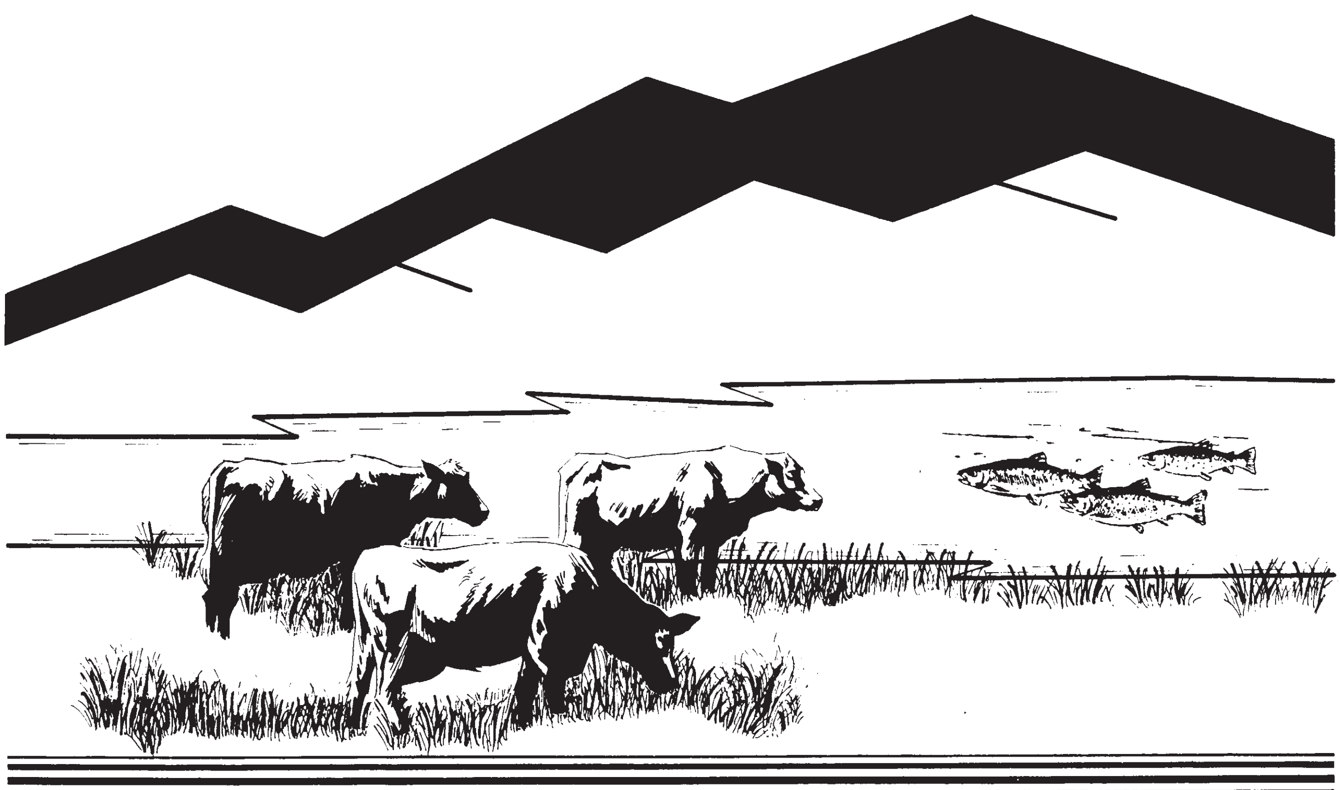
**Intermountain
Research Station**

General Technical
Report INT-263

May 1989

Managing Grazing of Riparian Areas in the Intermountain Region

Warren P. Clary
Bert F. Webster



THE AUTHORS

WARREN P. CLARY is project leader for the Riparian-Stream Ecosystems research work unit at the Intermountain Station's Boise, ID, Forestry Sciences Laboratory. He has a B.S. degree in agriculture from the University of Nebraska, and an M.S. degree in range management and a Ph.D. degree in plant ecology from Colorado State University. He joined the Forest Service in 1960 and has conducted research on forested and nonforested rangelands in Arizona, Louisiana, Utah, Idaho, Oregon, and Nevada.

BERT F. WEBSTER is range, wildlife, and fisheries staff officer for the Sawtooth National Forest, Intermountain Region, Forest Service, Twin Falls, ID. He has a B.S. degree in range management from Utah State University. He joined the Forest Service in 1961. He served as a range conservationist in Wyoming and Idaho, as a District Ranger in Nevada and Idaho, and on the Regional staff for range adminstration and improvements.

FOREWORD

The riparian grazing management recommendations in this paper are intended as guidance for planning and implementing riparian grazing procedures on National Forest System lands in the Intermountain Region. They are general criteria that with some modification and site-specific adjustments can be applied to a variety of situations. The application of these basic concepts along with riparian standards and guidelines in a Forest Plan will achieve the desired objective of healthy riparian systems.

J. S. Tixier
Regional Forester
Intermountain Region

CONTENTS

Intermountain Research Station
324 25th Street
Ogden, UT 84401

Managing Grazing of Riparian Areas in the Intermountain Region

Warren P. Clary
Bert F. Webster

INTRODUCTION

This paper was prepared as a guidance document for planning riparian grazing procedures on National Forests of the Intermountain Region of the Forest Service, U.S. Department of Agriculture. Much of the supporting information is broadly based; therefore the recommendations should be applicable beyond the Intermountain Region. Recent research information on grazing systems and grazing-riparian interactions was combined with our experience in various areas within the Intermountain Region to form a basis to guide future riparian grazing management.

These riparian grazing management recommendations have been developed as an aid in reducing nonpoint source pollution in western streams and as suggestions that could be incorporated in appropriate State Best Management Practices. "Best Management Practices" (BMP) means a practice or combination of practices that are determined by a State or designated areawide planning agency to be the most effective and practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality and related riparian-stream habitat goals. These are determined after problem assessment, examination of alternative practices, and appropriate public participation (Federal Register 1975). Designation of grazing management actions as Best Management Practices to protect water quality requires approval by the water quality management agencies of individual States. The Forest Service's Intermountain Region and the Intermountain Research Station are coordinating with the States within their respective boundaries to incorporate appropriate management into the States' recognized Best Management Practices.

The recommendations in this document are generic: they are general criteria that can be applied to a variety of situations. Selection of specific actions to accomplish the required result on a site-specific basis should normally be made by the land/resource/livestock managers based on soils, climate, special problems, management objectives, and water quality requirements. The recommendations may also be useful guides for reduction of grazing impacts on other resources in addition to reduction of nonpoint source pollution.

BACKGROUND

Improper livestock management, through excessive grazing and trampling, can affect riparian-stream habitats by reducing or eliminating riparian vegetation, causing channel aggradation or degradation, causing widening or incisement of stream channels, changing streambank morphology, and as an accumulative result often lowering surrounding water tables (Platts 1986). Once a riparian-grazing problem has been identified, the possible solutions depend upon the following (Skovlin 1984): How depleted is the riparian and aquatic habitat? How critical is the habitat for riparian-dependent resources such as water quality, fisheries, or recreation, and does the habitat contain any threatened or endangered species? What is the timetable goal for restoration? And what level of restoration is acceptable for reinstituting grazing?

A six-step planning process for grazing riparian zones has been suggested (in part from Dwyer and others 1984): (1) determine what factor, such as bank instability or loss of woody plants, is of primary concern, (2) determine site potential and capability, (3) determine the suitability of the affected sites for livestock grazing, (4) determine the kind and class of livestock and duration and intensity of livestock grazing best suited to the area, (5) determine the best grazing strategy, and (6) apply the proper grazing intensity in keeping with animal distribution patterns.

Livestock Grazing

Interest is high concerning livestock grazing, particularly cattle grazing, on riparian habitats. Grazing systems typically used for riparian areas are similar to those developed to maintain or improve conditions of upland vegetation types. However, no grazing system has been devised for ensuring proper use of small riparian meadows within extensive upland range. In addition, the most recent information on grazing uplands suggests that although conventional grazing systems have great intuitive appeal, they are less effective at maintaining ecological quality and livestock production than previously thought (see appendix I).

The most obvious benefit of a grazing system is to help provide the necessary livestock control to do a good management job. **The level of utilization occurring on a site—including riparian areas—is the most important consideration.** In fact, most riparian grazing results suggest that the specific grazing system used is not of dominant importance, but good management is—with control of use in the riparian area a key item (see appendix II). Specially designed grazing systems that control degree and timing of use in the riparian area can be highly beneficial.

Another item of importance is season of use. Spring grazing of riparian areas has several advantages (see appendix II). Grazing early usually results in a better distribution of use between the riparian area and adjacent uplands. This is likely due to more similarity in vegetation succulence between riparian and upland areas than would be the case later in the season, cooler temperatures in the early season, and in some cases livestock may avoid streamside areas that are often wet in the spring. Early grazing, followed by complete livestock removal, allows riparian plant regrowth to occur before the dormant period in the fall. Fall grazing is a second choice in most areas but is probably acceptable if utilization levels are carefully controlled to leave protective vegetation cover for the following winter-spring high streamflow periods. Grazing riparian areas during the summer should be limited or carefully controlled because of the strong tendency of cattle to concentrate there in the hot and often dry months.

Managers of rangelands are accustomed to giving primary consideration to plant physiological vigor. **However, a major additional need in most riparian areas is to consider the requirements of other riparian-dependent resources including maintenance of streambank structure and channel form—key factors in fisheries habitat and hydrologic function.** Careful control of grazing pressure results in maintenance of the streambank vegetation and limitation of trampling, hoof slide, and accelerated streambank cave-in (see appendix II). Residual streamside vegetation biomass encourages trapping and deposition of sediments as a basis for maintaining or rebuilding streambanks. Concentrated livestock use, as often occurs in uncontrolled season-long continuous and certain rotational grazing systems, may cause unacceptable damage to woody plants and streambank morphology.

Recent On-the-Ground Experience

In a recent inventory of almost 250 miles of National Forest riparian areas, no single grazing strategy was found to be effective in every riparian situation (USDA FS 1987). However, a few key points seemed to be important. Grazing conflicts with riparian-dependent resources were usually not severe in type A stream channels or in most type B stream channels (stream types identified by Rosgen 1985). Generally, these stream channels are in narrow valleys occupied by woody species and are armored by rocks providing resistance to erosion and trampling damage. The greatest conflicts occurred in type B channels with medium- to fine-textured, easily eroded soil materials and most type C channels. The latter channel types are typically associated with meadow complexes that are attractive to livestock and are often important fishery habitats. In these channel types a vigorous plant community is important for protecting streambanks against erosive forces and for trapping sediments (Swanson 1989).

Riparian areas associated with medium- to fine-textured B channels and most C channels were generally: (1) in a late seral status if they were only grazed in the spring or, if grazed in the fall, the fall grazing was light and late in the season; (2) in a mid seral status where summer grazing was light; and (3) in a late or improving seral status with vigorous riparian species and stable streambanks after receiving complete rest for several years (see appendix III for description of seral status). Reduction of shrubs in the riparian plant community appeared to be due to grazing of young reproduction age classes rather than due to the mechanical damage to the older shrub age classes by rubbing and bedding.

GRAZING MANAGEMENT RECOMMENDATIONS

Once it has been determined that livestock grazing can and should continue on a particular riparian area, management practices in any grazing system must provide for regrowth of riparian plants after use, or should leave sufficient vegetation at the time of grazing for maintenance of plant vigor and streambank protection. To achieve this **it is recommended that a minimum herbage stubble height be present on all streamside areas at the end of the growing season, or at the end of the grazing season if grazing occurs after frost in the fall. The residual stubble or regrowth should be at least 4 to 6 inches in height to provide sufficient herbaceous forage biomass to meet the requirements of plant vigor maintenance, bank protection, and sediment entrapment.** Also, for pastures grazed in the fall, the retention of this standing crop of herbaceous forage will normally detour significant feeding on willows and most other riparian woody plants (see appendix II). The stubble height criterion should be adhered to regardless of the grazing system used. To help achieve this goal:

1. On most National Forest pastures grazed in spring only, utilization of streamside herbaceous forage should be limited to about 65 percent of the current growth, and livestock should normally be removed by July 15 to allow sufficient time for plant regrowth. On lower elevation National Forest pastures the appropriate spring removal date may be substantially earlier.

2. Streamside utilization of herbaceous forage in summer-grazed pastures should not exceed 40 to 50 percent of the current growth.

3. Fall use of streamside vegetation should not exceed about 30 percent, and the herbaceous stubble remaining at the end of the grazing period should meet the 4- to 6-inch criterion.

4. Season-long grazing should be limited to those situations where animal use and distribution can be carefully controlled, such as by the use of riparian or other special use pastures, and where the stubble height requirements can be met.

5. Special situations such as critical fisheries habitats or easily eroded streambanks may require stubble heights of greater than 6 inches.

The utilization guides for these recommendations are based on use in pastures in good to high ecological status and on information in appendix II.

Degraded riparian areas may require complete rest to initiate the recovery process. In systems requiring long-term rest, the rest period will be highly variable depending upon the situation. It may be as short as 1 year or it may be 15 years or longer. Recovery of degraded streambank form usually will require more time than the recovery of plant community composition, in some cases much more time, particularly if the channel has become incised and confined. Once an area has improved to a mid or late seral status through the use of rest or careful management, rotation management systems may allow riparian habitats to remain in good condition while being grazed. However, no rotation system will allow recovery or maintenance of the riparian system unless all livestock are removed after the use period. In any event, rest-rotation or any other conventional grazing system should not be considered the sole answer to riparian grazing needs.

Riparian area managers must have a commitment to do whatever is necessary to control livestock use and distribution. A wide variety of management techniques are available to do this including establishment of special use riparian pastures, development of alternate water sources away from riparian areas, location of stock driveways outside of these areas, periodic herding of livestock away from the areas, salting outside of riparian areas, and other common range management practices that may help reduce concentration of livestock. Whatever approach or approaches are used will likely be successful if use rates are carefully controlled and, if possible, grazing is avoided during mid and late summer.

The practices described in this section should provide for plant and streambank requirements under most grazing situations. The specific management approach used to meet the recommendations will need to be determined on a site-specific basis. Physical factors such as stream type, geology, climate, and elevation greatly influence the recovery of riparian areas. Therefore, the specific management action must be tailored to fit local conditions.

Monitoring should be an integral part of any management change designed to improve riparian habitats. When recovery does not occur or is progressing too slowly, further changes in management practices are warranted.

SUGGESTED INITIAL ACTIONS

Ecological Status - Early Seral

1. "A" and most "B" channel types (inherently stable types):

   Apply rest or the recommended riparian grazing management practices until the ecological status improves.

2. "B" channel types with medium to fine easily eroded soil materials and most "C" channel types:

   Apply rest until the ecological status improves.

Ecological Status - Mid Seral

1. "A" and most "B" channel types (inherently stable types):

   Continue present management or apply the recommended riparian grazing management practices.

2. "B" channel types with medium to fine easily eroded soil materials and most "C" channel types:

   Apply the recommended riparian grazing management practices.

Ecological Status - Late Seral

1. All types:

   Continue current management or apply the recommended riparian grazing management practices.

Environmentally Sensitive Areas

1. Streambanks subject to early season grazing damage:

   Where a combination of high soil moisture and fine soil texture results in streambanks susceptible to trampling damage, grazing may need to be delayed to a late season period. The herbaceous stubble height criterion would still apply.

2. Habitats where threatened, endangered, or sensitive species occur, or where streambanks/channels are highly erodible:

   The herbaceous stubble height criterion may need to be increased to greater than 6 inches. Under extreme conditions, the area may need permanent protection, or at a minimum, grazing may need to be removed for long periods.

REFERENCES

Blackburn, W. H.; Knight, R. W.; Wood, M. K. 1982. Impacts of grazing on watersheds. MP 1496. College Station, TX: Texas A & M University System, Texas Agricultural Experiment Station. 32 p.

Bohn, Carolyn. 1986. Biological importance of streambank stability. Rangelands. 8(2): 55-56.

Branson, Farrel A. 1985. Vegetation changes on western rangelands. Range Monograph 2. Denver: Society for Range Management. 76 p.

Bryant, Larry D. 1985. Livestock management in the riparian ecosystem. In: Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses: first North American riparian conference; 1985 April 16-18; Tucson, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 285-289.

Bryant, Larry D. 1988. [Personal communication.] LaGrande, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory.

Clary, Warren P. 1987a. Herbage production and livestock grazing on pinyon-juniper woodlands. In: Everett, Richard L., compiler. Proceedings—pinyon-juniper conference; 1986 January 13-16; Reno, NV. Gen. Tech. Rep. INT-215. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 440-447.

Clary, Warren P. 1987b. Livestock effects on riparian vegetation and adjoining streambanks. Study plan on file at: Forestry Sciences Laboratory, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Boise, ID. 26 p.

Clary, Warren P. 1988. Data on file at: Forestry Sciences Laboratory, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Boise, ID.

Crouse, Michael R. 1987. New approaches to riparian area management on public lands. In: Wetland and riparian ecosystems of the American West: Proceedings of the Society of Wetland Scientists' eighth annual meeting; 1987 May 26-29; Seattle, WA: 32-35.

Dwyer, Donald D.; Buckhouse, John C.; Huey, William S. 1984. Impacts of grazing intensity and specialized grazing systems on the use and value of rangeland: summary and recommendations. In: Developing strategies for rangeland management. Boulder, CO: Westview Press: 867-884.

Eckert, Richard E., Jr.; Spencer, John S. 1986. Vegetation response on allotments grazed under rest-rotation management. Journal of Range Management. 39(2): 166-174.

Eckert, Richard E., Jr.; Spencer, John S. 1987. Growth and reproduction of grasses heavily grazed under rest-rotation management. Journal of Range Management. 40(2): 156-159.

Elmore, Wayne. 1988. Stream processes and grazing strategies. Presentation at: Riparian management workshop: challenges and opportunities; 1988 May 3; Elko, NV: Nevada Cooperative Extension.

Elmore, Wayne; Beschta, Robert L. 1987. Riparian areas: perceptions in management. Rangelands 9(6): 260-265.

Federal Register. 1975. EPA amends policies and procedures for State continuing planning process. Federal Register 40(230): 55338.

Gillen, R. L.; Krueger, W. C.; Miller, R. F. 1985. Cattle use of riparian meadows in the Blue Mountains of northeastern Oregon. Journal of Range Management. 38(3): 205-209.

Goodman, Tim; Donart, Gary B.; Kiesling, Herman E.; Holcheck, 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, Jeffery L., eds. 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.

Green, Douglas. 1989. [Personal communication]. Corvallis, OR: Oregon State University, Department of Rangeland Resources.

Heady, Harold F. 1970. Grazing systems: terms and definitions. Journal of Range Management. 23(1): 59-61.

Heady, Harold F. 1984. Concepts and principles underlying grazing systems. In: Developing strategies for rangeland management. Boulder, CO: Westview Press: 885-902.

Hormay, A. L.; Evanko, A. B. 1958. Rest-rotation grazing—a management system for bunchgrass ranges. Misc. Paper 27. Berkeley, CA: U.S. Department of Agriculture, Forest Service, California Forest and Range Experiment Station. 11 p.

Kauffman, J. Boone; Krueger, William C.; Vavra, Martin. 1982. Impacts of a late season grazing scheme on nongame wildlife in Wallowa Mountain riparian ecosystem. In: Peek, James M.; Dalke, P. D., eds. Wildlife-livestock relationships symposium: Proceedings 10; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station: 208-220.

Kauffman, J. Boone; Krueger, W. C.; Vavra, M. 1983. Effects of late season cattle grazing on riparian plant communities. Journal of Range Management. 36(6): 685-691.

Kauffman, J. Boone; Krueger, W. C. 1984. Livestock impacts on riparian ecosystems and streamside management implications—a review. Journal of Range Management. 37(5): 430-438.

Kinch, Gene. 1987. Riparian area management. Draft technical reference on grazing management in riparian areas. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 47 p.

Knopf, Fritz L.; Cannon, Richard W. 1982. Structural resilience of a willow riparian community to changes in grazing practices. In: Peek, James M.; Dalke, P. D., eds. Wildlife-livestock relationships symposium: Proceedings 10; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station: 198-207.

Kothmann, Mort M. 1984. "Concepts and principles underlying grazing systems": a discussant paper. In: Developing strategies for rangeland management. Boulder, CO: Westview Press: 903-916.

Kovalchik, Bernard L. 1987. Riparian zone associations: Deschutes, Ochoco, Fremont, and Winema National Forests. Region 6 Ecol. Tech. Pap. 279-87. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 171 p.

Krueger, William C. 1989. [Personal communication]. Corvallis, OR: Oregon State University, Department of Rangeland Resources.

Laycock, W. A.; Conrad, P. W. 1981. Responses of vegetation and cattle to various systems of grazing on seeded and native mountain rangelands in eastern Utah. Journal of Range Management. 34(1): 52-58.

Marlow, Clayton B.; Olson-Rutz, Kathrin; Atchley, Jennifer. 1989. Response of a southwest Montana riparian system to four grazing management alternatives. In: Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffery L., eds. 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: 111-116.

Marlow, Clayton B.; Pogacnik, Thomas M.; Quinsey, Shannon D. 1987. Streambank stability and cattle grazing in southwestern Montana. Journal of Soil and Water Conservation. 42(4): 291-296.

Meehan, William R.; Platts, William S. 1978. Livestock grazing and the aquatic environment. Journal of Soil and Water Conservation. 33(6): 274-278.

Myers, Lewis H. 1981. Grazing management vs. riparian management in southwestern Montana. Abstracts 34th Annual Meeting, Society for Range Management; Tulsa, OK. Denver, CO: Society for Range Management: 30.

Myers, Lewis H. 1989. Grazing and riparian management in southwestern Montana. In: Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffery L., eds. 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: 117-120.

Pieper, R. D.; Heitschmidt, R. K. 1988. Is short-duration grazing the answer? Journal of Soil and Water Conservation. 43(2): 133-137.

Platts, William S. 1982. Sheep and cattle grazing strategies on riparian-stream environments. In: Peek, James M.; Dalke, P. D., eds. Wildlife-livestock relationships symposium: Proceedings 10; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station: 251-270.

Platts, William S. 1983. Those vital streambanks. Western Wildlands. 3(9): 7-10.

Platts, William S. 1986. Riparian-stream management. In: National range conference proceedings; 1985 November 6-8; Oklahoma City, OK. Washington, DC: U.S. Department of Agriculture: 70-74.

Platts, William S. 1989. Compatibility of livestock grazing strategies with fisheries. In: Gresswell, Robert E.; Barton, Bruce A.; Kershner, Jeffery L., eds. 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: 103-110.

Platts, William S.; Nelson, Rodger Loren. 1985. Impacts of rest-rotation grazing on stream banks in forested watersheds in Idaho. North American Journal of Fisheries Management. 5: 547-556.

Platts, William S.; Raleigh, Robert F. 1984. Impacts of grazing on wetlands and riparian habitat. In: Developing strategies for rangeland management. Boulder, CO: Westview Press: 1105-1117.

Pond, Floyd W. 1961. Effect of three intensities of clipping on the density and production of meadow vegetation. Journal of Range Management. 14(1): 34-38.

Range Term Glossary Committee. 1974. A glossary of terms used in range management. 2d ed. Denver, CO: Society for Range Management. 36 p.

Range Inventory Standardization Committee. 1983. Guidelines and terminology for range inventories and monitoring: report of the Range Inventory Standardization Committee. Denver, CO: Society for Range Management. 13 p.

Ratliff, Raymond D.; George, Melvin R.; McDougald, Neil K. 1987. Managing livestock grazing on meadows of California's Sierra Nevada: a manager-user guide. Leaflet 21421. Berkeley, CA: University of California Division of Agriculture and National Resources Cooperative Extension. 9 p.

Rosgen, David L. 1985. A stream classification system. In: Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses: first North American riparian conference; 1985 April 16-18; Tucson, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 91-95.

Shaw, Nancy. 1988. Natural regeneration of willows and cottonwoods. Preliminary report on file at: Forestry Sciences Laboratory, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Boise, ID. 3 p.

Siekert, Ronald E.; Skinner, Q. D.; Smith, M. A.; Dodd, J. L.; Rodgers, J. D. 1985. Channel response of an ephemeral stream in Wyoming to selected grazing treatments. In: Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses: first North American riparian conference; 1985 April 16-18; Tucson, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 276-278.

Skovlin, Jon M. 1984. Impacts of grazing on wetlands and riparian habitat: a review of our knowledge. In: Developing strategies for rangeland management. Boulder, CO: Westview Press: 1001-1103.

Storch, Robert L. 1979. Livestock/streamside management programs in eastern Oregon. In: Proceedings of the forum—grazing and riparian/stream ecosystems. Denver, CO: Trout Unlimited: 56-59.

Swanson, Sherman. 1989. [Personal communication]. Reno, NV: University of Nevada-Reno, Department of Range, Wildlife and Forestry.

Trlica, M. J., Jr. 1977. Effects of frequency and intensity of defoliation on primary producers of arid and semiarid rangelands: Proceedings second U.S./Australia Rangeland Panel; Adelaide, South Australia. Perth, Western Australia: 27-56.

U.S. Department of Agriculture, Forest Service. 1987. Data on file at: Sawtooth National Forest, Twin Falls, ID.

Van Poollen, H. Walt; Lacey, John R. 1979. Herbage response to grazing systems and stocking intensities. Journal of Range Management. 32(4): 250-253.

Volland, Leonard A. 1978. Trends in standing crop and species composition of a rested Kentucky bluegrass meadow over an 11-year period. In: Hyder, Donald N., ed. Proceedings of the first international rangeland congress; 1978 August 14-18; Denver, CO. Denver, CO: Society for Range Management: 526-529.

Winward, A. H. 1989. Ecological status of vegetation as a base for multiple-product management. Abstracts 42nd Annual Meeting, Society for Range Management; Billings, MT. Denver, CO: Society for Range Management: 277.

APPENDIX I: GENERAL REVIEW OF GRAZING SYSTEMS

The sensitivity to grazing of many Western native forage plants was recognized in the early 1900's, but realization of the significance of this developed slowly, and serious application of known information lagged. For 30 years grazing systems have been advocated by public land management agencies for use on Western ranges in the hope of achieving better livestock distribution, greater herbage and livestock production, and improved range condition. Grazing systems, which combine periods of use and nonuse, were originally proposed to improve ranges that had deteriorated under improper grazing (Hormay and Evanko 1958). A grazing system is defined as "A *specialization of grazing management* which defines systematically recurring periods of grazing and deferment for two or more pastures or management units" (Range Term Glossary Committee 1974). Deferred-rotation, rest-rotation, high intensity-low frequency, and short duration are forms of grazing systems (Kothmann 1984).

Past reviews of grazing systems have pointed out, first, that grazing systems were originally proposed as a means to improve deteriorated ranges through judicious use of seasonal grazing and periods without grazing. Second, more emphasis is being given to grazing systems as means to increase animal productivity. Third, grazing systems facilitate application of other range improvement *practices such as fencing, water development*, brush control, and seeding. The review papers point out, however, that (1) every grazing system has shown a wide variation in attaining improvement in range condition, (2) livestock productivity has varied from significant increases to significant decreases when systems were compared, (3) differences in results have been inconsistent and unexplained, (4) grazing systems that do well on one kind of rangeland may not work at all in another region, and (5) few analyses of the cost effectiveness of grazing systems have been made (Heady 1984). The one certainty is that there is no single grazing system that will improve rangeland everywhere (Dwyer and others 1984).

The success of grazing systems depends in part upon managerial control of time, place, and degree of forage utilization. The new fencing and additional livestock watering points that are required to initiate a grazing system also result in smaller pastures, better distribution of animals, and hence more even use of the forage plants across the pasture. Movement of animals from one pasture to another gives the manager some control over severity and timing of use (Heady 1984). These systems with additional pastures and movement of livestock often provide incentive and opportunity for vegetational manipulations such as brush control, seeding, and pitting, which can result in improved range condition and live*stock production. Confusion occurs when results are as*cribed to the grazing system when in fact they are due to the whole range management program (Heady 1970). Laycock and Conrad (1981) provided a case in point. Their study compared native sagebrush-grass range summer-long grazing every year, summer-long every other year, and a three-unit rest rotation system. Plant cover, production, and composition, and average daily gains of cattle were similar after 7 years of study. The key to this result was that each system had adequate fencing, good *distribution of water and salt, and adequate riding to* ensure uniform cattle distribution. In other words good range management was practiced regardless of the grazing system. Unfortunately, results of whole range management programs have often been attributed to grazing systems alone (Heady 1970).

Numerous hydrologic studies have upheld the conclusions of Blackburn and others (1982), who stated that little information supports claims for grazing systems. In a review of recent studies, Pieper and Hietschmidt (1988) found no results to suggest that the application of short-duration grazing has a different effect on hydrologic performance and soil characteristics than does any other grazing system. They concluded that heavy stocking would result in long-term downward trend in hydrologic characteristics and that vegetation growth response in a short-duration grazing system is similar to that expected from any other grazing system. There was no consistent advantage for individual livestock gains under short-duration grazing on arid and semiarid rangeland. The authors concluded that much of the success attributed to short-duration grazing is not directly attributable to that system but rather to improved overall management. They suggested that stocking rate is and always will be the major factor affecting the degradation of rangeland resources. No grazing system can counteract the negative impacts of overstocking on a long-term basis.

Generally, defoliation reduces the capacity of a plant to grow. A corresponding reduction in production usually occurs as either the frequency or intensity of defoliation increases (Trlica 1977). Vegetation appears to be more affected by grazing intensity than by grazing systems. Van Poollen and Lacey (1979) reviewed 18 studies comparing continuous grazing and the implementation of grazing systems at a moderate rate of use, and they compared 14 studies on grazing intensities of light, moderate, and heavy rates. Their analysis showed a 13 percent increase in forage production in favor of grazing systems over continuous use. However, the herbage production response to reductions in grazing intensity was much greater. Reduction in level of use from heavy to moderate increased production 35 percent, while reducing use from moderate to light increased production 28 percent. This value is in line with a review of herbage production that showed grazed areas usually produced less than 800 lb per acre, while ungrazed areas often exceeded 1,200 lb per acre (Clary 1987a). Such results suggest that managers should place more emphasis on proper stocking intensity and less on grazing system implementation (Van Poollen and Lacey 1979). The concentrated use of grazed pastures is not compensated for during rest years if grazing use is heavy (Eckert and Spencer 1986, 1987).

In summary, although grazing systems have great intuitive appeal, they are apparently of less consequence than once thought. In fact, as long as good management is practiced so that there is control of livestock distribution and grazing intensity, the specific grazing system employed may not be significant.

APPENDIX II: CURRENT INFORMATION ON GRAZING RIPARIAN AREAS

Although some riparian areas are resistant to damage from grazing livestock, others are vulnerable. If damage occurs it usually includes reduction or elimination of riparian vegetation, modifying streambank and channel morphology, increasing stream channel width or incisement, increasing stream sediment transport, and lowering surrounding water tables. Few examples exist of careful grazing system study within riparian areas. Numerous case history studies and experience of a variety of people suggest that no specific grazing system has proven universally successful.

Grazing Effects

Documentation shows that cattle, given the opportunity, will spend a disproportionate amount of time in a riparian area as compared to adjacent xeric upland areas. This may be five to 30 times higher than expected based on the extent of the riparian area. Features that contribute to higher use levels in riparian areas are: (1) higher forage volume and relative palatability in the riparian area as opposed to the uplands, (2) distance to water, (3) distance upslope to upland grazing sites, and (4) microclimatic features (Skovlin 1984).

Although many of the riparian-fisheries-grazing studies have been deficient in design, measurement, or documentation (Platts and Raleigh 1984), a great deal of case history and observational information has been accumulated. Concerning grazing impacts on riparian areas, four components were most often studied: (1) fish habitat in the aquatic system, (2) woody vegetation components of the riparian area relating to fish and bird habitat, (3) herbaceous utilization and grazing levels that can influence yields of plants, small mammals, and invertebrates, and (4) watershed conditions of cover and soil compaction on the floodplain and runoff from upland range (Skovlin 1984).

Platts and Raleigh (1984) summarized direct effects of livestock grazing:

1. Higher stream temperatures from lack of sufficient woody streamside cover.
2. Excessive sediment in the channel from bank and upland erosion.
3. High coliform bacteria counts from upper watershed sources.
4. Channel widening from hoof-caused bank sloughing and later erosion by water.
5. Change in the form of the water column and the channel it flows in.
6. Change, reduction, or elimination of vegetation.
7. Elimination of riparian areas by channel degradation and lowering of the water table.
8. Gradual stream channel trenching or braiding depending on soils and substrate composition with concurrent replacement of riparian vegetation with more xeric plant species.

Kauffman and Krueger (1984), in an extensive review of livestock impacts on riparian ecosystems, documented many factors interrelated with grazing effects, primarily dealing with instream ecology, terrestrial wildlife, and riparian vegetation. However, as with many others, the authors were not able to find much information other than that abusive grazing practices are damaging to many features of riparian ecosystems. Little information is available on how well-managed grazing affects riparian-stream systems. Criticisms of conventional grazing systems such as rest-rotation typically contain no information on actual grazing intensity or degree of plant utilization (Meehan and Platts 1978; Storch 1979).

Permanent removal of grazing will not guarantee maximum herbaceous plant production. Volland (1978) found that a protected Kentucky bluegrass meadow reached peak production in 6 years and then declined until production was similar to the adjacent area grazed season-long. Similar results were reported by Bryant (1988) and Green (1989) in northeastern Oregon. The accumulation of litter over a period of years seems to retard herbage production in wet meadow areas. Thus, some grazing of riparian areas could have beneficial effects. This is a response similar to that documented by Branson (1985).

Resistance of common riparian woody plants to defoliation has not been investigated. However, genera commonly represented in riparian areas such as dogwood, maple, cottonwood, willow, and birch appear to be more resistant to foliage and twig removal than genera common to xeric uplands. Light to moderate grazing generally appears to have little adverse effect and in some cases may stimulate growth (Skovlin 1984). Severe overgrazing almost invariably is detrimental to willow communities (Kauffman and Krueger 1984). Knopf and Cannon (1982) reported that cattle altered the structure of a high-altitude willow community by changing the size, shape, volume, and quantity of live and dead stems per bush, and the spacing of plants. They concluded that 10 to 12 years was not sufficient time for a riparian willow community to recover from a history of excessive grazing. Alternatively, Skovlin (1984) reported that reestablishment of acceptable wildlife habitat often occurred about 5 years after release of remnant shrubs from heavy grazing. Little information is available on how careful grazing affects willow communities except for observations that leaving a residual herbaceous stubble of about 4 inches usually results in little or no use of willows (see "Utilization" section in this appendix).

While Skovlin (1984) suggested that vegetation recovery after release from excessive grazing generally can occur within 5 to 15 years, Platts and Raleigh (1984) pointed out that impacts on fishery environments go far beyond the riparian vegetation. Channel and bank morphology, instream cover, and water flow regimens are important factors. Little is known about the recovery time for these factors in different environments. Skovlin suggested that sediment delivery to the stream was the most detrimental impact of trampling to fisheries. Platts and Raleigh, however, pointed out that the retention of bank morphology and stability are probably more important. The maintenance of streambank structure and function is a key item in riparian-stream habitats from both fisheries and hydrologic standpoints (Bohn 1986; Platts 1983).

Vegetation plays a dominant role not only in the erosional stability of streambanks but also in the rebuilding of degraded streambanks. Streamside vegetation serves as a natural trap to retain sediments during high flows. These sediments form the physical basis for new bank structure (Elmore and Beschta 1987).

Grazing Systems

An evaluation of the effects of rest-rotation grazing on streambanks was conducted on forested watersheds in Idaho (Platts and Nelson 1985). Forage in the streamside zone was used at a higher rate than on either immediately adjacent range or the grazing allotment. Relative use of streamside vegetation was less during the early grazing period than during the late grazing period. Small treatment pastures experienced 11 percent higher average use of streamside vegetation with late grazing than with early grazing. This was suggested to be the result of "a general tendency for cattle to avoid certain streamside zones early in the season when the soils and vegetation may be wet" (Platts and Nelson 1985). Also, the vegetation on adjacent rangeland was more succulent during the early growing season.

Platts (1989) provided an evaluation of several livestock grazing systems based on his own observations. He identified, described, and evaluated 17 grazing "strategies" on a scale of 1 to 10. All strategies that were described as having use levels of heavy or heavy to moderate were rated on the lower half of the scale (1 to 5). Those strategies that incorporated moderate or moderate to light use rated in the mid-upper portion of the scale (6 to 8). Those management strategies that featured light or no use were rated at the top of the scale (9 to 10). Although the strategies, use levels, and ratings described above are largely qualitative in nature, they do provide support for the opinions of several other authors (Van Poollen and Lacey 1979; Skovlin 1984) in that use levels seem to be the most important factor in a grazing situation.

In a test of different grazing systems at Meadow Creek, Starkey Experimental Forest and Range, deferred-rotation, rest-rotation, and season-long grazing all resulted in increases in production of floodplain herbage when utilization at the end of the grazing period was 70 percent or less. Likewise, each of these grazing systems produced almost twice as much herbage as ungrazed plots after 6 years (Bryant 1985). Bryant (1988) concluded that probably any grazing system, even season-long, would be acceptable for floodplains if use was controlled. However, Bryant made no grazing study of the streamside vegetation.

Other studies have also shown little net benefit from specific grazing approaches. Gillen and other (1985) showed that the same residual standing crop of herbage was present on dry meadows under both continuous and deferred-rotation grazing systems. Marlow and others (1989) found little difference in streambank stability among four grazing strategies studied during three drought years. Platts and Raleigh (1984) quoted Myers' (1981) results as showing no correlation between riparian condition and type of grazing system used. The grazing intensity was an important factor in the resulting riparian condition but not as important as amount of vegetation used during the hot season of the year. Vegetation did not respond when defoliated during that period.

As more studies of grazing systems are completed, it appears that the complex array of factors in rangelands tends to buffer the theoretical benefits of many systems. This has been true in a number of comparisons of upland grazing, and experience in riparian areas has generally failed to show an advantage to any specific grazing system.

Utilization

Few guidelines are available on what the allowable use of riparian plant communities should be to maintain ecosystem integrity. Allowable use could be described in terms of percentage of weight removed, residual biomass, or residual stubble height. Ratliff and others (1987) suggested that for site protection the herbage remaining after grazing should equal the proportion of production that decomposes annually. This translated into utilization rates of 35 to 45 percent on excellent-condition meadows down to 20 to 30 percent on poor-condition meadows. Platts (1982) suggested that rest-rotation grazing with 65 percent use or higher resulted in altered riparian habitat conditions while 25 percent use or less had little effect. Based on studies at Meadow Creek, Bryant (1985, 1988) thought that use of floodplain herbage could be up to 70 percent regardless of grazing system if about 3 inches of forage stubble height remained. Similar opinions on stubble height were given by Krueger (1989). Kauffman and others (1983) report observations by F. C. Hall that a shift to shrub use does not generally occur (except in the case of highly palatable shrubs) if 4 inches of herbaceous stubble remains. Elmore (1988) suggested that 3 to 4 inches of stubble height would maintain plant vigor, provide streambank protection, and aid deposition of sediments to rebuild degraded streambanks. Elmore also suggested that in some situations the use on willows begins when use on herbaceous plants reaches about 45 percent. An evaluation of 34 grazing systems in place for 10 to 20 years showed the importance of providing residual vegetation cover (Myers 1989). Vigorous woody plant growth and at least 6 inches of residual herbaceous plant height at the end of the growing/grazing season typified the riparian areas in excellent, good, or rapidly improving condition. This residual plant cover appeared to provide adequate streambank protection and sediment entrapment during high streamflow periods.

An approximate relationship between percentage utilization and stubble height of riparian graminoids was developed based on 1988 data from the Stanley Creek (mountain meadow ecosystem) and Pole Creek (sagebrush ecosystem) studies (Clary 1987b). The data suggest that average utilization levels of 24 to 32 percent were obtained when riparian graminoids were grazed to a 6-inch stubble height, that average use levels of 37 to 44 percent were obtained when grazing to a 4-inch stubble height, and that average use levels of 47 to 51 percent were obtained when grazing to a 3-inch stubble height (Clary 1988). This relationship shows some continuity between recommendations of 40 to 50 percent utilization and recommendations of leaving 3 to 4 inches of residual stubble height for maintenance of plant vigor. However, additional stubble height, such as 6 inches or more, may be necessary to protect riparian ecosystem function (Myers 1989).

Season of Use

Seasonal distribution of use often varies from heavy riparian area use in the summer to little riparian area use in winter (Goodman and others 1989). Myers (1989) reported that livestock are much less likely to disperse across a large grazing unit during the hot portion of the growing season than in the spring, particularly if the upland vegetation has ceased growth. The resulting summer concentration of use in the riparian zone becomes a key factor in severity of trampling and mechanical damage, soil compaction, and plant utilization.

Kauffman and others (1982) suggested late-season grazing for riparian zones on the basis of livestock production, maintenance of plant vigor and production, and minimum disturbance of wildlife populations. Clipping studies by Pond (1961) showed a similar response by the plant community. Results in southwestern Montana suggested that streambanks were most stable when grazed in late summer (Marlow and others 1987). Others, however, feel that fall grazing is not necessarily the optimum on many sites (Kinch 1987). A fall-grazed plant community, particularly a heavily grazed plant community, has a reduced ability to protect existing banks and to trap new sediments as part of the streambank building process. Although late season grazing may be a good approach from the standpoint of some plant communities and some terrestrial wildlife situations, spring grazing may be preferred in many situations to maintain proper streambank structure and function (Elmore and Beschta 1987).

A promising approach is to graze riparian areas in the spring, then remove all livestock and allow forage plants to regrow for the remainder of the season. This should provide vegetation cover for streambank protection during the following winter and early spring high streamflow periods. Several of the riparian grazing examples given by Elmore (1988) showed substantial improvements when grazed in spring only. Crouse (1987) reported beneficial results from spring grazing. Platts and Nelson (1985) recorded less severe use of streambanks in the spring than occurred in the fall relative to the surrounding uplands. Cattle use was more evenly distributed in the spring and therefore not as concentrated in the riparian zone. In Wyoming, relatively intense short-term spring grazing appeared to have no adverse effect on channel morphology of an ephemeral stream, while changes did occur during summer grazing (Siekert and others 1985). Animal sightings in the riparian zone and use of riparian species in the spring were less than half those occurring later in the season. In Oregon cattle avoid many riparian areas until late summer because of wet soil conditions. Thus, little grazing occurs during spring-only grazing strategies (Kovalchic 1987).

In a mountain meadow on Stanley Creek in Idaho, grazing in late June and early July resulted in slightly less use of streamside areas than the adjacent dry meadows (Clary 1988). This apparently occurred in part because of level topography and because the succulence (moisture content) of the herbage was similar between streamside vegetation and adjacent "dry" meadows in early summer. A similar distribution of use between streamside vegetation and dry meadows occurred in the fall after heavy frosts had "browned off" all vegetation.

In a study on Pole Creek in eastern Oregon, the natural regeneration of willows, cottonwoods, and other woody riparian shrubs was monitored in the protected, moderate spring-grazed, moderate fall-grazed, and heavy season-long pastures (Shaw 1988). Although topographic variability among pastures and heavy year-around browsing by deer complicated evaluations, two trends seemed apparent after two growing seasons: (1) total seedling density of willows and cottonwoods in the heavy use season-long pastures was less than a fourth that of any other treatment, and (2) willow and cottonwood seedling densities were somewhat greater in the spring-grazed pastures than any of the other treatments.

APPENDIX III: CALCULATING ECOLOGICAL STATUS AND RESOURCE VALUE RATINGS IN RIPARIAN AREAS

A. H. Winward

Regional Ecologist, Intermountain Region, Forest Service, U.S. Department of Agriculture, Ogden, UT

Ecological Status

Ecological status is used to relate the degree of similarity between current vegetation and potential vegetation for a site. It can be measured on the basis of species composition within a particular community type or on the basis of community type composition within a riparian complex. The categories for ecological status include: early seral, mid seral, late seral, and potential natural community(ies) (PNC) based on the degree of similarity to the potential natural community. Similarity between the present vegetation and the PNC can be calculated by a coefficient of similarity ($2w/a+b$) where a is the sum of species values for measured factors of present vegetation, b is the sum of values in the PNC, and w is the sum of the values common to both (table 1) (Range Inventory Standardization Committee 1983).

Composition values for the species or PNC's must be obtained by sampling sites in as natural a condition as possible. If no representative undisturbed areas are available, extrapolation of composition from ecological settings approximating the PNC may be necessary. Only those species or community types known to be native to a particular ecological setting may be used for establishing PNC values. Tables 2 and 3 provide examples of several ecological status ratings in different riparian settings using community type composition values.

Table 1—Example of ecological status of vegetation using coefficient of community similarity on foliar cover data

Species	Potential natural community	Present community	Amount in common
	Percent		
Booth willow	65	30	30
Water sedge	5	2	2
Beaked sedge	85	35	35
Kentucky bluegrass	0	53	0
Solomon-seal	5	0	0
	a=160	*b*=120	*w*=67

Similarity to PNC	Ecological status
Percent	
0-25	Early seral
26-50	Mid seral
51-75	Late seral
76+	PNC

Therefore, similarity index of (2*67/160+120) = 48 percent or mid seral status

Table 2—Example of an ecological status rating in the mountain alder/dogwood-steep gradient riparian complex (Rosgen channel A) using community type composition values

Community type	Potential natural composition	Present composition	Amount in common
	Percent		
Alder/dogwood	65	50	50
Booth willow/dogwood	5	5	5
Booth willow/horsetail	5	5	5
Booth willow/bluejoint reedgrass	5	5	5
Booth willow/mesic grass	5	2	2
Wooly sedge	10	5	5
Winged sedge	5	0	0
Kentucky bluegrass/redtop	0	28	0
	a=100	*b*=100	*w*=72

Therefore, similarity index of (2*72/100+100) = 72 percent or late seral status

Table 3—Example of an ecological status rating in the Nebraska sedge-low gradient riparian complex (Rosgen channel D) using community type composition values

Community type	Potential natural composition	Present composition	Amount in common
		Percent	
Coyote willow/bar	3	1	1
Nebraska sedge	85	10	10
Water sedge	5	2	2
Baltic rush	2	20	2
Mesic forb	3	10	3
Silver sagebrush/hairgrass	2	2	2
Kentucky bluegrass/redtop	0	55	0
	a=100	*b*=100	*w*=20

Therefore, similarity index of (2*20/100+100) = 20 percent or early seral status

Table 4—Examples of a resource value ratings (RVR) in the Booth willow/beaked sedge-moderate gradient riparian type (Rosgen channel C) using community type composition values

Community type	Desired composition	Present composition		Amount in common	
		Area A	Area B	Area A	Area B
			Percent		
Booth willow/beaked sedge	20	16	3	16	3
Wolfs willow/hairgrass	5	3	1	3	1
Water sedge	7	2	1	2	1
Beaked sedge	60	50	8	50	8
Baltic rush	3	10	10	3	3
Kentucky bluegrass	0	5	47	0	0
Mesic forb	3	13	30	3	3
False-hellebore	2	1	0	1	0
	a=100	*b*=100	*b*=100	*w*=78	*w*=19

Similarity to desired *Percent*	Resource value rating (RVR)
0-25	Poor
26-50	Fair
51-75	Good
76+	Excellent

Therefore, area A similarity index of (2*78/100+100) = 78 percent or excellent.
Therefore, area B similarity index of (2*19/100+100) = 19 percent or poor.

Or, alternatively, using a similarity criterion of >75 percent:

Area A similarity index of 78 percent = meeting management objectives;
Area B similarity index of 19 percent = not meeting management objectives.

Additional factors such as ground cover, soil compaction, streambank breakage, or channel form may be used to refine ecological status. These values will likewise be based on percentage of similarity to values obtained in an undisturbed setting.

Resource Value Ratings

We often choose to manage vegetation for some seral stage other than PNC. In these cases, another approach used to evaluate status or condition of riparian areas is to compare the present species or community type composition of an area to a desired set of species or community types capable of occurring in that area (Winward 1989). On public lands, the "desired values" are developed by professionals in an interdisciplinary setting. Similarity values between "present" and "desired" are calculated using a process similar to that used in developing ecological status ratings. Categories for rating the site are poor, fair, good, and excellent as in past range condition ratings (table 4). Or, categories can be developed to determine whether the site is or is not meeting management objectives. Information from the Range Inventory Standardization Committee Report (1983) suggested that a value of 75 percent similarity or greater may be used to differentiate between meeting and not meeting management objectives.

Clary, Warren P.; Webster, Bert F. 1989. Managing grazing of riparian areas in the Intermountain Region. Gen. Tech. Rep. INT-263. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 11 p.

Concern about livestock grazing in riparian habitats and its effect upon riparian-dependent resources has resulted in numerous controversies about the appropriate management approach. This document provides guidance for grazing of riparian areas in a manner that should reduce both nonpoint source pollution and potential grazing impacts on other riparian-dependent resources.

KEYWORDS: nonpoint source pollution, utilization, stubble height, grazing systems, streambanks

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

The Intermountain Research Station territory includes Montana, Idaho, Utah, Nevada, and western Wyoming. Eighty-five percent of the lands in the Station area, about 231 million acres, are classified as forest or rangeland. They include grasslands, deserts, shrublands, alpine areas, and forests. They provide fiber for forest industries, minerals and fossil fuels for energy and industrial development, water for domestic and industrial consumption, forage for livestock and wildlife, and recreation opportunities for millions of visitors.

Several Station units conduct research in additional western States, or have missions that are national or international in scope.

Station laboratories are located in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Ogden, Utah

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)

USDA policy prohibits discrimination because of race, color, national origin, sex, age, religion, or handicapping condition. Any person who believes he or she has been discriminated against in any USDA-related activity should immediately contact the Secretary of Agriculture, Washington, DC 20250.