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A Framework for Evaluating the Economic Benefits, Costs, and Trade-offs Associated with Riparian-Area Management Practices and Strategies

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Abstract

The purpose of this paper is to provide an overview of the significant economic considerations in the analysis of the management, use, and enhancement of riparian zones in the interior West. Applied demonstration work has been done, including basic biological research relating to the functioning of riparian ecosystems and to the effects of domestic livestock grazing on the performance of the riparian system. The literature relating to that work is reviewed here, with an emphasis on implications for economic analysis. Attention is given to the subject of the costs and benefits of riparian-zone management, use, and enhancement strategies from the private and from the social perspectives. The final part of the paper deals with the types of values riparian zones provide, the social benefits resulting from the improvement of riparian zones, the private and social costs of riparian-zone degradation, and the possibilities for the provision of economic incentives to encourage voluntary private sector participation in riparian improvement projects on both private and public lands.

INTRODUCTION

Twenty years ago, riparian areas in the semiarid West were almost universally viewed as “sacrifice zones”—areas bordering streams that were habitually overgrazed by livestock. Given the traditional system of livestock grazing used nearly everywhere, the moderate to heavy season-long stocking levels with little active herding or cross-fencing, and the preferences of livestock for the forage and climate of riparian areas, sacrifice seemed natural. No one seemed to care, or to be very concerned, about the condition of these sacrifice zones.

Times have changed. Today the condition of Western riparian areas in relation to domestic livestock grazing is a major public concern (Holechek et al. 1989). The condition of Western riparian areas now constitutes a leading indicator of the environmental quality of the Western rangelands. Pressure is in-

creasing to reduce or eliminate livestock grazing in riparian areas. What has happened?

CONFLICTING INTERESTS: THE HEART OF THE PROBLEM

Many users of riparian areas and their resources have come to believe, with some justification, that domestic livestock, and range cattle in particular, have done, and in the absence of intercession will continue to do, significant damage to riparian areas—and the charge has been led by fishery interests. That hypothesis guides the literature reviewed and evaluated in this paper.

This hypothesis is not tested; but it illuminates the way in which the body of knowledge on livestock grazing/riparian habitat condition/watershed relationships has developed over time. These interpretations are affected by the scientists’ value and preference systems.

Social preferences and trade-offs in riparian-area

management were suggested in a report dealing with the Oregon Range Evaluation Project (Megank and Gibbs 1979). All types of recreators favored more intensive livestock management, including additional fencing. Hunters favored practices to enhance forage for livestock in the belief that this would improve habitat for deer and elk. Fishermen opposed practices that would alter the native (meaning, essentially, ungrazed) riparian habitat. According to the American Fisheries Society (1982), "19,000 miles of sport fishing streams have declined in quality as a result of land management practices, including overgrazing." The key to this statement is the term *quality*, which, in this context, probably refers to stream and aquatic habitat supporting the sports fishery and negatively affected, in belief or fact, by livestock grazing in the adjacent riparian zone.

SCOPE AND DIVERSITY OF WESTERN RIPARIAN AREAS

Various definitions of *riparian areas* exist. The one used in the present discussion follows Skovlin (1984). Riparian areas are wetland fringes along rivers and streams. Wetlands are associated with swamps, marshes, and lakes. The narrow fringe of the riparian zone is critical to the functioning of the stream for aquatic habitat. Often, beyond this zone is the floodplain with a shallow water table providing meadow and sometimes shrub or forest vegetation. The herbaceous meadow layer may begin adjacent to the stream bank if an overstory of riparian shrubs or trees is not present (Ibid.: 1002).

This definition is important because when addressing interactions between livestock grazing and riparian zones and habitat conditions we must remember that the lines between aquatic zones and habitat, riparian zones and habitat, adjoining meadow or other wetland-zone habitats, and adjacent upland zones and habitat are not distinct. The interrelationships among these zones and habitats pose significant management challenges and hence have significant economic connotations. This point has been emphasized by Platts and Raleigh (1984), who state that at least three classes of riparian zones—forested, willow-shrub, and herbaceous—need to be distinguished from adjacent uplands (and from adjacent streams and meadows¹) in the development and implementation of livestock grazing management plans (Behnke and Raleigh 1979, Platts 1979).

Extent and Ownership of Western Wetlands and Grazing Lands. The geographic scope of the riparian management challenge in the interior West is overwhelming. Various writers give different estimates of the extent of riparian and associated habitats; but

whatever the actual numbers may be, they are quite large. In the eleven contiguous Western states, the federal government owns and manages 316 million acres of land, just under one-half of the total surface acres in the Western United States. Livestock grazing occurs on 500 million acres of land, of which 288 million acres (just under 60 percent) are public grazing land administered by either the Forest Service or the Bureau of Land Management (BLM) (Armour et al. 1991). Over 90 percent of all federal land holdings in the Western states are grazed by livestock.

Wetlands, including mountain meadows, arid and semiarid rangeland marshes, and riparian corridors, constitute a small but very significant portion of these grazed lands. Owen (1979) states that the Western public lands include 103,000 miles of fishing streams, of which only 19,000 miles (18 percent) are found on BLM rangelands while the remainder are on Forest Service lands. Of the 84,000 miles of Forest Service fishing streams, 12,400 miles are located in the Intermountain West range region. Skovlin (1984) estimates that there may be another 19,000 miles of fishing streams located on private lands in the interior West.

Lakes and reservoirs occupy 2,800,000 acres of federal property in the West, a similar percentage of which are on BLM lands. Another 2,800,000 acres of federal lands in the West are classified as riparian and wetland habitat, but this total may not include the additional 4,045,000 acres of mountain meadow reported by Skovlin (1984).

Extent and Nature of Grazing Management on Western Wetlands. With the possible exclusion of the strips of wetland vegetation surrounding man-made lakes and reservoirs, riparian and closely related habitats account for at least 2 percent of the total grazed surface area in the interior West—and this does not include the surface area of the perhaps 50,000 miles of fishing streams located on public and private lands in the region. These riparian areas provide a disproportionate amount of the total forage consumed by grazing livestock in the interior West (Skovlin 1984, General Accounting Office 1988, Chaney et al. 1990), and 93 percent of the riparian area on public lands is grazed. Kauffman et al. (1983b) stated that while riparian zones account for only 2 to 3 percent of the area in Western mountain rangelands, they provide 20 percent of the available forage in fenced pastures and 80 percent of the total amount of forage actually consumed by grazing livestock in the mountainous region.

The intensity of grazing management in the public-land portion of these riparian areas varies among regions. In the Western mountain rangelands, Skovlin (1984) estimated grazing management to be minimal on 25 percent of the public-land riparian area (averaging 0.6 animal unit months [AUMs] per acre),

¹Author's remark. *Ed.*

extensive on 52 percent of the acreage (averaging 0.9 AUMs per acre), and intensive on only 4 percent of the acreage (averaging 2.5 AUMs per acre). He noted that on another 12 percent of the public-land riparian acreage grazing management is done to maximize forage production for livestock at a rate of 2.7 AUMs per acre, and it may be hypothesized that the same holds true for most of the privately owned riparian areas in the interior West.

LIVESTOCK GRAZING IN RIPARIAN AREAS: A CHRONOLOGY OF KNOWLEDGE BUILDING

Platts attributed the birth of interest in the interactions between livestock grazing and riparian condition to a speech given by a member of the Western conservation movement, A. S. Leopold:

Leopold (1974), at the West Yellowstone Wild Trout Symposium, said that livestock grazing may have cumulative ecological ill effects on productivity of both lands and waters. Leopold admitted this hypothesis was intuitive, with few clear facts to back up his statement, and pleaded for studies to clear up the issue (Platts 1981).

A public outcry resulted, even though at the same time the Council for Agricultural Science and Technology (CAST) stated that well-managed livestock grazing is consistent with the preservation of environmental quality on public lands (1974). Two years later, a panel of scientists appointed by CAST concluded that the existing body of theory and data did not support declarations that grazing negatively influences other resources, presumably including the resources of riparian areas (1977).

ROLE OF THE FEDERAL LAND POLICY AND MANAGEMENT ACT

In the same year, Congress passed the Federal Land Policy and Management Act (FLPMA 1988) calling for the management of public lands for multiple uses and sustained yields:

Congress declares that it is the policy of the United States that . . . the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide *food and habitat for fish and wildlife*

*and domestic animals;*² and that will provide for outdoor recreation and human occupancy and use [Section 102. (a) (8)].

Elsewhere in FLPMA (especially Section 103), considerable emphasis was placed on the need to recognize livestock grazing as an authorized use of federal lands but to manage the grazing use in such a way that long-term or irreversible environmental damage is avoided. FLPMA, together with Leopold's earlier challenge, resulted in a surge of basic and applied research (summarized by Busby 1979, Meehan and Platts 1978, and Platts 1979) dealing with the interactions between livestock grazing and the functions and productivities of riparian habitats.

FACT-FINDING BY THE NATIONAL RESEARCH COUNCIL

Another result of FLPMA was a request for assistance in implementing FLPMA requirements made by the BLM to the National Research Council. This request led to six organized workshops over a two-year period beginning in November 1980 (Platts and Raleigh 1984). Workshop III dealt with the impacts of grazing intensities and specialized grazing systems on the use and value of rangeland, including riparian areas (Skovlin 1984, Platts and Raleigh 1984). Skovlin's conclusions were similar to the earlier CAST statements, while Platts and Raleigh were somewhat more negative with respect to the environmental compatibility of livestock grazing and restoration of riparian ecosystems.

Controlled Grazing Can Enhance Riparian Zones. Skovlin's findings and recommendations were particularly well developed and set the stage for subsequent public-sector participation in grazing management/riparian area restoration research and demonstration programs. According to Skovlin, the literature clearly suggests that control over grazing intensity (light to moderate preferred to heavy) and season of use (emphasizing mid- to late-season grazing) is in net terms beneficial to riparian zones and meadows and to most of the nonlivestock uses these zones support. Controlled grazing of this sort is, in the interest of cost efficiency, preferred to no grazing. The key to effective control over livestock preferences for riparian zones and adjoining meadows is distributional control through herding, fencing, and water developments away from the riparian corridor.

Livestock Management Options in Riparian Zones. Skovlin outlined ten management options for riparian-zone management. (He recognized shifting from cattle to sheep as a viable riparian-management alternative, although an impractical one for extensive adoption.) These options were to

²Author's emphasis. *Ed.*

1. Do nothing.
2. Improve distribution, including using more upland area, moving the animals out of the area, and making appropriate changes in the age class of cattle.
3. Change the season of use.
4. Implement specialized grazing seasons.
5. Rest for five years or until target riparian-zone recovery levels are achieved.
6. Separate by fencing the meadow floodplain zone from the adjoining riparian corridor.
7. Provide livestock access to fenced streamside corridors for stock watering purposes where needed.
8. Combine two or more of the above.
9. Revegetate with woody cover and apply the principles of items 5, 6, and 7 above.
10. Eliminate grazing.

Prescribed Management Strategies for Priority Enhancement Efforts. For prioritization purposes, Skovlin stated that critical stream reaches for fish should be identified. Acceptable targets for riparian habitat improvement and the desired time schedule for achieving those targets should be specified. Fencing corridors with limited watering access points is technically effective but costly and should be considered only for critical stream reaches, although it may be more economically efficient than reducing stocking rates to below moderate levels. Cross-fencing the meadow and riparian corridor is economically more efficient and may be environmentally preferable to riparian enclosures. Spring deferment or light grazing is appropriate in riparian areas during the restoration stage. Heavy late-season grazing is economically more acceptable to ranchers than light grazing in the riparian corridor season long and may even be effective in achieving revegetation targets as well.

THE GENERAL ACCOUNTING OFFICE INVESTIGATION

The National Research Council's findings were constructive, but the public outcry about the negative effects of public-land livestock grazing persisted. In view of the mixed signals from the scientific and public-land management communities, Congress again decided to act. This time the action took the form of an October 1986 request from the chairman of the House Committee on Interior and Insular Affairs and the chairman of its Subcommittee on National Parks and Public Lands to the General Accounting Office (GAO). GAO was asked to (1) identify specific examples of successful efforts to restore degraded riparian areas on Western public rangelands, (2) determine why those efforts had been successful, and (3) ascertain the transferability of the successful restoration techniques.

The GAO report was issued in June 1988. Its conclusions can be summarized as follows. First, riparian restoration with continued livestock grazing will not work unless the permittee is willing to actively manage, using alternatives to unmanaged, heavy, season-long grazing. If the restoration program is mandated on an active grazing allotment, trespass is probable. Upland water development and possibly upland reseeding may be necessary (if existing upland water and range conditions warrant) if cross-fencing is used. Additional herding and fence maintenance are requirements for riparian restoration with continued livestock grazing. Riparian enclosures should be used only if the nonlivestock values of the riparian area are quite high. Major instream and other habitat improvement expenditures probably are not warranted except under extremely fragile soil circumstances or when native seed sources needed for restoration have been entirely eliminated from the site.

EDUCATION COMMISSIONED BY THE ENVIRONMENTAL PROTECTION AGENCY

The need for information to use in public education and for efforts to encourage ranchers and others to adopt improved grazing management systems for Western riparian areas and adjacent uplands was subsequently recognized by the U.S. Environmental Protection Agency (EPA). EPA commissioned a two-part study, with the first part being aimed at the general public. The result was titled "Livestock Grazing on Western Riparian Areas" (Chaney et al. 1990).

The conclusions of this report were similar to, but more specific than, the GAO observations. The successful riparian-restoration projects evaluated by the Northwest Resource Information Center under a contract with EPA illustrated that while specifics vary from case to case it is possible to improve both riparian areas *and* livestock-carrying capacity and animal performance using managed livestock-grazing systems.

Why Have Some Riparian-Enhancement Projects Succeeded? Keys to success are as follows:

1. Defined objectives for the riparian area
2. Accurate knowledge of current and potential conditions in the riparian area
3. Grazing strategies based on encouraging specific plant composition and balancing needs of both upland and riparian vegetation through either inclusion of riparian areas in smaller pastures, close herding, or riparian exclosures throughout the recovery period
4. Avoiding simple reductions in stocking levels
5. Controlling the timing of livestock use to avoid

soil compaction and stream bank damage and to coincide with the physiological needs of target plant species

6. Adding longer or more rests to the grazing cycle
7. Increasing herding
8. Limiting grazing intensity
9. Minimizing the length of the riparian recovery interval

Also important are flexibility, commitment, monitoring and evaluation, progressiveness, education, and cost-sharing consistent with public benefits, as well as an expanded federal small watershed program, dedication of a portion of grazing-fee receipts to riparian-enhancement projects, fish and wildlife foundation grants, and expanded state and federal challenge cost-share programs. Further contributing to the success of riparian-enhancement projects are technology transfer by demonstration, applicable governmental incentives and disincentives, and withdrawal of permits and allotments as they become vacant or are transferred, including holding recovered riparian-area permits in reserve for use during droughts or as safety valves for degraded riparian areas elsewhere.

Policy and Management Implications. The EPA study suggests that site-specific goals and technical information are necessary if riparian-enhancement projects are to be successful. The by-the-book approach will not succeed. Rapport must be established among all interested or affected private and public parties. Livestock owners have the most to lose, particularly in the short run, but their cooperation is essential if riparian-enhancement efforts are to succeed. Incentives, either in the form of more or better livestock forage allocations and/or monetary transfers, are warranted in public-land riparian-enhancement projects.

GRAZING SYSTEMS AND PRACTICES FOR RIPARIAN-ZONE SUSTAINABILITY AND ENHANCEMENT

Prior studies have been done of the relationships among grazing intensities, grazing systems, and distribution-control practices. In a major literature review, Van Poollen and Lacey (1979) concluded that enhancement of herbage production adjustments in livestock numbers (intensities) had more influence than adjustments in systems. They recommended moderate (maximum *sustainable* level of forage removal by livestock) versus light (taking little forage with the aim of improving range condition and soil stability) or heavy (in excess of range carrying capac-

ity and advocated only under controlled short-duration grazing systems) stocking rates but noted that most prior studies used some combination of intensities and systems.

GRAZING INTENSITIES

Moderate intensity of use does not necessarily imply uniformity of use in a given pasture or range tract. Riparian zones typically receive heavy grazing pressure. Methods to encourage better distribution of grazing livestock have been suggested. One of the reasons for greater grazing pressure is the higher palatability and gentler topography of meadows and related habitats in riparian zones. Overgrazing tends to be most extreme in the early summer and, topography permitting, may be reduced by salting away from the riparian zone (Roath 1979). Salting is not effective on dryer and steeper rangelands. Livestock-use preferences in riparian zones seem to be independent of changes in rainfall patterns over time (Roath 1979).

DISTRIBUTION CONTROL PRACTICES

Factors contributing to livestock preferences for riparian zones include (1) forage density and palatability in the riparian zone opposed to the adjacent uplands, (2) distance to water, (3) distance upslope (slope length), and (4) microclimatic features (Skovlin 1984). More of the herbage is forage; and the forage stays green and is more nutritious for a longer period of time, including the interval of regrowth, in the riparian zones, leading to both livestock and big-game preferences for riparian zones.

Relative to use of upland forages, grazing animals expend less energy per unit of forage consumed in the riparian zone. Hence, given an adequate forage supply, it can be expected that the performance of ungulates (both domestic and wild) may be better if most of the grazing occurs in the riparian zone.

The riparian stream is often the sole source of water in a fenced pasture or range tract in the interior West, and level and pattern of forage utilization is directly related to distance from water. The same direct utilization relationship exists with regard to steepness and length of slope. Under hot weather and semiarid rangeland grazing conditions, the cool microclimate of the riparian zone created by a combination of evaporation, shade, and wind movement along with drinking water makes the riparian zone attractive to all mammals, including livestock. Following fall rains, cattle customarily will vacate riparian zones in favor of uplands.

For these reasons, researchers have found that water developments on uplands, salting, and herding on moderately stocked ranges that include riparian

zones can reduce pressure on riparian areas in an economically efficient manner (Skovlin 1965; Workman and Hooper 1968). Riparian enclosure fencing has not been found to be economically efficient on either private or public rangelands, although there is some indication that at least temporary (two- to five-year) riparian enclosure fencing is a preferred control technique in many riparian and watershed enhancement projects on public (especially Forest Service) lands (Callahan 1990, Chaney et al. 1990, GAO 1988). On either private or public lands, livestock performance possibly could be efficiently enhanced through enclosure fencing on riparian areas with little vegetation, assuming ample forage and water is available on adjacent uplands, since forage intake diminishes with lower levels of forage availability (Hodgson and Wilkenson 1968).

GRAZING SYSTEMS

The traditional livestock grazing system on Western rangelands is season long or, in parts of the Southwest, year long. Specialized alternatives include deferred, rotation, rest rotation, and deferred rotation. Other than simple deferred grazing, each specialized system requires pasture or range-tract subdivision.

Do Grazing Systems Make Economic Sense on Private Rangelands? Available evidence suggests that livestock performance is poorer under all specialized systems, possibly due to the level of management intensity and site-specific flexibility needs in each case. Skovlin (1984) stated that, "No grazing system has been devised for insuring proper use of small riparian meadows within extensive upland range." A better alternative may be fenced trailing lanes to riparian watering points (Seneva et al. 1971) or fencing off larger (thirty- to forty-acre) riparian meadows from adjoining upland ranges with corresponding control over season of use (Busby 1979).

Do Grazing Systems Make Economic Sense on Public Rangelands? From the public-land managers point of view, grazing systems on public lands may be a more cost-effective way to achieve environmental goals for riparian areas since the minimum requirement may only be to maintain animal production while enhancing other riparian resource values. From this public or social perspective, even temporary overuse of riparian zones has to be avoided. Following overuse of the riparian zone in any one year, it may take several years for the riparian zone to return to its previous ecologic condition. For this reason, many fish and wildlife biologists argue for complete exclusion of livestock from public riparian zones currently in degraded condition.

Busby (1979) and Kimball and Savage (1977) maintain that exclusion is not necessary. One popular

recommendation is temporary exclusion for two to four or five years with concurrent reseeding and other artificial improvements, followed by subsequent grazing but with destocking to moderate intensity levels and a three or more unit rest-rotation system. The grazed units in any year would be alternatively deferred early and late in the grazing season. An added wrinkle could be rotation of winter use, particularly in the Southwest and in the Northern Great Plains states (Severson and Boldt 1978).

WHICH APPROACH TO GRAZING MANAGEMENT IS BEST?

Methods to rehabilitate riparian zones include complete livestock exclusion, rotation grazing systems, changes in the type or class of livestock, and improved livestock distribution methods. The exclusion method is preferred by many professional land managers but is most heavily resisted by livestock operators. Skovlin (1984) has shown that riparian-zone improvement is possible without complete livestock exclusion. Rest rotation in conjunction with moderate stocking rates (Pieper and Heitschmidt 1988) seems to be the most effective way of improving riparian-zone vegetation and physical characteristics (Davis 1982, Platts 1982, Bohn and Buckhouse 1985).

It often is recommended that cattle be replaced with sheep due to ease of herding of the latter (Platts 1982), although Skovlin (1984) and others question the practicality of that option. Another possibility in changing type of livestock is to selectively cull for animals with preference for upland vegetation (Roath 1979, Roath and Krueger 1982).

Additional fencing and delayed grazing of riparian zones until late summer can benefit vegetation, stream banks, wildlife, and livestock performance (Holechek et al. 1982, Kauffman et al. 1983a, 1983b). This strategy has the dual advantage of reducing livestock gathering and removal costs at the end of the grazing season, although fencing costs do increase. Under other conditions, early spring grazing of riparian areas may be beneficial (Elmore and Beschta 1987).

Increased control over the distribution of domestic livestock, with or without reduced grazing intensity, appears superior to management-intensive grazing systems as a means of improving riparian habitats. Unless distribution is controlled, even reduced numbers of livestock will still show a preference for meadows and riparian areas vis-a-vis uplands. No grazing-management strategies other than riparian enclosure have been shown to be completely effective in riparian-enhancement projects, and even enclosures will be ineffective if upstream grazing is unmanaged and/or trespass cannot be eliminated.

The most appropriate strategies for effective and efficient riparian-zone enhancement are (1) site-pre-

scriptive improvements in livestock distribution, (2) controlled periods of grazing deferment, rest, and rotation through pastures and tracts with a mix of riparian and upland habitats, and (3) combinations of fencing (with or without upland water developments).

SUMMARIZING THE PRESENT STATE OF KNOWLEDGE

In summary it would seem that both major and more specific research and demonstration efforts have tended to confirm the CAST statements made in 1974 and 1976. Domestic livestock grazing and restoration of riparian areas are compatible uses of public rangelands. The key it would seem is scientific and managerial knowledge coupled with appropriate incentives and the dedication to succeed. However, the knowledge base remains incomplete (Armour et al. 1991). A good portion of the knowledge void relates to the economic benefits, costs, and trade-offs associated with alternative livestock-grazing strategies for riparian areas and adjacent uplands.

CONCEPTUAL UNDERPINNINGS FOR RIPARIAN ECONOMICS

One often hears the phrase, "Just do the right thing." A common response from a hardened economist might be, "Right for whom, for what, where, and when?" The answer: "For everyone, everywhere, in every way, always!"

This not-so-contrived dialogue illustrates the way in which resource economists think about natural resource management and policy issues. Ask a simple question, get a complex response. What is "right" in the management and use of a fragile riparian zone in the semiarid vastness of the semiarid West is a matter of perspective.

PRIVATE AND PUBLIC PERSPECTIVES ON RIPARIAN-ZONE-ENHANCEMENT ISSUES

The perspectives offered here are those of the rancher (and other private users of the commodities and amenities provided by riparian areas) and those of society deriving enduring pleasure and satisfaction from the environmental services and economic resources riparian zones can provide. In a mixed-enterprise economy such as ours, both perspectives are relevant. The private rancher (or recreationist) has private interests in his or her use of private property—some of which are riparian. The American public has social interests in its use of public property—some of which also are riparian.

To complicate the situation, when private use of

public property is allowed, as in our system of permitted livestock grazing on public lands, the private party (permittee) has legitimate private interests in public property (the permit or allotment); and further, when public interests are affected by private actions, the American public has legitimate social interests in private management actions and practices. That is the reason why nonpoint-source pollution and other regulatory concerns of the Environmental Protection Agency and other governmental organizations figure in the management of privately owned riparian areas.

There are four perspectives in the analysis of Western riparian areas: Private interest in private property; private interest in public property; public interest in private property; and public interest in public property. The benefits and costs germane to each perspective will differ, as will the solution to the basic question: What can be done to sustain and enhance the productive potential of our Western riparian zones for all uses, users, and times? In other words, not only does successful riparian enhancement require site-specific prescriptions but for each such prescription there may be as many as four relevant economic accounts. Ask a simple question, get a complex answer.

ECONOMIC STANDARDS FOR RIPARIAN-ZONE MANAGEMENT AND POLICY ANALYSIS

There are three economic standards or criteria for sound resource (including riparian-resource) management and use policy. Those standards are *efficiency* (from both the private and the social perspectives); *equity* (in the sense of the distributions of the benefits and costs associated with riparian-zone management and use allocations among individual people, regions, economic sectors, and over time); and *sustainability* (in both the productive capability of the riparian resource and its continuing contribution to the livelihood and welfare of its users). Efficient, fair, and sustainable approaches to the management and use of riparian zones must be sought if, from both private and public perspectives, enhancement projects are to succeed.

The problem in management and policy analysis is that different people and different groups attach different weights at different times to each of these three standards. The relative importance of the consequences of riparian-zone management, use, and enhancement strategies is a matter of individual and collective interpretation.

RELEVANT STANDARDS FROM DIFFERENT PERSPECTIVES

Profit-driven hedonists place great importance on maximizing private efficiency. Generating the larg-

est amount of gross personal revenue at the least personal cost as quickly as possible is of primary concern. Short-term profit maximization is the primary motivating factor in private landowners' decisions about riparian-zone management, use, and enhancement.

While they may seek profit (or its conceptual equivalent, net satisfaction) in the management, use, and enhancement of riparian zones, those private parties who are permitted the right to use public riparian areas do so at the discretion of their landlord, i.e., the American public acting through its government and the various land- and resource-management (and regulatory) agencies. To retain that private right in public property over the long term, the permittee cannot afford to intentionally overgraze the riparian area any more than the camper can afford to litter it. Hence, the standards for those with private interest in public riparian property are profit maximization subject to sustaining the long-term productivity of the riparian zone.

The U. S. government and its management and regulatory agencies infringe on private management and use decisions when it serves the public interest to do so. This infringement occurs if a management or use practice on privately owned riparian areas generates off-site effects that are viewed, by society, as public costs. Intervention is driven by the dual standards of equity and social efficiency.

Finally, public-land riparian zones are managed and used for the public good. They are managed for multiple commodity and amenity uses, striving to maximize social efficiency by generating the greatest good for the largest number of people (as directed by FLPMA). Public-land riparian zones are managed with balance so that in the interest of equity no one is excluded from enjoying them. They are managed with foresight so that fragile riparian zones and their many uses and resources are conserved and sustained for all uses and users over time. In the case of public interest in public property, the standards for riparian management, use, and enhancement reach full fruition.

RIPARIAN ECONOMICS: THE SOCIAL AND PRIVATE PERSPECTIVES

In his systematic literature review of the effects of range-livestock grazing on vegetation, watershed, and fish and wildlife, Skovlin (1984) placed special emphasis on trees, shrubs, and herbaceous plants; on water quality, stream bank stability, and features of upland erosion; and on large and small mammals, birds, and invertebrate organisms. He also proposed

grazing strategies to improve habitats. Adding economics to Skovlin's biological approach to problem analysis is a convenient way to place riparian-zone management, use, and enhancement issues in a social context.

Riparian zones are critical for aquatic (primarily fish) habitat, providing buffering shade and cover for water-temperature regulation, cover for fish shelter or protection, and habitat for a terrestrial food supply. In the interior West, most livestock forage actually comes from surrounding mountain meadows and uplands, while the riparian streams provide drinking water for livestock. The riparian zones filter overland water flow that carries sediment and other pollutants into streams. Streamside vegetation stabilizes channel banks against cutting action, reduces further sedimentation, and provides improved water quality for downstream communities. For the recreationist, these areas are aesthetically pleasing. These functions and products of riparian zones are their sources of social and private value.

TYPES OF VALUES ASSOCIATED WITH RIPARIAN ZONES

Noneconomists should understand that when economists talk about resource values they are referring to "net" concepts—for example, gross benefits minus gross costs. In order to obtain and use any resource, something must be given up or foregone, even if it is nothing more than time. Time is not free nor is any other scarce thing. The values of riparian-zone resources are the benefits derived from them less the monetary and nonmonetary costs incurred in order to use the riparian resources.

Riparian zones yield, primarily as inputs in production processes, products that have market-based commodity values. Commodity values associated with riparian zones include wood, livestock forage, and water for mining, industrial, agricultural, and domestic uses. Most of the commodity uses of riparian zones are consumptive. Commodity values are fairly easy to measure but not as easy as many people may believe.

As final outputs, riparian zones also yield services valued directly by consumers. Most of these outputs have nonmarket amenity values. The amenity values of riparian zones are derived, in large part, from the recreational value of fish and wildlife for which the riparian zone serves as a life-support system. Amenity values usually are measurable, but there is much debate in economic circles over the relative appropriateness of the various measurement techniques.

In addition riparian zones consist of biota and physical components that people, to varying degrees and for various reasons, find pleasing. These attributes of the riparian zone thus have intrinsic

value. Unfortunately, intrinsic values are almost impossible to measure.

THE SOCIAL BENEFITS OF RIPARIAN ZONES AND THEIR ENHANCEMENT

Lant and Tobin (1989) note that while riparian corridors have economic value in the social sense these values may not be reflected in market prices. The result is that while the corridors are farmed (in the Western United States, they are grazed) for the value of the agricultural products (domestic livestock) produced in part from their use in some cases the agricultural (grazing) use can be socially inefficient.

Nonmarket Riparian Benefits. The nonmarket benefits of riparian corridors include such environmental services (public goods) as improved water quality (resulting in part from the lower temperature of shaded streams and less stream-bank erosion) and enhanced recreational activities associated with improvement of sports fishery habitat and the aesthetic attributes of a stream and associated stream-bank vegetation in good condition. These benefits can be quantified using willingness-to-pay techniques. The multiple benefits then can be aggregated and expressed as an average total riparian value per acre, where it is understood that this value is a composite of all use values other than the grazing use. This nonlivestock-use riparian value can be called the "gross social benefit" resulting from enhancement of the riparian zone, including both the stream or waterway and the surrounding riparian vegetation.

The social benefits of riparian-zone enhancement accrue as follows. First, water quality and aquatic (as well as riparian) ecosystems improve. There may be concurrent direct benefits in the forms of flood control, salmonid and other fishery enhancement, terrestrial wildlife-habitat enhancement, and stream and associated riparian-zone aesthetics. Second, these improvements in environmental conditions increase the flow of available recreational opportunities and enhance the intrinsic attributes and values of the waterway. Third, these improvements lead to measurable increases in socioeconomic values.

From an economic perspective, riparian values vary in the spatial sense. Spatial factors affecting riparian values are both longitudinal and cross-sectional. The net effects of these spatial factors are to cause riparian areas to have greater economic value when (1) small acreages—generally those areas nearest to the stream bank containing predominately natural vegetation and/or composed of poorly drained soils—play critical roles for hydrologic reasons in regulating water quality; (2) local recreational users of riparian areas place high value on the environmental services furnished by streams and riparian corri-

dors; and (3) large urban areas are directly affected by water quality. Consequently, the benefits to riparian enhancement will vary from site to site and with the size of a given site or a given enhancement project.

Implications for Locating Riparian Improvement Projects. Since riparian areas are found on both private and public lands, there are corresponding opportunities for improvement projects on both private properties and public-grazing allotments. The underlying economic logic is similar in both instances, however; and on both private and public grazing lands, the question, given limited time and money as well as knowledge, is *where* should the riparian enhancement occur.

If the aggregate nonlivestock riparian value exceeds the corresponding grazing value per acre, society would be better off to rent the properties at their riparian values from the property owners if the riparian zone were on private lands. The privately owned riparian areas contributing least to livestock revenues on private grazing lands or possessing the highest nonlivestock grazing riparian values thus would be converted from grazing to nongrazing uses. This conversion likely would result in a patchwork of privately owned and nongrazed riparian acreages which, at present, provide the least livestock forage and/or provide the most critical sports fishery habitats.

If the riparian area were in a grazing allotment, it would follow that the grazing use should be reduced until the value of the grazing use is equal to the average total nongrazing riparian value on the permit. Note, however, that this logic would justify total exclusion of livestock from the riparian area only if the livestock use had no positive value or if nonlivestock riparian values could be realized only in the absence of any livestock grazing. Again, the probable result would be a patchwork of riparian enclosures on public grazing lands that, at present, contribute least to permittee seasonal forage requirements or have the highest fishery habitat potential.

THE PRIVATE AND SOCIAL COSTS OF RIPARIAN DEGRADATION

According to Skovlin (1984), only 10 percent of the original riparian habitat of the United States remains intact today; and of this, 6 percent is lost annually. These losses have been due largely to the conversion of natural riparian areas to modified agricultural uses. Other causes of riparian-area loss include channelization for flood control, flooding for storage to produce hydroelectric power supplies, irrigation, recreation, and industrial and municipal encroachment.

In the riparian areas that still exist, alterations are taking place due to grazing, timber harvesting,

mining, road construction, and other factors. In the interior West, public concern centers on riparian degradation resulting, or thought to result, from domestic livestock grazing.

The social costs of degradation of riparian zones are reflected in decreasing natural infiltration and corresponding increases in sediment yield (Braden and Uchtmann 1985, Clark et al. 1985, Cooper et al. 1987, Maas et al. 1985, Schlosser and Karr 1981); decreasing flood-control potential (Novitski 1979, Peterjohn and Correll 1984, Tobin 1986); and deteriorating fish and wildlife habitat and aesthetic quality of the riverine environment (where the latter are intrinsic attributes sometimes referred to as "river or stream quality"). These intrinsic riparian-zone attributes vary in direct relation to the ecological health of the riparian, adjoining meadow or wetland, and adjacent upland ecosystems. The private costs of riparian-zone degradation in the interior West are primarily the value of reduced livestock forage availability.

From a social perspective, the riparian-area degradation costs are reflected in reductions in the consumptive and nonconsumptive recreational usefulness of the riparian zone. The willingness to pay on the part of these various recreational users generates the measure of social benefit (average total nonlivestock value) for incremental improvements in the condition of riparian zones (Cerda 1991, Lant 1987). Foregone recreational benefits (opportunity costs) are the measure of the value of degradation.

From a private perspective, the costs of riparian degradation are reflected in either reduced aggregate carrying capacity for the overall ranch operation or in the cost of buying or renting alternative sources of feed and forage to replace the reduced forage available on the degraded riparian zone. These costs are best estimated using a "whole-ranch" approach to estimating the effects of either positive or negative changes in riparian-zone conditions on the economic performance and financial risk of the ranching operation, since the riparian zone is only a seasonal forage source. However, the literature is devoid of any such applications with respect to riparian-zone management, use, and enhancement.

ECONOMIC INCENTIVES FOR RIPARIAN-ZONE ENHANCEMENT

Much of the biological and popular literature has focused on the enhancement of public-land riparian areas. Successes have been observed; but as GAO and others have observed, the pace of restoration has been slow. Restoration may or may not be achieved if livestock are removed from riparian zones; and in any case, the removal of livestock is both controversial and to a degree inconsistent with the body of

underlying public-land law. For the sake of both private interests in public property and public interests in public property, incentives for enhancement of public-land riparian zones need to use livestock, under relatively more intense management, as a prescriptive tool.

Prescriptive grazing for riparian-zone enhancement is possible if either the permittee is awarded a larger overall forage allocation, a higher quality forage allocation, or both or if monetary incentives for better and more intensive livestock management on the allotment are provided. The points to remember are that more management means higher costs and carrots work better than sticks.

Voluntary private-land riparian enhancement is more problematic. No more is known about the technical and economic feasibility of riparian improvement strategies on private lands than on public lands. Further, private-land owners cannot capture the social values associated with improved riparian zones on private property. Streams and other waterways normally are openly accessible and nonexcludable (with the recreational users being "free riders").

If the private benefits of riparian-enhancement projects are less than the associated private costs, improvement programs will not, in most cases, be adopted on private properties. This reality has led some resource economists to suggest the implementation of "riparian-enhancement markets" where development and use rights for specific acreages of riparian areas would be bought and sold. The underlying logic is that while the private owner might not be able to capture private revenues in excess of private costs there is nonetheless a marketable social value from improvement of privately owned riparian acreages.

This logic explains why subsidies (rents) obtained through riparian-market transactions might be required as incentives for riparian-zone improvements on private grazing lands. It also is why other types of subsidies or incentives (e.g., cost-sharing arrangements and other monetary incentives or increases in levels of permitted use elsewhere in the allotment or perhaps in a different allotment) could, from a social perspective, be rationalized to entice cooperation in riparian-enhancement programs on the part of permittees.

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