Strategies to Define and Implement Large-Scale Watershed Restoration Project Policy on the Navajo Nation

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Introduction

Range scientists generally agree that the condition of riparian areas on the Navajo Reservation has deteriorated seriously over the last century. Historic accounts of overgrazing in the latter half of the 19th century suggest that much damage occurred at that time (Sheridan 1981). Since then, continued grazing has additionally degraded, or at least prevented the natural restoration of riparian areas (USGAO 1982).

Fortunately, techniques for restoring small riparian zones, at least on an empirical basis, are well known and not technically difficult. Additionally, although overgrazing is often the reason for degraded riparian zones, it probably is not necessary to remove all livestock to effect restoration. For example, the Executive Committee of the American Fisheries Society has drafted a position stating "when properly implemented and supervised, grazing could become an important management tool benefiting fish and wildlife riparian habitats" (Armour et al. 1991). The technical literature contains several successful case histories of riparian restoration. One study, conducted by the U.S. Forest Service Rocky Mountain Experimental Station in western Colorado (Heede 1977), demonstrated the dramatic effects a series of check dams could have on a formerly overgrazed watershed. In addition to halting erosive losses of soil, vegetative cover was restored, the water table was raised, and an ephemeral stream became perennial once more. Other successful projects have been conducted in the Bear Creek watershed in Oregon (Young 1991) and watersheds located in several other western locations (USGAO 1988).

Check-dams constructed on streams within the Navajo Reservation during the New Deal were later washed away by floods (Parman 1976). The work by Heede (1977), however, demonstrated that with improvements in design and construction, rock check-dams can be built to withstand expected floods. Moreover, work performed by Rosgen (1992) showed that restoring streams to near-natural geometries can result in stable systems without significant long-term maintenance. Conflicts over the management of riparian zones in arid landscapes are already severe and are becoming increasingly complex (Zube and Simcox 1987). Consequently, additional research in watershed restoration is needed in order to determine whether the Navajo Nation should enter into the large-scale, multi-million dollar, long-term commitment that would be needed to fully restore degraded riparian areas.

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It is important to note that the effects and benefits of riparian restoration are accepted, but only from empirical and biological points of view (Zube and Simcox 1987). The hydrologic aspects, especially as translated into economic effects, have not been quantified. As noted by a speaker at a recent National Policy Conference on American Rivers, "emphasis in the 1990's will be on restoration rather than protection. . . .the need to restore watersheds, for example, will make science and technology more and more vital" (Marston 1991).

Current Status

The typical effects of poor land-management practices on riparian zones are evident throughout the Navajo Nation. After many years (50 to 100 or more) of overgrazing by livestock, the original riparian vegetation is gone. Seedlings were eaten and killed until only the most grazing-resistant plants remained: the sparse and shallow-rooted vegetation that remains is insufficient to prevent severe erosion.

Often vegetation which survives severe overgrazing does so only because it cannot be eaten by livestock. Plant-type changes caused by overgrazing eliminates alders and willows at higher altitudes, leaving only associated grasses. At middle elevations, sycamores and cottonwoods are often entirely missing, and are replaced by bermuda grass, desert willow, seep willow, and sometimes tamarisk (Kennedy 1977).

Similar effects of eliminating riparian vegetation were reported by Glinski (1977), who studied cottonwood reproduction in a southern Arizona stream. Cottonwood reproduction was nearly absent in areas grazed extensively by cattle, and was confined to the narrow erosion channel. Two significant, negative consequences of such channeling are evident: the containment of floodwaters within the confines of the relatively narrow channel, and the scouring of vegetation that occurs within the erosion channel. When overgrazing occurs, rain falling within the watershed spends relatively less time in the drainage because the channel quickly transports the water along the valley floor. Thus, water cannot disperse laterally from the creekbed onto the adjacent floodplain. The rapid transport of water through eroded channels, also negatively affects the water table recharge rate. Once streambed cutting begins, it is perpetuated and accelerated by floodwaters that concentrate in the erosion channel. These floodwaters transport and remove vegetation and debris that otherwise would have remained in place and promoted dispersal of less forceful floods. Erosive channeling that results causes an elevated terrace adjacent to the channel, which becomes increasingly dry due to reduced overbank flooding outside the channel. The depth of the water table increases as erosion progresses.

Various studies have shown that riparian zones can be restored and that rapidly eroding watersheds can be stabilized. For example, check dams installed nearly 30 years ago in the Alkali Creek watershed in western Colorado (Heede 1977) remain intact. These dams have trapped suspended sediment, raised the base level of the stream, and permitted the establishment of a thick cover of vegetation. The project was described as expensive, but no cost/benefit analyses were performed. More recent projects in larger streams have also demonstrated that dramatic improvement of aquatic and riparian habitats is possible (Rosgen 1992). The prospect of determining the value of large-scale restoration of degraded riparian areas now may have significant implications for the Navajo Nation because of the consequence of such actions on water balance, water quality, livestock production, and reservoir operation.

Finally, for a restoration project to have lasting beneficial effects, it is desirable that the tribe be active participants in the project. Examples of training and experience that can be gained include: training of students in monitoring and surveying techniques, training of workers in the necessary construction and revegetation methods, and the eventual assumption of all decision-making tools (e.g., models) by tribal scientists. The hoped-for result, therefore, is;

(1) a decision-making tool that can be used to determine where and how much restoration to perform, and

(2) a trained work force with the experience and knowledge to conduct such projects when appropriate.

Research Needs

Water balance and the timing of water release within the watershed are important considerations in stream restoration efforts. Currently, water quality and water balance are controlled by circumstances of channeling, downcutting, and the resultant lowering of the water table. If a large-scale watershed restoration project was conducted, what changes would occur in the water balance of the individual, small watersheds? With a fully restored and functioning watershed, the spring floods would provide less water because more of it would be held back in the now higher water tables associated with restored streams. Undoubtedly, some of this water would be lost by evapotranspiration due to greater quantities of the increased riparian vegetation, and some would merely be released more slowly and delivered later in the season. Under which circumstance --restored versus non-restored -- would water loss and water quality be greater? How would the change in watershed processes affect grazing and the need for irrigation? What is the appropriate balance between the benefits derived from watershed restoration and livestock production? These are the types of questions that need to be answered in order to determine if a large-scale project should be initiated to restore watersheds.

Another scientific question to be answered is whether water quality (e.g., salinity) can be improved. The literature suggests that salinity decreases as the sediment load is decreased (Gellis et al. 1991). As reported by Schlosser and Karr (1981), efforts to improve water quality during base flow should emphasize maintenance of riparian vegetation and stable flow conditions. If there are improvements in water quality, what is the value of the economic benefit? Considering that millions of dollars are spent on salinity control throughout the western United States, any alteration due to large-scale restoration projects could have a significant economic benefits and thus, lead to increased federal support for more large-scale restoration efforts.

Concurrent with studies of water issues, thorough evaluations of the effects of watershed restoration on wildlife and aesthetics are needed. Increasingly, economists and landscape scientists are developing quantitative procedures for establishing a dollar value on such features. For example, the recent literature has presented approaches to evaluating the economic benefits of instream flow levels (Douglas and Johnson 1991; Brown et. al. 1990; Ward 1987), wetlands (Farber and Costanza 1987), range improvement projects (Pope and Wagstaff 1987), and environmental features in general (Bergstrom 1990; Rahmatian 1987, Turner et al. 1988).

Although it may appear that the benefits of watershed restoration are obvious, recent work has demonstrated that the results of economic analyses are affected by several complex factors. For example, a study concerning the value of instream flow in the Colorado River Basin expected to focus on effects on water deliveries and consumptive uses. The authors found instead that impacts of flow increases on water use were dwarfed by the impacts of changes in reservoir operating rules (Brown et al. 1990). Similarly, a study evaluating the economic effects of erosion control in the east and midwest suggested that the locations with the greatest erosion losses did not suffer the most economic damage (Ribaudo and Young 1989)

A watershed approach to ecological monitoring has been proposed for use in national parks (Herrmann and Stottlemyer 1991). Applying a similar approach to a recovering watershed would provide the information to determine the quantitative effects on water balance and water quality. Tracer studies could also be performed as a means of obtaining concentration-versus-time curves (Castro and Hornberger 1991) which could be used to quantify changes that occur during the restoration process. It is assumed that the curves will show that solutes have a longer residence time in reaches of the stream as the restoration process continues. Eventually a steady-state situation should be attained which can be used to evaluate water balance and the time needed to determine whether the restoration process is complete.

After all data are obtained and an economic value for watershed restoration is established, landscape modeling techniques could be used to extrapolate the results to the reservation as a whole. This process is difficult because insufficient replication of broad-scale experiments limits one's ability to test the process (Turner et al. 1989). Nevertheless, with continued pressure on natural resources, it is necessary that socially acceptable rates of range deterioration be assessed in terms of trade-off in welfare between present and future generations -- a process that currently is being promoted in parts of Africa (Livingstone 1991). A project of this type could be used to determine whether large-scale watershed restoration should be a goal of the Navajo Nation.

References

Armour, C. L., D. A. Duff, and W. Elmore. 1991. The Effects of Livestock Grazing on Riparian and Stream Ecosystems. Fisheries, 16:7-11.

Bergstrom, J. C. 1990. Concepts and Measures of the Economic Value of Environmental Quality: A Review. Journal of Environmental Management, 31:215-228.

Brown, T. C., B. L. Harding, and E.A. Payton. 1990. Marginal Economic Value of Streamflow: A Case Study for the Colorado River Basin. Water Resources Research, 26:2845-2859.

Castro, N. M., and G. M. Hornberger. 1991. Surface-Subsurface Water Interactions in an Alluviated Mountain Stream Channel. Water Resources Research, 27:1613-1621.

Douglas, A. J., and R. L. Johnson. 1991. Aquatic Habitat Measurement and Valuation: Imputing Social Benefits to Instream Flow Levels. Journal of Environmental Management, 32:267-280.

Farber, S., and R. Costanza. 1987. The Economic Value of Wetlands Systems. Journal of Environmental Management, 24:41-51.

Gellis, A., R. Hereford, S. A. Schumm, and B. R. Hayes. 1991. Channel Evolution and Hydrologic Variations in the Colorado River Basin: Factors Influencing Sediment and Salt Loads. Journal of Hydrology, 124:317-344.

Glinski, R. L. 1977. Regeneration and Distribution of Sycamore and Cottonwood Trees Along Sonoita Creek, Santa Cruz County, Arizona. Symposium on the Importance, Preservation, and Management of the Riparian Habitat, 116-123. Tucson, Ariz.

Heede, B. H. 1977. Case Study of a Watershed Rehabilitation Project: Alkali Creek, Colorado. USDA Forest Service Research Paper, RM-189, United States. Department of Agriculture.

Herrmann, R., and R. Stottlemyer. 1991. Long-Term Monitoring for Environmental Change in U.S. National Parks: A Watershed Approach. Environmental Monitoring and Assessment, 17:51-65.

Kennedy, C. E. 1977. Wildlife Conflicts in Riparian Management: Water. Symposium on Importance, Preservation, and Management of the Riparian Habitat, 52-58, Tucson, Ariz.

Livingstone, I. 1991. Livestock Management and Overgrazing Among Pastoralists. Ambio, 20:80-85.

Marston, E. 1991. Summary of Remarks, General Session, River Protection and Water Use: Setting the Conservation Agenda for the 90's. National Policy Conference, Denver, Colo.

Parman, D. 1976. The Navajos and the New Deal. New Haven, CT: Yale University Press.

Pope, C. A., and F. J. Wagstaff. 1987. Economics of the Oak Creek Range Management Project. Journal of Environmental Management, 25:157-165.

Rahmatian, M. 1987. Valuing Public Goods Using the Linear Expenditure System Approach. Journal of Environmental Management, 24:225-236.

Ribaudo, M. O., and C. E. Young. 1989. Estimating the Water Quality Benefits from Soil Erosion Control. Water Resources Bulletin, 25:71-78.

Rosgen, D. 1992. Applied Fluvial Geomorphology. Presented by Wildland Hydrology Consultants, July 20-24, 1992, Pagosa Springs, Colo.

Schlosser, I. J., and J. R. Karr. 1981. Water Quality in Agricultural Watersheds: Impact of Riparian Vegetation During Base Flow. Water Resources Bulletin, 17:233-240.

Sheridan, D. 1981. Desertification of the United States, Council of Environmental Quality. U. S. Government Printing Office, Washington D.C.

Turner, M. G., E. P. Odum, R. Costanza, and T. M. Springer. 1988. Market and Nonmarket Values of the Georgia Landscape. Environmental Management, 12:209- 217.

Turner, M. G., V. H. Dale, and R. H. Gardner. 1989. Predicting Across Scales: Theory Development and Testing. Landscape Ecology, 3:245-252.

USGAO. 1982. Public Rangeland Improvement -- A Slow Costly Process in Need of Alternate Funding. GAO/RCED-83-23. U. S. General Accounting Office.

USGAO. 1988. Public Rangelands: Some Riparian Areas Restored but Widespread Improvement Will Be Slow. GAO/RCED-88-195. U. S. General Accounting Office.

Ward, F. A. 1987. Economics of Water Allocation to Instream Uses in a Fully Appropriated River Basin: Evidence From a New Mexico Wild River. Water Resources Research, 23:381-392.

Young, D. 1991. Managing the Riparian Zone and the Watershed: Workshop Presentation, River Protection and Water Use: Setting the Conservation Agenda for the 90's. National Policy Conference, Denver, Colo.

Zube, E. H., and D. E. Simcox. 1987. Arid Lands, Riparian Landscapes, and Management Conflicts. Environmental Management, 11:529-535.