Understanding and Managing Southwestern Riparian-Stream Ecosystems: National Forest Systems and Forest Service Research Partnerships

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Abstract.--Partnerships between research scientists and land managers can facilitate the application of research findings. Successful partnerships developed between Rocky Mountain Station scientists and the Southwestern Region staff have been involved in addressing riparian-stream interactions. These successful partnerships involve several interpersonal and organizational considerations. Examples and Keys to successful partnerships are described.

INTRODUCTION

Although National Forests cover over 21 million acres in Arizona and New Mexico, less than 1 percent is comprised of riparian ecosystems (Rinne and LaFayette 1991). Riparian areas in the semi-arid regions, such as the Southwest, are extremely valuable for wildlife and fish habitat, recreation, maintaining landscape diversity, sediment filtering and flood reduction, points of recharge for ground water, maintenance of water quality, commercial timber, and sustainable forage for livestock and wildlife (DeBano and Schmidt 1989).

Since the late 1800's, the impact of extensive unmanaged livestock grazing, wildfires, and forest clearing--coupled with numerous small linear perturbations such as travelways, low standard roads, and livestock trails--have dramatically influenced the land-riparian interactions observed today. Vegetation removal and soil compaction have substantially increased surface runoff, produced sediment-laden flows, and increased erosive power to the channel system, which has upset the balance between riparian areas and the surrounding watershed (LaFayette and DeBano 1990), leading to the degradation, channel incision, and (in some cases) complete destruction of riparian areas. Estimates of the total loss of southwestern riparian areas vary widely. The greatest losses have occurred along the banks of the larger river systems flowing through the lower elevation deserts, where up to 90 percent of the area has been lost (Carothers 1977). Higher elevations have fared better. But the overall loss of riparian areas for the state of Arizona has been estimated to be 30 to 35 percent (Dahl 1990).

Past information about riparian areas and their relationship to the surrounding watersheds is fragmented and dispersed through the literature. Only recently has some of this information been synthesized into state-of-the-art and other technical publications that link these research findings to management applications. The development of these publications has been prompted by establishing partnerships between key Rocky Mountain Station (RMS) scientists and Southwestern Region (R-3) managers, National Forest System (NFS).

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The objectives of this paper are to: (1) present a brief overview of three examples of successful partnerships between NFS and RMS involving southwestern riparian areas, (2) identify some specific products generated by these partnerships, and (3) summarize some of the requirements for establishing successful research-management partnerships. Readers who are interested in further detail of the brief overviews presented in this paper are encouraged to obtain and study copies of the individual publications. The following syntheses of published and unpublished work have helped NFS managers conceptualize research information:

SUCCESSFUL PARTNERSHIPS AND PRODUCTS

Partnership I - Publication on Riparian Area Enhancement

Although considerable effort has been concentrated on vegetation structure and classification, plant succession, water consumption, and grazing-wildlife interactions in riparian areas, only recently have the beneficial effects of different watershed practices on enhancing riparian areas been recognized. In the past, several watershed rehabilitation treatments were implemented solely for erosion control without realizing the additional benefit these treatments could have on improving and enhancing riparian areas.

To document these benefits, DeBano and Schmidt (1989) prepared a state-of-the-art report on riparian hydrology in the Southwest that summarized and interpreted data collected during past studies in the Southwest and throughout the West. Their paper provided general guidelines for improving hydrologic relationships in naturally occurring and human-induced riparian areas. The authors highlighted the effects that different watershed treatments have on enhancing riparian areas. This publication assumed that opportunities for riparian enhancement should be considered while improving watershed condition and riparian health.

Management opportunities for rehabilitating many upland riparian areas generally involve improving watershed condition, modifying plant cover by replacing deep-rooted shrubs with shallow-rooted grasses, installing small channel structures or gully plugs, or using a combination of all these rehabilitation techniques. Implementing these practices can alter both the amount and duration of streamflow. Before implementing watershed treatments, however, land managers need to be aware of the strong relationship between watershed condition and riparian health so they are better able to assess treatment effects. In nearly all cases this requires an interdisciplinary approach to management, covering abiotic as well as biotic factors operating within a watershed.

Products.--The most important products for NFS managers resulting from the synthesis by DeBano and Schmidt (1989) were: (1) a reference source of past watershed rehabilitation treatments, (2) a synthesis of existing information on watershed practices that is useful for both watershed and riparian rehabilitation, (3) guidelines for improving watershed condition and riparian health, and (4) identification of further research needed for southwestern riparian areas.

The publication also discusses the health of riparian areas, where a healthy riparian area reflects a dynamic equilibrium (i.e., volumes of incoming sediment equal those of outgoing sediment). In this condition, riparian vegetation remains vigorous but does not encroach into the active mean annual flood channel. In addition, streamflow does not rapidly expand stream meander cutting or point bar growth through the riparian area or affect it by eroding the channel bed. This equilibrium between channel deposition and down-cutting by erosion in riparian areas was illustrated by using a simple diagram that describes the relationship between sediment and production and streamflow (Lane 1955) that was later expanded by Heede (1980) to describe changing streams (Figure 1). A healthy riparian area maintains a dynamic equilib-

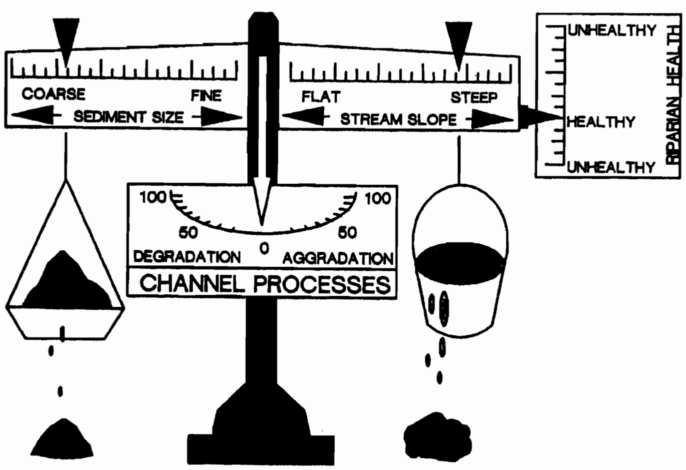

Figure 1. Relationship between sediment and production and streamflow.

rium between streamflow forces acting to produce change and vegetative, geomorphic, and structural resistance. When this natural riparian system is in dynamic equilibrium, it is sufficiently stable so that compensating internal adjustments can occur without producing changes that overwhelm this equilibrium.

It is important to note that the information presented in this state-of-the-art publication did not require any new or unpublished research findings; instead, it was based entirely on a comprehensive synthesis of existing information. While we cannot say that sufficient information exists to address all current and future riparian area issues, there is a need to more fully utilize existing information before establishing future research problems.

Partnership II - Linkages Between Watershed Condition and Riparian Health

The interrelationships between riparian health and watershed condition (DeBano and Schmidt 1989) were further expanded by LaFayette and DeBano (1990). Three concepts are presented along with supporting figures to assist in understanding the relationships between watershed condition and riparian health. The first concept addressed the commonality, or likelihood, of possible combinations of the two factors. The second concept presented the acceptability of these combinations to managers and the public. These two concepts were then integrated into a conceptual framework (third concept) designed to assess existing conditions, specify improvement objectives, and assist in formulating strategies for achieving these objectives.

The balance between watershed condition and riparian health can be expressed in terms of regions of commonality among the different combinations of watershed condition and riparian health (Figure 2). In Figure 2, the horizontal axis represents watershed condition, ranging from poor to good, while the vertical axis shows riparian health, also ranging from poor to good. Combinations of these two axes share distinct regions that are labeled most common, common, uncommon, and least common. These regions of commonality describe the frequency or likelihood that certain combinations of watershed condition and riparian health will occur in field situations. As a result, all combinations are not of equal likelihood.

LaFayette and DeBano (1990) further expand the relationship between watershed condition and riparian health (Figure 2) to include a value dimension, that

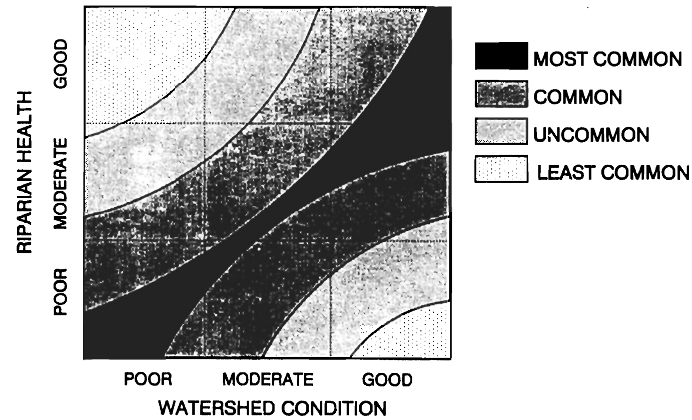

Figure 2. Regions of commonality between watershed condition and riparian health.

of acceptability to land managers and the public (Figure 3). Four classes of acceptability are developed: highly acceptable, acceptable, marginally acceptable, and not acceptable.

Figure 4 combines the concepts presented in Figures 2 and 3 and provides managers a framework for assessing current combinations of watershed condition and riparian health. It also provides a framework to formulate guidelines for meeting different management objectives. The horizontal axis represents a range of watershed condition from very poor (-5) to very good (+5). The vertical axis represents a range of riparian health from very poor (-5) to very good (+5). The intersection of the two axes represents a neutral position, where physical conditions are relatively common and acceptable from a management standpoint.

The four quadrants formed by the axes in Figure 4 represent a range of combinations of commonality of occurrence and acceptability to management and the public. The upper right (northeast) quadrant represents a combination of watershed condition and riparian health that commonly occurs and is acceptable under good management. The lower left (southwest) is also quite common but least acceptable to management. Both watershed condition and riparian health are below average in the southwest quadrant. The lower right (southeast) quadrant is less common and less acceptable from a management perspective, and although watershed condition is above average, riparian health is below average. The upper left (northwest) quadrant is least common and not less

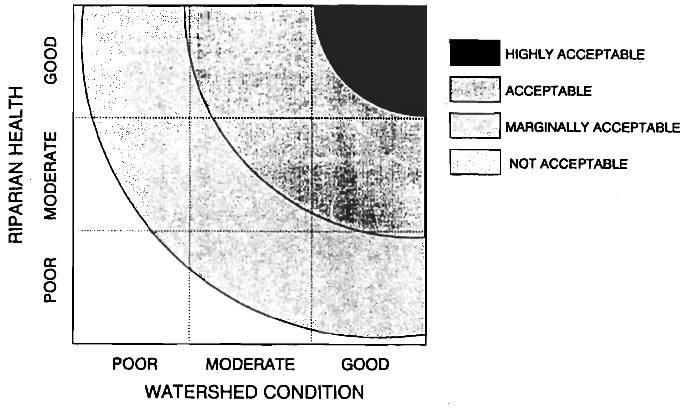

Figure 3. Acceptability of watershed condition and riparian health combinations.

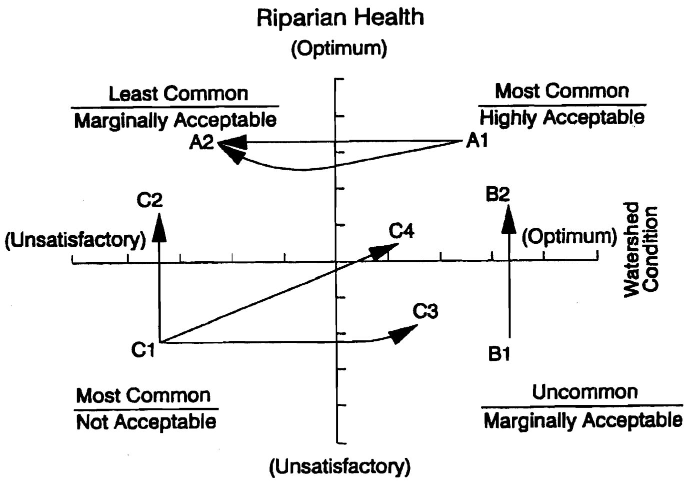

Figure 4. Framework for assessing current combinations of watershed condition and riparian health.

acceptable to management. Watershed condition is below average even though riparian health is above average.

Classifying watershed condition and riparian health within the domain of Figure 4 provides land managers with a method for portraying not only the current status of a given watershed/riparian area but also the consequences of a range in options when managing these areas. Unless an area falls with one factor in a +5 or -5 condition, the area in question can move in any direction in a 360-degree arc. Changes in management can make watershed condition and riparian health either better or worse. Managers may choose to change either watershed condition or riparian health or both simultaneously. Several examples (A,B,C) were used to illustrate this point in the paper by LaFayette and DeBano (1990).

Only watershed condition/riparian health situations existing at position C^1 are discussed here. At point C^1, both factors are well below normal and possibly declining. Management must employ some strategy to improve both factors, either one at a time, or in combination. Treating the riparian area without improving the management of the watershed, as shown by a move to position C^2, is fraught with danger and represents a temporary change. Unless the watershed improves, riparian health is at risk from severe hydrologic responses to runoff events. Treating watershed condition without riparian area treatment is less risky (C^3) and will likely result in a gradual but delayed improvement in riparian health as the watershed provides a chance for the riparian area to recover naturally.

The strategy that will provide for the fastest recovery of both factors is to treat them simultaneously, working in the watershed and along the riparian area. A recovery path toward C^4 is more likely and more acceptable, although probably more costly in the short term. In the long term, however, as the land and channels recover and become more productive sooner, this strategy may prove most cost effective.

Products.--LaFayette and DeBano (1990) reported no new research information, but instead synthesized and conceptualized existing information. The products provided for NFS managers were: (1) an extension of the concept of watershed condition and riparian health into a framework linking watershed and riparian processes, (2) a framework describing some combinations of commonality and acceptability between watershed condition and riparian health, (3) and guidelines for developing rehabilitation strategies based on a conceptual framework describing commonality and acceptability of different combinations of watershed condition and riparian health.

Partnership III - Research Design for Riparian-Stream Ecosystems

Rinne and LaFayette (1991) did report some new research findings, but more importantly, discussed specific concerns relating to research design that must be addressed when conducting riparian-stream studies. They describe four case studies, in Arizona and New Mexico, within the context of research design using intrastream and interstream methodologies.

Intrastream Research Design.--The authors used the intrastream approach was used to determine the effect of grazing on fish populations and their habitats. This is done by conducting studies on contiguous grazed and ungrazed reaches of one stream. Although some differences in abundance and biomass of fish and aquatic macroinvertebrate community composition were found, it was difficult to interpret these differences between grazed and ungrazed stream reaches. Part of this difficulty in interpretation was due to the lack of background pretreatment data. It was problematic to isolate treatment differences from those attributed to natural linear changes in stream morphology, water quality, and solar radiation.

Although many grazing studies have been done linearly in treatments (pastures) on the same stream, there are several inherent difficulties associated with this experimental approach. While this research design removes interstream variability, it is deficient in the context of functioning stream ecosystems. That is, although the terrestrial components of treatments (pastures) are relatively confined and definable, the aquatic components are dynamic. Water, its quantity and quality, and stream biota can change frequently and quickly and are not delimited by strands of barb wire. The influences of spatial relationships of grazed stream reaches versus contiguous ungrazed reaches must be considered in designing research studies. If an intrastream approach is necessary, grazing must be allowed only in downstream reaches.

The research design of an intrastream study involving plant, aquatic biota, or substrate components is further complicated by inherent differences in elevation and associated habitat and flood plain composition. Obligate riparian species are often limited in elevational distribution within a given watershed by such factors as aspect, climate, edaphology, geology, geomorphology and general availability of water. The composition of substrates can change from organism-rich cienegas to sandy, gravelly-cobble types within a short distance. Concomitant stream flows also change abruptly relative to gradient and substrate types. Aquatic biota also change in composition relative to availability of organic and inorganic substrates, vegetation, and flows. Hence, interpretations of changes in vegetation/biotic composition and density or habitat parameters resulting from grazing, or other treatments, are also confounded by the influences of these natural factors.

Interstream Research Designs.--The interstream design was to use paired watersheds to determine the effects of different land uses on stream habitat and fisheries. In one study, fish populations were measured in three watersheds that had been managed differently for more than a half a century. One watershed had been closed to normal multiple uses since the 1930's and was relatively pristine. It was paired with two other watersheds that had been subjected to normal National Forest land uses during the same period. Measurements of fish populations showed no statistical differences between the pristine watershed and the two watersheds under normal multiple use. Reasons for this were attributed partly to inherent differences in geologic strata, watershed exposure, vegetation, and natural variation in fish populations. Also, differences in sport fisheries use between the streams further masked any differences.

Another interstream study used six perennial first-order streams below the Mogollon Rim in central Arizona. Historically, the watersheds containing these streams had been subjected to varied grazing and timber management practices. The least used watershed is one that had not been logged or grazed for over 25 years, but another had been continually grazed and timber had been harvested for years. Preliminary results indicated that stream size, based on mean width and flow, strongly influences fish numbers and size.

The studies reported by Rinne and LaFayette (1991) illustrate that conducting viable research on the effects of the combination of natural- and land-management-induced factors on stream environments and biota in southwestern National Forests is complex. Factors contributing to complexity include: interactions of multiple land uses, spatial-temporal relationships, inability to establish a frame of reference, inability to replicate study areas, jurisdiction in habitat and species management, and frequent changes in land management objectives and direction. Combined, these factors render it difficult to effectively study land management impacts on riparian ecosystems. But, Rinne and LaFayette (1991) pointed out that a stable partnership between research and management personnel can overcome these difficulties and identify research opportunities. Such a partnership operating within the framework of daily forest land management activity will be effective in generating valid, defendable, and applicable information for future management of forest lands.

Products.--The products of the publication by Rinne and LaFayette (1991) for NFS managers were: (1) a conceptual framework for designing fishery and aquatic studies, (2) an illustration of the complexity involved in designing defendable research effort in terms of frames of reference, replication, time, and natural and management disturbances, and (3) increased awareness of opportunities for NFS managers and Research scientists to form partnerships that address riparian-stream ecosystems.

Examples of Other Partnerships.--Less formal, but effective, partnerships have also been established between various NFS and RMS scientists. On the Tonto National Forest (FNF, scientists have designed monitoring strategies for use by District personnel in evaluating offsite effects on threatened and endangered species. Station scientists are largely responsible for monitoring the effects of Arizona's largest wildfire, the Dude Fire of 1990, on water quality, fisheries, and riparian habitat. In these evaluations, information is transferred immediately to NFS managers for inclusion into rehabilitation planning. Likewise, on the Apache-Sitgreaves NF, scientists and forest personnel work hand in hand in collecting much needed information on T&E plant and fish species. They also work together on studies related to productivity of pinyon-juniper woodlands.

These examples serve to demonstrate that partnerships are needed by both parties and can be effective. The products of these partnerships are immediate, although not necessarily highly visible. Information is interpreted by scientists and transferred to field personnel for incorporation into management plans long before the information can be published. This probably is the most important product to be derived from these NFS/RM partnerships.

Keys to a Successful Partnership

Successful partnerships between Forest Service Research scientists and NFS managers strongly depend on identifying combinations of scientists and managers that are committed both to making these partnerships succeed and to establishing mutual priorities. Several interpersonal and organizational considerations involved when developing successful partnerships are discussed below.

Cooperative Attitude.--Both parties must approach the partnership with a cooperative attitude. This includes a willingness to learn from each other and to make allowances for the pressures each is under.

Personal Relationships.--While not mandatory, developing strong personal relationships is helpful in making partnerships work well. These personal relationships help to establish trust and credibility between the partners. The examples discussed earlier all involved strong personal relationships.

Spending Time Together.--Familiarity and the exchange of information between NFS and Research is essential. Opportunities must be provided to spend both field and office time together. This allows both NFS and Research to view and discuss projects, visit sites together, and identify common ideas and issues.

Learning Each Other's Programs.--Researchers need to know more about NFS and vice versa. Understanding how the organizations are similar and different aids in a successful partnership.

Mutual Respect for Each Other.--People in the NFS and Research often hold stereotypical views of each other, many of which are incorrect. Development of mutual respect for each other's abilities and knowledge is essential.

Understanding the Pressures.--Each partner needs to understand the work pressures each struggles under. Researchers often must "publish or perish." The NFS people often have "hard" targets to meet in short and changeable time frames.

Providing Lead Time.--Depending upon the complexity of the project, lead time for research involvement is often needed to line up funding, gather pretreatment baseline data, etc. Managers often want results in unrealistic time frames. Understanding lead time from both parties' perspective is important.

Funding.--Understanding project funding is essential for both parties. Some projects can be done with little funding; others require extra funds to do the required work. As a result, priorities may have to be negotiated and rearranged. Recognition must also be paid to differences between "hard" and "soft" money on the part of both parties.

Assistance in Lieu of Money.--In many cases, NFS personnel may be able to offer assistance instead of funds (e.g., data collection, vehicles, materials, etc.). Research studies are not without substantial investments in treatment implementation and subsequent monitoring of responses. In many cases, long-term monitoring and measurement will require a mutual commitment and sharing of resources to sustain a complex and long-term evaluation.

Publications.--The NFS managers need to recognize the value of a good publication and assist researchers in publication of useful information. Joint publications co-authored by NFS and Research lends credibility to the work. Publishing good work can be career-enhancing for both parties.

Technology Transfer.--An important final step in a successful partnership is making sure that the information and data that has been collected is analyzed and applied on the ground (i.e., technology transfer). Although publications can be one product of technology transfer, publications may not in themselves assure the successful transfer of the research studies in the time frames required. The application of the technology produced involves a continuing dialogue among the partners until it has been successfully implemented on the ground. Because it is such an important part of the partnership, technology transfer requires the same intensity of commitment and participation as was required for the initial study design, data collection, analyses, and interpretation.

SUMMARY

Various levels and intensities of partnerships between NFS and Research personnel can be established. These partnerships can range from simple consultations and exchange of information concerning monitoring strategies between Forest Service scientists and managers to intensive long-term associations involving detailed research studies. Published papers and other less formal partnerships between RMS scientists and R-3 managers illustrate successful partnerships.

Successful partnerships also may involve several interpersonal and organizational considerations. Some important ingredients are: a cooperative attitude, personal relationships, spending time together, learning about each other's programs, respect for each other, understanding the pressures, providing lead time for funding and other support, and publications. A final step in a successful partnership is applying the results obtained from the research studies to on-the-ground situations. Technology transfer involves a continuing dialogue among the partners until the technology has been successfully implemented. Because of its importance, technology transfer requires the same intensity of commitment and participation as was involved in the initial study design, data collection, analyses, and interpretation.

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