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Characteristics of Successful Riparian Restoration Projects In the Pacific Northwest

CHARACTERISTICS OF SUCCESSFUL RIPARIAN RESTORATION PROJECTS IN THE PACIFIC NORTHWEST

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EXECUTIVE SUMMARY

The Region 10 U.S. Environmental Protection Agency (EPA) recognizes the importance of healthy riparian ecosystems to the maintenance of State Water Quality Standards. Consequently, the EPA developed a Region 10 Riparian Management Policy designed to protect, improve, and restore riparian areas - particularly those affected by non-point source (NPS) pollution. This policy emphasizes the importance of riparian enhancement to control NPS impacts and to enable states to meet water quality standards. In addition, it establishes a high priority for EPA funding of riparian restoration projects.

Riparian enhancement programs may incorporate BMPs as restorative methods designed to moderate the impacts of poor land-use practices and to improve degraded areas; they may also be designed to prevent or moderate water quality impacts. To carry out the objectives of its Riparian Management Policy, the EPA intends to identify common "key" characteristics of riparian enhancement projects which promote successful design, implementation, and monitoring of BMPs. By identifying these attributes, the EPA and other federal, state, and local agencies and groups will be better equipped to design and implement successful restoration projects.

This report summarizes and evaluates thirteen successful riparian enhancements in Region 10. Collectively, these projects represent a wide range of geographic locations, disturbance histories, restoration techniques (ie. BMPs), and restoration participants. Processes related to successful BMP design, implementation, and monitoring were evaluated for effectiveness and contribution to final project results. This analysis was conducted through questionnaire surveys, personal interviews, and site visits.

The evaluation identified various process oriented characteristics which contributed to project success. Some of these were common to several or all projects, regardless of location and type of impact. These attributes appear to be "key" components of success and should be acknowledged by land managers and funding agencies as operational standards for riparian restoration projects. These characterisitics and recommendations are summarized below.

CONCLUSIONS IN SUMMARY

- **Strong leadership** of a few designated leaders is required to successfully complete a restoration project.

- **A political environment which promotes environmental protection** enables restoration practitioners to work creatively and as a result, effectively.

- **A watershed approach** that incorporates structural improvements with coordinated management plans is far more effective than site specific treatments.

- **Recognition of natural watershed/riparian characteristics** enables planners to design a restoration project which accounts for natural cycles or disturbances which might influence project results.

- **Establishment of well defined goals** at the onset of a restoration project enables participants to focus on critical problems and develop effective methods for treatment.

- **Public awareness of proper land use practices** is critical to the preservation and conservation of riparian areas.

- **Community involvement** in project implementation increases the chances of success.

- **Demonstration projects** provide the most useful educational tool for promotion of riparian restoration projects.

- **Support of individuals who use public lands** is necessary to effectively implement and maintain a restoration project on those lands.

- **Close interaction and communication between government agencies, local landowners, and permittees** are necessary to restore riparian areas on and adjacent to public lands.

- **Interagency participation** on restoration projects facilitates problem identification and development of coordinated resource plans.

- **Pretreatment inventories and surveys** enable field staff to identify critically degraded areas and habitat limiting factors.

- **Post-treatment monitoring** enables land managers to identify changes on the project site which may indicate improvement.

- **Projects allotted adequate time and financial support** to develop have a greater chance of succeeding than those that don't.

RECOMMENDATIONS IN SUMMARY

- **Agencies responsible for permitting instream work need to provide better guidelines for permit applicants involved in restoration projects.**

- **In urban areas, attention should focus primarily on riparian preservation, whenever this is a land-use option.**

- **Demonstration projects should receive priority for restoration funding.**

- **Photodocumentation should always be utilized for monitoring restoration sites.**

- **Private citizens involved in restoration projects should receive recognition for their work and be provided a public forum for discussing results.**

- **On public lands, efforts should be made to include interested and affected publics and permittees in the restoration process - a sense of teamwork is essential.**

- **Agencies must provide adequate resources to monitor and maintain a project after completion - this should planned in initial project design.**

- **Land and resource management agencies should be supportive of restoration efforts, both financially and philosophically.**

- **Riparian restoration monitoring should include physical, chemical, and biological parameters for assessing changes in water quality.**

I. INTRODUCTION

In an effort to preserve the chemical, physical, and biological integrity of our Nation's waters, the Clean Water Act of 1987 (Section 319) designated the Environmental Protection Agency (EPA) responsibility for review and approval of 1) state assessments of water quality problems due to nonpoint source (NPS) pollutants and 2) state programs designed to confront these problems. In response to these duties, the EPA (Region 10) has recently developed a policy for the management of riparian ecosystems, particularly those impacted by NPS disturbances.

The EPA - Region 10 Riparian Area Management Policy promotes protection of water quality from NPS pollutants through the preservation and restoration of riparian habitats. In the policy, EPA promises to "assist the states in Region 10 with the implementation of riparian area protection or improvement in their NPS management programs" (Rasmussen 1991). In order to encourage riparian enhancement, the EPA will be identifying characteristics of successful restoration projects. These characteristics promote successful design, implementation, and monitoring of BMPs. This paper reviews a selection of riparian restoration and protection projects in Region 10, and identifies attributes which are fundamental to project success. Emphasis will be placed on nonstructural and operational considerations incorporated in project planning, design, and implementation.

II. STUDY OBJECTIVES

Healthy riparian habitats serve a variety of ecological functions including control and reduction of NPS impacts on aquatic ecosystems. As a result, riparian areas can help states protect and maintain their water quality standards. Unfortunately, poor land-use practices and over development have destroyed substantial portions of riparian areas in Region 10. Similarly, much of the remaining riparian habitat has been severely degraded.

The EPA - Region 10 Riparian Area Management Policy clearly outlines the importance of riparian enhancement to controlling NPS impacts and encourages the development and application of BMPs to address site-specific problems in riparian management. The success of this program depends upon appropriate planning, design, and use of BMPs and may be handicapped by the application of ineffective or inappropriate restoration practices and procedures.

The planning, design, and implementation of BMPs for riparian NPS control projects should be evaluated and compared across a large cross-section of restoration sites. This will allow identification of common characteristics which contribute to project success, regardless of geographic location or type of disturbance. By distinguishing and acknowledging these patterns, land managers will be better equipped to design management plans for riparian enhancement. This study evaluates the planning, design, and implementation of BMPs employed in selected riparian restoration projects in Region 10. Particular emphasis was placed on nonstructural practices such as problem identification, pretreatment inventories, interagency agreements and communication, community education, and post-treatment monitoring and evaluation.

Study objectives included:

1) Documentation and review of successful riparian restoration projects in Region 10;

2) identification of design, implementation, and monitoring practices that contribute to project success;

3) a synthesis of these findings that represents the experience and advice of riparian restoration practitioners and;

4) the development of recommendations for the EPA that will assist the agency in working with state and federal land management agencies and others to implement the Region 10 Riparian Area Policy.

III. BACKGROUND

RIPARIAN RESTORATION

In addition to improved water quality, restoration of riparian areas provides other benefits to adjacent ecosystems, wildlife, and human beings. Many restoration projects have been initiated to improve species habitat for reproduction or to enhance community diversity. In such cases, improved water quality is a secondary (yet substantial) benefit. Because multiple benefits result from riparian restoration, it is important to understand the characteristics of riparian ecosystems and their significance to their local environment. Only then can we truly appreciate the consequences of riparian degradation and the full worth of their restoration.

RIPARIAN ECOSYSTEMS

Riparian habitats constitute an area of vegetation that exerts a direct biological, physical, and chemical influence on (and are influenced by) an adjacent stream, river, or lake ecosystem, through both above- and below-ground interactions. This area of association extends from the rooting systems and overhanging canopies of streamside flora outward to include all vegetation reliant on the high capillary fringe characteristic of soils surrounding aquatic environments. Riparian ecosystems can vary greatly in both physical appearance and vegetative complexity due to differences in local topography, stream bottom, soil type, water quality, elevation, climate, and surrounding vegetation (Odum 1971). As a result, the composition and expanse of riparian communities reflects site specific conditions.

Despite such differences, riparian habitats share many common characteristics regardless of location. These include but are not limited to: 1) high rates of energy, nutrients, and species exchange, 2) high productivity, 3) a unique microclimate with respect to upslope conditions, 4) high edge to area ratios - characteristic of transition environments (ecotones), 5) they support a diverse faunal assemblage that is unique within their local environment, 6) they benefit from a relatively high water table, and 7) they are subject to periodic flooding events (Thomas et al. 1979). Because riparian ecosystems share these common traits, they also share many common functions, independent of location. These functions are summarized in Table 1. and described in the text of the report.

RIPARIAN VEGETATION AND TERRESTRIAL WILDLIFE

Because riparian zones support a diverse and highly stratified vegetative community distinct from their surrounding environment, their importance to terrestrial wildlife is often disproportionately greater than other habitats (with respect to total area). While riparian areas comprise less than one percent of total land area in the western United States they are among the most productive (Elmore and Platts 1990). In the Great basin of Oregon, more than seventy five percent of terrestrial wildlife species are dependent upon or use riparian habitats (Elmore and Platts 1990).

As ecotones, riparian areas contain and support many organisms associated with adjacent aquatic, wetland, and terrestrial upland habitats. In addition, they support species endemic (and limited) to the riparian zone. Riparian corridors also create a vegetative continuum along streams and rivers which serves as migration routes for wildlife such as birds, bats, deer, and elk (Stevens et al. 1977). In many areas (particularly in urban locales) these environments provide the only protected pathways available to animals, and are essential to the continued survival of many species.

RIPARIAN VEGETATION AND AQUATIC ORGANISMS

Riparian ecosystems also influence the distribution, composition, and diversity, of aquatic organisms by acting as a food source, creating instream habitat, and by moderating water temperature extremes. The origin of instream food resources reflect changes in nutrient flux between terrestrial and aquatic environments. For instance, entry of detrital material from riparian vegetation often provides the primary energy base for smaller streams and rivers (eg. stream orders 1-3). These oligotrophic ecosystems depend on such inputs to support the metabolic and growth activities of aquatic consumers (Windell 1983). Organic debris entering a stream or river also provides a nutrient source for downstream ecosystems. This flow of energy may be water-borne or transported by aquatic organisms.

The energy base of higher order streams and rivers (which tend to be wider and deeper than their headwaters), is typically dependent on the primary production of algae and other aquatic vegetation. As a result, they are less dependent on terrestrial inputs of organic detritus for nutrients (Windell 1983).

Table 1. Functions of Riparian Vegetation. (adapted from Swanson et al. 1982)

Site	Vegetative Component	Function
aboveground/above channel	canopy and stems	1. shade controls temperature and stream primary production 2. source of large and fine plant detritus 3. wildlife habitat
in channel	large debris derived from riparian vegetation	1. controls routing ofwater and sediment 2. dissipates stream energy 3. creates habitat-pools, riffles, cover 4. substrate for biological activity
streambanks	roots	1. increases bank stability 2. creates over-hanging bank cover 3. nutrient uptake and release between ground and surface water
floodplain	stems and low-lying canopy, large woody debris	1. retards movement of sediment, water, and organic debris in floods 2. reduces erosion from animal trampling

Rooting systems of riparian trees create protective cover for fish and other organisms by protecting undercuts along stream banks. Similarly, understory vegetation provide shade and cover (when overhanging the water) which can hide instream fauna from terrestrial predators.

Input of large woody debris (eg. trees and branches) from riparian ecosystems also provides habitat for aquatic organisms. In any body of water, woody material enhances structural diversity, which in turn increases available space for foraging, hiding, and breeding. Microorganisms which colonize woody debris attract macroinvertebrates which feed on them. These in turn attract secondary consumers such as crayfish, amphibians, and fish. In time trophic interactions increase in both number and complexity, creating a diverse and resilient food web. In addition, habitat created by riparian debris may augment species diversity due to increased niche partitioning.

Riparian vegetation often overhangs waterways, intercepting incoming solar radiation and shading the water's surface. Water temperatures are therefore greatly affected by riparian vegetation, particularly along small order streams and rivers. In environments characterized by high annual or seasonal air temperatures, riparian shading can buffer water temperatures against excessive diurnal fluctuations and upper extremes. In colder environments or during winter, riparian vegetation often buffers water temperatures against minimum extremes resulting from heat loss. The influence that riparian vegetation exerts on instream temperatures varies with location and climate, stream size, and vegetation density. Effects are typically greatest on small streams and rivers subject to high annual or seasonal air temperatures and which are surrounded by dense riparian borders.

The survival and life cycle events of many aquatic organisms are closely related (directly and indirectly) to water temperatures. For instance, many fish maintain a very narrow temperature optima or range in which to live and reproduce. Suboptimal temperatures often inhibit normal growth and metabolic activities, endangering both individuals and entire populations. If unsuitable temperatures continue over time, species composition and community structure may be altered. This may be detrimental to the natural functioning and aesthetic appeal of the ecosystem.

RIPARIAN VEGETATION AND WATER CHEMISTRY

Many effects of temperature on aquatic organisms (and water chemistry) are related to concentrations of dissolved oxygen. Water holds less oxygen as it becomes warmer (Windell 1983). As a result, less is available for heterotrophic respiration. Elevated temperatures also cause nutrients to attach to suspended solids, reducing available soluble forms (Windell 1983). Under natural conditions aquatic biotas' are adapted to the thermal regime native to their environment. When these environments are disturbed and temperatures altered (as might happen when riparian vegetation is damaged or removed), the aquatic ecosystem suffers.

Riparian zones also influence water chemistry by retarding the movement of sediment, water and organic debris into the stream ecosystem. For instance, riparian areas (typically characterized by high surface roughness) may reduce the amount of nitrogen and phosphorus entering into aquatic ecosystems from agricultural soils by trapping erosional sediments. Once deposited, these nutrients may be assimilated by riparian flora. Similarly, extensive rooting by riparian vegetation serves to protect stream and riverbanks from the destabilizing forces of flowing water - reducing instream sediment loads and turbidity.

RIPARIAN VEGETATION AND STREAM GEOMORPHOLOGY

Riparian vegetation influences stream and floodplain geomorphology by trapping sediment, stabilizing streambanks, and routing streamflow. Groundcover and understory in riparian ecosystems create a highly varied and rough surface area which retards movement of sediment, water, and organic debris from adjacent uplands into the aquatic environment, and from these ecosystems onto adjacent floodplains during overbank flows. As a result, debris is deposited and retained within the riparian zone without accumulating (to excess) in neighboring waterways - sustaining natural flows and meander patterns.

Rooting systems (particularly of woody plants) along streambanks increase bank stability by consolidating and improving the structure of riparian soils. This reduces bank erosion and downcutting which might otherwise destroy valuable instream habitat. Finally, input of detrital material (eg. large woody debris) from riparian zones often influences stream flow by routing the movement of water and sediment and by shaping pools and riffles.

RIPARIAN ECOSYSTEMS AND HUMAN USE

Riparian ecosystems also provide many services to humans. Riparian areas furnish shade during hot summer days and scenic resting spots to recreationists and artists. By supporting a diversity of terrestrial and aquatic wildlife, they provide opportunities for birdwatching, hunting, and fishing. Similarly, they are highly productive and diverse ecosystems with great potential for scientific study and environmental education. Under certain conditions, properly managed riparian areas provide productive (and sustainable) livestock forage. Riparian areas also help maintain the natural balance of sediment transportation and nutrient flow across the water/land interface. Consequently, they help maintain water quality both onsite and in downstream reservoirs.

DEGRADED RIPARIAN HABITATS

Healthy riparian ecosystems are characterized by high faunal and floral diversity, structural complexity, productivity, energy/nutrient exchange, and resilience to disturbance. When degraded they cannot support a comparable variety of wildlife nor can they maintain many of their physical functions.

For example, when riparian vegetation is removed terrestrial and aquatic habitat available for shelter, forage, and reproduction is destroyed. Organisms which are unable to adapt to such intrusions must migrate to undisturbed habitat. When no migration routes or adequate habitats exist, mortality is likely. Community diversity will eventually decrease and non-native species may emigrate into the area. As a result, natural trophic interactions and nutrient exchanges will be altered.

Removal of the riparian canopy will expose additional stream surface to incoming solar radiation. As a result, diurnal and seasonal water temperature fluctuations and extremes may increase -followed by a corresponding decrease in dissolved oxygen concentrations. These changes will endanger aquatic organisms. As instream temperatures change, chemical reactions and processing rates of organic material will also be modified. Water quality may be degraded by these disruptions.

Removal of riparian vegetation and destruction of their rooting systems will reduce the structural integrity and stability of riparian soils, especially along streambanks. Bank erosion may increase - boosting instream sediment loads and disrupting natural flow patterns. Similarly, overland movement of sediment and debris into the aquatic environment may increase instream sedimentation and pollutant loads (from pesticides, fertilizers, stormwater etc.). By increasing streambank erosion, the hydraulic gradient between land and water will steepen, groundwater height will be lowered, and soil water storage decreased.

In concert, these disruptions will diminish the aesthetic, recreational, and educational appeal of aquatic/riparian ecosystems. In addition, effects of riparian degradation often extend beyond the area of impact. As instream water quality is degraded - downstream reservoirs maintained for municipal drinking water may be impacted.

RIPARIAN LAND-USE IN THE UNITED STATES

Historically, riparian areas have been among the most intensively developed ecosystems in North America (Elmore and Platts 1990, Windell 1983). Native americans and european settlers were attracted to riparian valleys and floodplains, which provided shelter and flourished with plant and wildlife. Because food resources and building materials were abundant in riparian forests and groves, settlement and food gathering was concentrated within these areas. Flowing waterways offered a medium for transportation and communication between communities. In addition, energy harnessed from flowing water was used for grinding grains and processing wood for building materials. Fertile alluvial soils and access to dependable water supplies (for irrigation) encouraged timber removal and tillage for agricultural development and livestock grazing. Frequently, croplands extended up to the very edge of streams and rivers.

Through time poor land-use practices and continued urban expansion have greatly reduced the total area of riparian ecosystems in the United states. For instance, approximately 70 to 90 percent of the natural riparian ecosystems in the United States have been lost to human activities (Windell 1983). Furthermore, much of the remaining riparian habitat has been degraded. Riparian deterioration has been especially pronounced on rangelands of the American West. Estimates by the United States Department of Agriculture in 1980 indicated that vegetation on more than half of all western rangelands was deteriorated to less than 40% of their potential productivity; on 85% of this land productivity was reduced to less than 60% of its potential (Elmore and Platts 1990). Widespread destruction of riparian habitats have now prompted many investigators to declare these ecosystems endangered (Windell 1983).

ESTABLISHMENT OF BEST MANAGEMENT PRACTICES FOR RIPARIAN ECOSYSTEMS

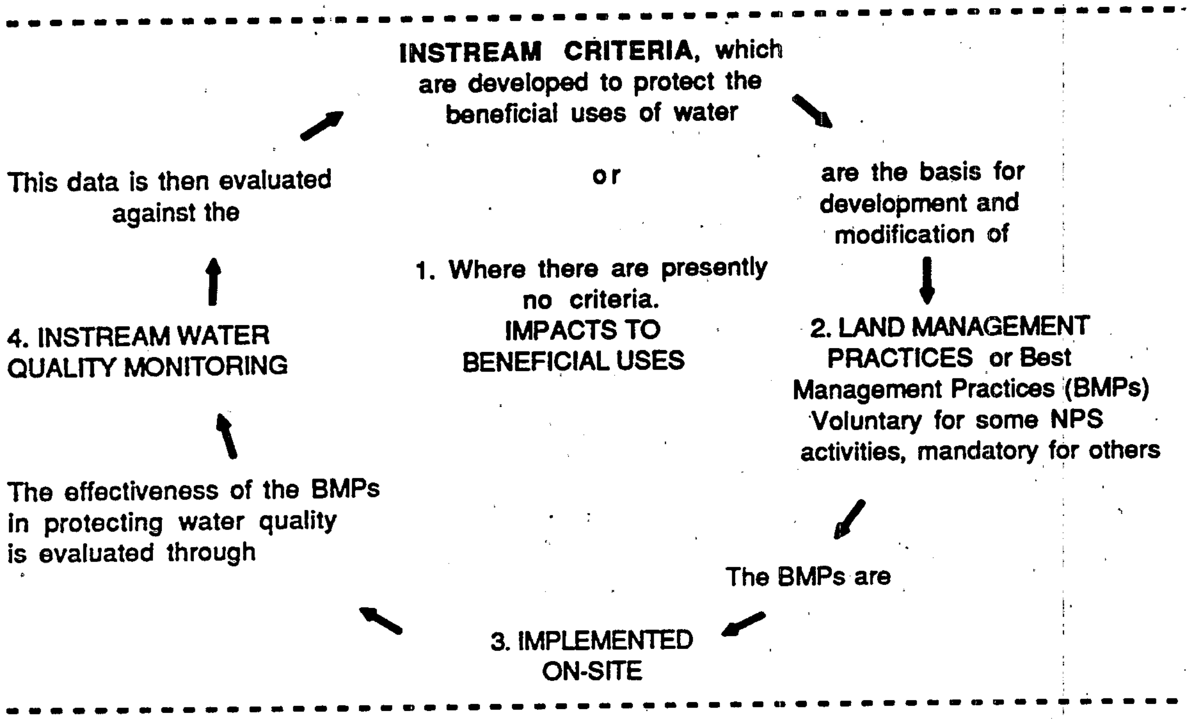
Pursuant to the 1987 Clean Water Act, states are required to identify sources of NPS pollution and to develop and implement methods to achieve state and national water quality goals. The EPA recognizes that many important hydrologic and geologic associations exist between riparian areas and adjacent upland and aquatic ecosystems which influence water quality (eg. surface and groundwater flow, nutrient cycling, sediment transport etc.). In this context, healthy riparian ecosystems function as barriers which buffer waterbodies from NPS impacts.

Numerous field studies and observations indicate that the capacity of degraded riparian areas to limit NPS impacts is substantially reduced. As a result, the EPA places high priority on the protection and improvement of riparian areas and the abatement of NPS pollution affecting these ecosystems. The EPA (acting in response to riparian initiatives established in the 1987 Clean Water Act, Section 319) encourages states to develop and implement riparian protection policies by funding watershed improvement programs which promote the preservation and enhancement of riparian areas, which in turn will help states to meet water quality standards.

The most effective method for riparian protection is to eliminate poor land-use and development practices which impair or destroy these ecosystems. Most riparian areas in Region 10 (and throughout the United States) have already been disturbed by human activity - either directly or indirectly. In an effort to restore the natural condition of these areas, many land management agencies, private landowners, and conservation groups have adopted Best Management Practices (BMPs) to mitigate the effects of past impacts and to provide protective measures for the future.

Best Management Practices are "structural and non-structural controls and operation and maintenance procedures" designed to meet NPS control needs (Code of Federal Regulations 1990). In this context, they consist of controls and procedures adopted to improve water quality by providing an economically feasible means to reduce the impacts of NPS pollutants on aquatic environments. Best Management Practices are "process oriented in that they initiate planning, field investigation, and coordination activities prior to conducting a project, and describe the evaluation and monitoring to be conducted during and after project implementation" (Curry 1984).

Figure 2. The Feedback Loop Process for Nonpoint Source Pollution Management (from Bauer 1989).



The BMP implementation process may be broken into several phases, which include: 1) planning and design, 2) implementation, and 3) monitoring. When designed properly, BMPs can be evaluated (for effectiveness) throughout the development of an enhancement or management program and can be used to identify both problems which deter success and components of the project which contribute to success. In this capacity, BMPs allow for continual "feedback" throughout the NPS management process - allowing for adjustments and other controls as needed (Figure 2)

IV. METHODS

Riparian restoration projects in EPA Region 10 were selected for review and evaluation. Figure 1. displays the location of these projects. Selection was restricted to projects which demonstrated success upon completion. For the purpose of this analysis successful projects were defined as those maintaining sustained improvements over pretreatment conditions and those meeting the majority of project goals. Criteria for project selection and review are summarized as follows:

1. projects demonstrated improvement over pretreatment conditions for at least two years following completion;

2. ongoing projects must have been initiated prior to 1988 and have demonstrated continued improvement since that time;

3. projects designed to increase community appreciation for riparian areas were considered - if project goals were met.

Identification of riparian restoration projects in Region 10 was conducted by reviewing case studies prepared by the Wildland Resources Center (1990), the Environmental Protection Agency (Cheney et al 1990), Oregon's Watershed Enhancement Program (1987-90), American Fisheries Society - Excellence in Riparian Habitat Management Contest, and through recommendations by land management personnel in Region 10 (from such agencies as the U.S. Forest Service (U.S.F.S.), the Bureau of Land Management (B.L.M.), Soil Conservation Service (S.C.S), Washington State Department of Ecology (D.E.C.), etc.).

After restoration sites were identified, questionnaires were distributed to persons responsible for the design, implementation, and management of the projects. The questionnaire is in Appendix A. Upon return, questionnaires were reviewed and individual projects were chosen for further study and site review. Every effort was made to assemble a diverse (with respect to disturbance type, geographic location, land ownership, etc.) set of projects for final study. These projects are summarized in Section VI.

Figure 1
Selected Riparian Restoration Projects in Region 10

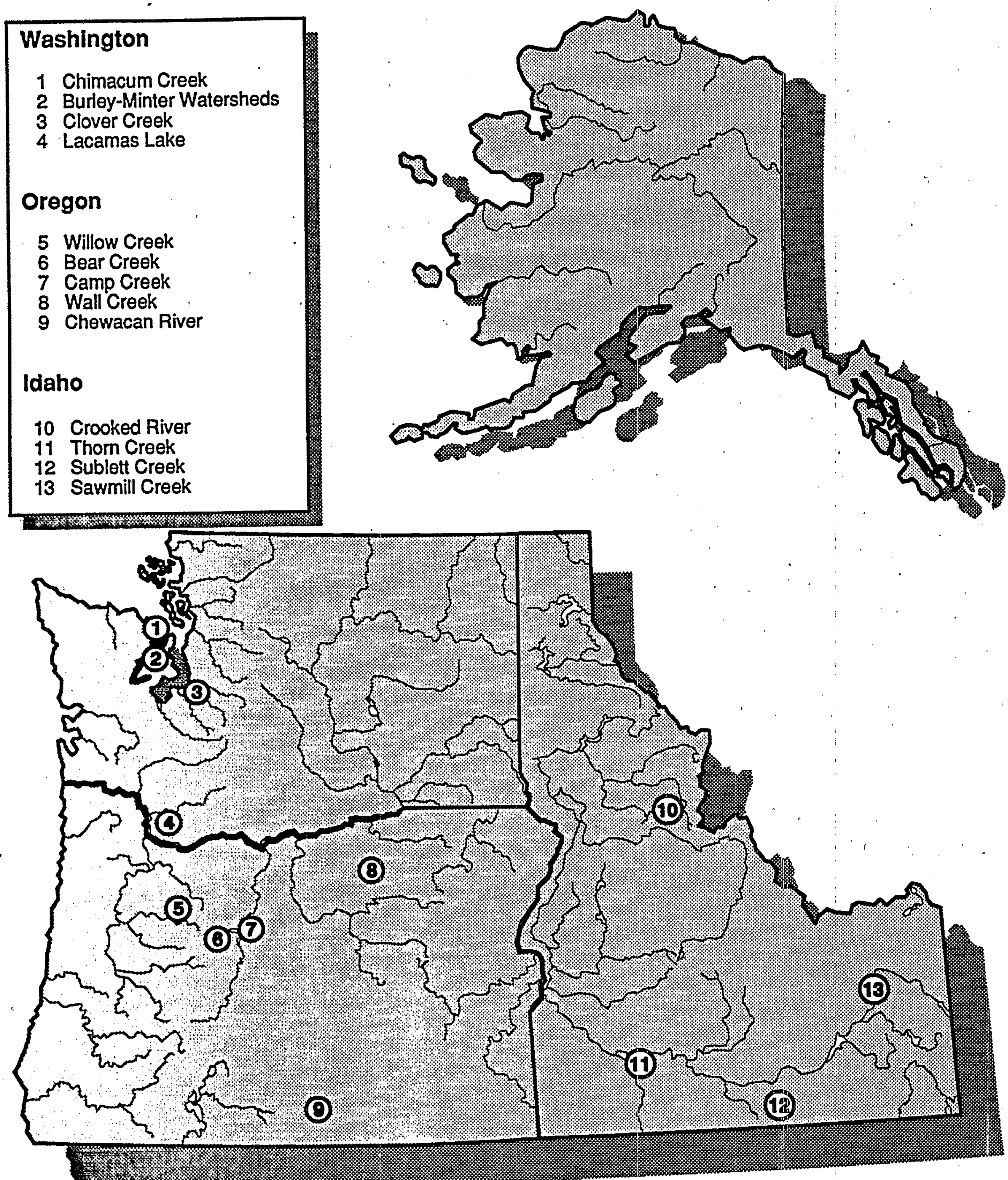


Table 2. Several Common Habitat Improvements Resulting From Riparian Enhancement.

1. Increased streamflow
2. Increased water depth
3. Reduced instream sedimentation
4. Reduced channel width
5. Streambank stabilization
6. Increased faunal and floral diversity
7. Shift from more xeric to mesic plant species
7. Reduced soil compaction and increased infiltration
8. Elevated water-table height
9. Decreased flooding frequency

Because quantitative post-treatment monitoring was absent on many restorations, evaluation for success was based upon recommendations from land management professionals, personal visits to project sites, and photographic documentation. While such interpretations are primarily qualitative, comparison between initial project objectives and post-treatment results can be used as a criterion for establishing success. For instance, in a well planned project, post-treatment results should have been identified and predicted prior to project implementation and should have resulted in response to treatment application. Common habitat improvements resulting from riparian enhancement are listed in Table 2.

V. CONCLUSIONS AND RECOMMENDATIONS

Riparian restoration provides a direct means to improve degraded terrestrial and aquatic habitats and to restore natural watershed functions. Other benefits include (but are not limited to) improved water quality and increased public appreciation for riparian areas. In EPA Region 10, many federal and state agencies and private interest groups have initiated and supported riparian enhancement programs. The success of these projects reflects the use of effective approaches (to riparian restoration) by participating groups.

This review evaluated nonstructural components of restoration projects and determined that several characteristics contributed to project success. Many of these were common to several or all projects, regardless of project location, cause of disturbance, or participants involved. These attributes appear to be "key" components of success and should be acknowledged by land managers and funding agencies as standards for the design, implementation, and monitoring of riparian restoration projects. These "keys" and additional recommendations are summarized below.

- **Strong leadership** of a few designated leaders is required to successfully implement a restoration project. These individuals should be recognized by all restoration participants and should be generally accessible to anyone interested in the project.

- **A political environment which promotes environmental protection** enables restoration practitioners to work creatively and as a result, effectively. Participants must feel that they are supported by their superiors. Increased environmental awareness within land management agencies has facilitated the success of many riparian restoration projects.

- **A watershed approach** that incorporates both structural and nonstructual improvements (as needed) with coordinated management plans is far more effective than site specific treatments. Riparian zones should be considered as integral components of a larger drainage area - the condition of that area determines the character and function of the riparian/stream ecosystem.

■ **Recognition of natural watershed/riparian characteristics** enables planners to design a restoration project which accounts for natural cycles or disturbances which might influence project results. In addition, recognition of the historical regulatory role environmental agents (eg. fire) have played in the ecosystem will aid in restoring native communities. In this context, restoration and management plans must reflect a watershed approach to riparian improvement.

■ **Establishment of well defined goals** at the onset of a restoration project enables participants to focus on critical problems and develop effective methods to treat them. Goals should be realistic in respect to work time and financial constraints.

■ **Public awareness of proper land use practices** is critical to the preservation and conservation of riparian areas. Communities that recognize deleterious effects of poor land use practices are more likely to support restoration projects and commit to a single coordinated management plan. Similarly, landowners who understand the importance of healthy ecosystems are more likely to consider their property as a public trust.

■ **Community involvement** in project implementation increases the chances of success. Private citizens and interest groups are often willing to donate time, supplies, and money to restoration work in their area. This reduces costs to government agencies involved in the project while increasing public enthusiasm for land restoration. Participants are likely to maintain the area after treatment completion since they have an invested interest in the restoration. In addition, participants often increase community awareness in environmental issues by discussing their involvement with friends and neighbors.

■ **Demonstration projects** provide the most useful educational tool for promotion of riparian restoration projects. When physical proof of the benefits of land restoration is available, people are more likely to support and adopt restoration programs.

■ Support of individuals who use public lands is necessary to effectively implement and maintain a restoration project on those lands. This is particularly important in the case of public grazing where permittees are often required to adopt new grazing strategies, construct structural treatments, and maintain the area after project completion. The success of restoration projects (on these lands) often depends primarily on permittee cooperation and participation.

■ Close interaction and communication between government agencies, local landowners, and permittees is necessary to restore riparian areas on public lands. Agencies should recognize that landowners and permittees have an economic tie to the land which determines the health and welfare of their families. As a result, agencies may need to convince these individuals that proper land-use practices will ultimately yield economic benefits. In sites (degraded by grazing) evaluated for this review, permittees experienced no reduction (and in some cases an increase) in AUMs following revisions of grazing plans. Similar cooperation is necessary when managing or restoring privately owned lands.

■ Interagency participation on restoration projects facilitates problem identification and development of coordinated resource plans. When resource specialists from different agencies are involved in a project, the agencies (as functioning units) are often more flexible and supportive of changes that arise in project design. Interagency participation also helps coordinate requirements, expedite project permitting, and improve political support.

■ Pretreatment inventories and surveys enable field staff to identify critically degraded areas and habitat limiting factors. Similarly, these activities may help delineate historical conditions and communities that existed prior to disturbance. Cumulatively, this information may be used to determine which BMPs will be effective and how to implement them and to predict habitat potential - which will help land managers formulate project goals.

■ Post-treatment monitoring enables project participants to identify changes on the project site which may indicate improvement. This provides a means to document success and garner additional support for restoration work. Knowledge of an ecosystems' response to manipulation also provides information useful for wildlife management and forage production programs (Gregg 1991). Monitoring also identifies trends in site recovery that may require land managers to alter or fine tune restoration plans.

Projects allotted adequate time and financial support to develop have a greater chance of succeeding than those that don't. Because ecosystems are dynamic entities, our understanding of their variability and functional roles requires extended periods of study (ie. years). As projects develop over longer periods of time, land managers can adapt treatments and management plans to address unforseen disturbances and habitat responses - maximizing project effectiveness. Adequate financial backing is necessary to support project development during this time.

The following recommendations are based upon personal observations of the author and the advice and concerns of land managers interviewed during this study.

- **Agencies responsible for permitting instream work need to provide better guidelines for permit applicants involved in restoration projects.** Guidelines should be clearly established so that the applicant understands the permitting requirements. Requirements should be established by the permitting agency in a timely manner.

- **In urban areas, attention should focus primarily on riparian preservation; whenever this is a land-use option.** Restoration efforts often fail in urban environments due to heavy human use of the riparian zone. Because degraded areas require adequate time to recover, restoration efforts are more likely to succeed in areas of low human density.

- **Demonstration projects should receive priority for restoration funding.** These programs are one of the most effective methods for increasing environmental awareness within a community. Physical evidence of success provides people with <u>tangible proof</u> that restoration can improve habitats. This is particularly important in areas that have been disturbed for several generations. In addition, when people <u>witness</u> benefits derived from habitat restoration they are more likely to support these efforts than when they are being "educated" by paid professionals.

- **Photodocumentation should always be utilized for monitoring restoration sites.** Photodocumentation can provide visual evidence of success (similar to demonstration projects). This proof may be used to convince skeptics of the restoration's merits and to secure future funding.

- **Private citizens involved in restoration projects should receive recognition for their work and be provided a public forum for discussing results.** These individuals can often "sell" a project to their peers more effectively than an agency or interest group. Similarly, a restoration project should receive recognition - so that people feel that it is important.

- **Efforts should be made to include landowners and permittees in the restoration process – a sense of teamwork is essential.** This often reduces conflicts which arise between private citizens and government agencies in their area. Furthermore, individuals who help plan and implement a restoration feel (appropriately) they have an impact on the process. This provides them with a sense of pride and accomplishment. As a result, they will be more likely to support the project and properly maintain the project site. In addition, such individuals are more likely to persuade their peers to restore damaged sites and adopt better land-use practices.

- **Agencies must provide adequate resources to monitor and maintain a project after completion – this should be planned in initial project design.** The success or failure of many projects depends upon continual maintenance of the restoration site. Help from the local community is often critically important in such efforts.

- **Agencies should be supportive of restoration efforts, both financially and philosophically.** In this context, agency employees must feel that they have the support of their superiors. When employees have such support, they often feel more empowered to make individual contributions which might benefit the restoration effort.

- **Riparian restoration monitoring should include physical, chemical, and biological parameters for assessing water quality.** Currently, most monitoring is limited to visual recordings and general habitat surveys. If NPS pollution is the premise for project funding, adequate sampling is imperative for evaluating water quality. Many sampling procedures are expensive and may preclude adequate testing. The author believes that sampling of macroinvertebrate communities may provide an index to water quality that is inexpensive and can be adopted by area schools for educational purposes. Such bioassessment techniques have been developed (EPA 1989).

IV. SELECTED RIPARIAN RESTORATION PROJECTS

Information for the following project descriptions was gathered from questionnaires distributed to project participants. Information gathered by other means has been referenced. Sites that were field reviewed are denoted by an asterisk. At many sites project implementation and monitoring is on-going.

Alaska

No riparian restorations were found (that met study criteria) in time for inclusion in this report. A number of projects (in the Alaskan interior) have been initiated to reclaim placer mines. However, many of these have been unsuccessful due to regional climate - which limits plant productivity and encourages buildup of winter ice and heavy spring runoff. Recent efforts by The Bureau of Land Management (BLM) (in Fairbanks) to restore the Independence Creek drainage have met some success and results are encouraging (Masinton 1991). The U.S. Forest Service (USFS) has launched several projects to improve fish habitat in Alaska (Smart 1991). The majority of these have been initiated within the past two years (Smart 1991).

IDAHO

Crooked River Restoration Project

Location:

The Crooked River Watershed is located in the South Fork of the Clear Water Drainage in the Nez Perce National Forest, approximately 10 miles Southwest of Elk City, Idaho.

Reported By:

Bill Baer, Elk City Ranger District, P.O. Box 416, Elk City, Idaho 83525. (208) 842-2245.

Watershed Setting and Description:

The Crooked River Watershed drains 42 acres of forest habitat dominated by Douglas fir and Lodgepole pine (average elevation is 4,000 feet). Local topography consists of rolling hills and valleys. Soils are derived from a highly erodible granitic base. The climate is temperate with 40 inches of precipitation annually, 50 percent occurs as snow.

Problem Statement and Objectives:

Intensive dredging (associated with gold mining) during the 1940's and 1950's eliminated riparian vegetation along Crooked River. Instream complexity was impaired (ie. large boulders, large woody debris, pooling etc. was reduced - if not eliminated). Unconsolidated dredge spoils were left at the site. All top soil was removed along the river. As a result of these disturbances, valuable fish habitat was destroyed. In 1984 the USFS initiated the Crooked River Restoration Project to restore the anadromous fishery. Project goals included: 1) increasing instream complexity and fish habitat, 2) reestablishing riparian vegetation, and 3) Creating rearing habitat for coho and steelhead by establishing side channels and ponds.

Treatments Implemented at the Site:

The USFS surveyed and inventoried 10 sites along Crooked River to identify areas of intense degradation and areas which limited fish production. The BMP plan included: 1) installation of rock and log weirs to create downstream pools, 2) instream boulder placement and addition of large woody debris to increase instream complexity, 3) installation of boulder deflectors to create eddies and backwater areas, 4) grading streambanks to reduce slope, 5) removal of unconsolidated material to create a floodplain, 6) planting riparian vegetation and seeding with grasses, and 7) creation of side channels and pools.

Project Monitoring or Evaluation:

Project monitoring consisted of visual surveys. Indices were employed to determine habitat condition in and along the river. In 1990 the USFS conducted a basin wide survey to classify macrohabitat types and measure trends in improvement.

Final Results of Treatment:

Construction of a river floodplain now allows overbank flooding and sediment deposition (which is necessary for the establishment of riparian vegetation). Seeding has stabilized streambanks along the river. Instream treatments have created greater stream complexity. Pool to riffle ratios have improved. Side channels and pools (combined with improvements previously mentioned) have augmented available fish habitat and rearing grounds.

Project Participants:

Bonneville Power Company, U.S. Forest Service, Idaho Division of Environmental Quality, Nez Perce indian tribe, and the Idaho Department of Fish and Game.

Funding Sources and Estimated Costs:

The project cost approximately $500,000 and was funded primarily by the Bonneville Power Administration. The USFS also helped support this project.

Comments on Project Success:

Pretreatment inventories helped determine areas with the greatest potential for rehabilitation and fish habitat enhancement. In addition, they provided information necessary for treatment selection and project planning. Use of BMPs (by the USFS) was flexible, allowing for modification as more was learned about the site. Such practice increased treatment efficacy. Strong interagency cooperation and agreement throughout the project increased flexibility to plan modification and helped coordinate resources. Development of several treatment plans (by the USFS) and review of these plans by other agencies provided the most effective restoration design possible. Adequate funding and time allowed identification and avoidance of potential problems.

The Sawmill Creek Restoration Project*

Location:

Sawmill Creek is located in the BLM's Big Butte Resource Area, 37 miles N.W. of Howe, Idaho.

Reported By:

Karen Aslett, Bureau of Land Management, 940 Lincoln Road, Idaho Falls, Idaho 83401. (208) 529-1020.

Watershed Setting and Description:

Sawmill creek resides within a 200,000 acre watershed that drains a high elevation (6,400 feet) desert valley surrounded by mountains. Soils are derived from alluvial deposits consisting of limestone and volcanic debris. The climate is semiarid consisting of hot summers and cold winters. Annual precipitation averages 100-114 inches, 66 percent occurs as snow. Sawmill Creek resides entirely on land administered by the BLM. Cattle grazing is the primary land use activity along the creek; fishing and camping are steadily increasing.

Problem Statement and Objectives:

Prior to 1986, the combined effects of flooding, wildfires, channelization, and fall grazing had degraded the riparian area along Sawmill Creek - causing bank instability, lateral degradation of the stream channel, and reduced fish habitat. In response, the BLM (Idaho falls District) and the Idaho Dept. of Fish and Game (IDFG) initiated the Sawmill Creek Project to restore the riparian zone and improve channel morphology. Specific project objectives included: 1) improved growth, vigor, and regeneration of the riparian zone, 2) increased bank stability, 3) increased fish populations, and 4) improved channel morphology.

Treatments Implemented at the Site:

Approximately 8 miles of Sawmill Creek were treated in this project. Best Management Practices included: 1) installation of 8.0 miles of fencing along the creek, creating two separate riparian pastures; the upper 5 miles of the riparian pasture has been allotted for spring grazing only, while the lower 3 miles has been excluded from grazing (for up to fifteen years); the previous grazing plan allowed season long grazing throughout the riparian zone, 2) establishment of upland troughs for off-site livestock water, and 3) planting of willow and cottonwood cuttings in the lower half of the riparian pasture.

Project Monitoring or Evaluation:

Treatment monitoring includes: 1) established photopoints, 2) reconnaissance inventories (every 3 years), 3) a willow survivability inventory, 4) infrared aerial photographs of the site (to be repeated every ten years), and 5) water quality sampling.

Final Results of Treatment:

Bank stability has increased in both riparian pastures. Survival of willow and cottonwood plantings has been poor. However, riparian vegetation has expanded naturally (particularly onto gravel bars). Beavers have moved back into the treatment area (Aslett 1991). Fish habitat appears to have improved (this has not been quantified). Post-treatment response has been slower on the lower pasture (compared to the upstream pasture) due to greater channel instability and pretreatment degradation.

Project Participants:

Soil Conservation Service, Bureau of Land Management, Little Lost Watershed Improvement District, Idaho Dept. of Fish and Game, Big Country Resource Conservation and Development Project, and the Butte Soil and Water Conservation District.

Funding Sources and Estimated Costs:

Funding was provided by mitigation money from the Little Lost River Diversion Project (supplied by the Bureau of Land Management, Soil Conservation Service, and Butte Soil and Water Conservation District. Total project costs amounted to $90,000.

Comments on Project Success:

Pretreatment surveys conducted by the BLM and IDFG enabled these agencies to identify critical areas and develop a riparian restoration plan. Photodocumentation has been effectively used to monitor habitat improvement in the treatment area. Cooperation by grazing permittees has been central to project success.

Sublett Creek Restoration Project

Location:

Sublett Creek is located within the Burley Ranger District on the Sublett Cattle Allotment in Sawtooth National Forest, approximately 55 miles southwest of Burley, Idaho.

Reported By:

Jerry Green, USFS, 2621 South Overland Ave., Burley, Idaho 83318. (208) 678-0430.

Watershed Setting and Description:

The Sublett drainage encompasses approximately 917 acres of high desert habitat (elevations range between 5,400 to 5,600 feet) and is intercepted at its base by an irrigation reservoir (Sublett Reservoir). Local topography consists of moderately dissected mountains; soils are derived from limestone. The local climate is frigid with 17 inches of precipitation annually, 80 percent occurs as snow. Sublett Creek drains USFS land except for the lower half mile above Sublett Reservoir, which resides on private land. Because Sublett Creek maintains a popular cold water fishery, use by recreationalists is heavy.

Problem Statement and Objectives:

By 1979, impacts from cattle grazing and camping along Sublett Creek had changed natural composition of streamside vegetation from desireable riparian species to thistle, Kentucky bluegrass, and other undesirable weeds. The creek had widened, becoming more shallow. Willows were absent along several sections of the creek. Streambank stability had decreased, increasing instream sediment loads and reducing gravel beds available for spawning trout. In addition, cattle were dying (from bloating) after grazing on watercress growing along Sublett Creek (Chard 1991). In response to these disturbances, the USFS and the Idaho Department of Fish and Game (IDFG) surveyed the stream to inventory fish habitat and developed measures to protect and restore the riparian zone; the USFS conducted a riparian habitat survey. Both surveys indicated that the drainage had been severely damaged. To protect and enhance the creek, the USFS initiated the Sublett Creek Restoration Project, Specific project objectives included: 1) reducing cattle losses, 2) reducing impact on canyon bottoms and riparian areas from cattle grazing, 3) stabilizing the stream channel, 4) reducing siltation and 5) improving fish habitat.

Treatments Implemented at the Site:

A new grazing allotment management plan (AMP) was developed (in 1983) in conjunction with grazing permittees. The old allotment plan consisted of a rest rotation system in which cattle were allowed to remain in a unit season long. The new AMP consists of a modified four unit rest rotation system with a five year rotation - each of the units is rested one year out of five except along the north fork of Sublett Creek, which is rested two out of five. Grazing on this section is now permitted only in the spring. Other BMPs included: 1) establishment of streambank protection structures along unstable portions of the creek (willows were planted but survival has been poor) 2) construction of several drift fences. 3) installation of log dams to create downstream pools, 4) installation of two cattle troughs on upland sites, and 5) improvement of permittee herding and salting practices.

Project Monitoring or Evaluation:

Post treatment monitoring (since 1987) by the Sawtooth National Forest Riparian Team includes: 1) sampling to obtain cross section measurements, 2) green line measurement and 3) woody-species regeneration measurements within the watershed. Photopoints were established prior to treatment and have been monitored since.

Final Results of Treatment:

Since implementation of the new AMP, Sublett Creek has improved and looks better. Post-treatment improvements include: 1) improved quality and quantity of spawning gravels, 2) increased streambank stability, 3) increased productivity of riparian meadows and forage, 4) improved flow duration, 5) narrower and deeper stream channels and, 6) decreased cattle losses. Monitoring from 1987 to 1990 indicates that improvements are not continuous throughout all portions of the creek (Chard 1991). Drought conditions over the past 5 years may have contributed to the slow recovery on portions of Sublett Creek during the last few years.

Project Participants:

Project participants included the U.S. Forest Service and the Sublett Cattle Allotment Grazing Association.

Funding Sources and Estimated Costs:

Funding was provided by the U.S. Forest Service and the Sublett Cattle Allotment Grazing Association. Project costs were split equally between these organizations; total costs amounted to approximately $70,000, $10,000 of which was invested in the riparian zone.

Comments on Project Success:

Development and use of a riparian classification scheme (based on relative value) and pretreatment stream and riparian surveys enabled the USFS to identify critical riparian areas and formulate project goals. Collection of baseline data allowed project participants to estimate habitat potential of degraded areas and to measure progress following treatment implementation. Cooperation of permittees has been (and continues to be) central to the projects success. Close interaction and continued communication between the USFS and permittees has facilitated this cooperation. Adequate time and funding has allowed a greater knowledge of the Sublett Creek ecosystem and flexibility in project planning and continued grazing management.

Thorn Creek Pilot Restoration Project*

Location:

The Thorn Creek Watershed is located in the Bennet Hills Resource Area, approximately 17 miles northeast of Gooding, Idaho.

Reported By:

Floyd DeWitt, Bureau of Land Management, P.O. Box 2B, Shoshone, ID 83352. (208) 886-2206.

Watershed Setting and Description:

The project area consists of 6,300 acres of rangeland habitat, located on public lands administered by the BLM. Local topography consists of moderate hills and valleys, underlain by highly weathered rhyolite. The climate is inland mediterranean with hot dry summers and cold moist winters. Thirteen to 17 inches of precipitation fall annually, fifty percent occurs as snow (Shoshone District 1987). Primitive roads, fences, and cattleguards are present on the site.

Problem Statement and Objectives:

Prior to 1983, the Thorn Creek drainage was open for Fall cattle grazing. This grazing strategy maintained populations of upland plants but allowed degradation of riparian vegetation, several typic species completely disappeared from the site. In 1983 the BLM acquired 1,000 acres within the drainage. This area included riparian zones in the upper meadow, streams feeding Thorn Creek, Thorn Creek, and the Thorn Creek Reservoir. Thorn Creek was selected by the BLM (in 1987) to be a pilot riparian management area and demonstration project - due to its disturbance history and its high potential for improvement. Project objectives included: 1) increased populations of native upland and riparian plant species, 2) elevated groundwater levels within the watershed, 3) reduced peak flows, 4) increased woody vegetation, 5) improved water quality, and 6) enhanced multiple-use opportunities.

Treatments Implemented at the Site:

The entire 6,300 acre pasture was rested from grazing and allowed to recover naturally. This area will not be grazed before

1993 (Dewitt 1991). Other BMPs included: 1) reestablishment of 3.5 miles of pasture boundary fence, 2) installation of two rock gabions - to trap sediment and raise the stream bottom, and 3) construction of exlosures at selected locations along the stream (for study of riparian improvement rates with, and without grazing). Since a 1990 fire swept through the basin additional treatments have been implemented. These include: 1) upland grass seeding, 2) installation of instream rock dams, and 3) construction of an earthen dam and adjacent spillway at the head of Thorn Creek. Interperative trails along Thorn Creek Reservoirs are planned for the near future (Dewitt 1991).

Project Monitoring or Evaluation:

Post treatment monitoring included: 1) sight boards located near individual shrubs to measure growth over time, and 2) ground monitoring wells to measure groundwater levels, 3) Low level color-infrared aerial photographs to inventory existing plant communities, and 3) photopoints in pasture enclosures (Dewitt 1991).

Final Results of Treatment:

Sedge and rush communities have expanded within the riparian and creek zone. Several near-stream springs flowed for longer periods of time than previously. Sediment trapped behind an upstream gabion raised the stream bottom approximately 18 inches. The second gabion was installed below Thorn Creek Reservoir and has been ineffective. Grazing Animal Unit Months have been maintained at pretreatment levels. The Thorn Creek Restoration has been used as a demonstration project for review by grazing permittees and other land management agencies. An ongoing 5 year drought has reduced stream flow and groundwater levels - which have slowed the recovery process.

Project Participants:

The Thorn Creek restoration project was designed and implemented by the BLM. Volunteers from the Boy Scouts, the Magic Valley Fly Fisherman, the Committee for Idaho's High Desert, and grazing permittees have also participated in the project.

Funding Sources and Estimated Costs:

Funding was provided by the BLM from grazing fees (Range Betterment Fund) and from congressional appropriations (Wildlife Fund, and Soil, Water and Air Fund). Initial costs were approximately $35,319; continued maintenance costs amount to $880 annually.

Comments on Project Success:

Cooperation from grazing permittees has been essential to project success. Close communication between the BLM and the permittees increased cooperation - a sense of teamwork was important to this process. The BLM recognized permittee work by giving them range excellence awards. Grazing permittees have increased awareness of riparian values among their peers. Increased environmental awareness and commitment to riparian conservation by the BLM was also important. Pretreatment surveys helped the BLM locate critical areas and develop methods to restore them. Use of the restoration project as a demonstration project may persuade other individuals and agencies to restore and protect riparian habitats in other areas.
Dedication of the area by area directors and congressman increased peoples perception that the project was important.

OREGON

Bear Creek Restoration Project*

Location:

The Bear Creek watershed is located southeast of Prineville, Oregon in Crook County. The watershed drains to the west (into Prineville Reservoir) from its origin in the Maury Mountains in the Ochoco National Forest.

Reported By:

John Heilmeyer, P.O. Box 550 Prineville, Oregon, 97754. (503) 447-4115.

Watershed Setting and Description:

The Bear Creek watershed drains approximately 55,500 acres of rangeland habitat (elevations range from 3400 to 5532 feet). Local topography consists of rolling hills and valleys intersected by steep basaltic ridges and incised drainages. Soils are derived from Columbia River Basalt and volcanic ash. The climate is semi-arid with 12 inches of precipitation annually, 40 to 60 percent occurs as snow. Approximately 75 percent of the watershed resides on public lands managed by the BLM (Prineville District), the remaining 25 percent is owned by cattle ranchers. The primary land use activity is cattle grazing.

Problem Statement and Objectives:

Since the 1860's intensive cattle grazing in the Bear Creek Watershed has degraded riparian areas along Bear Creek - reducing woody riparian species, lowering the watertable, destabilizing streambanks, and increasing instream sedimentation. Fire suppression in upland sites (by humans) coupled with lowered watertable levels permitted juniper to invade the watershed and replace native herbaceous species, resulting in large areas of bare erosive ground and reducing available forage. Subsequent to these changes, heavy flooding and overland storm flow within the watershed accelerated erosion and resulted in heavy sediment deposition in Prineville Reservoir and the Crooked River. To control and reduce these impacts, the BLM initiated the Bear Creek Restoration Project. Project objectives included: 1) reducing juniper populations and replacing them with herbaceous species, 2) increasing infiltration of precipitation into the soil, 3) stabilizing streambanks, 4) increasing native riparian vegetation, raising the stream-bottom.

Treatments Implemented at the Site:

The Bear Creek Project involved 55,490 acres of which 41,260 acres were administered by the BLM and funded from 1972 to 1978. Juniper trees were cut on upland sites (approximately 14,000 acres). Following this: 1) prescribed burns were used to inhibit further juniper invasion and aid establishment of herbaceous species, 2) 30 miles of pasture and enclosure fencing were installed on both upland and riparian sites (approximately 2.25 miles of riparian area were enclosed), 3) 16 miles of juniper rip-rap was placed along banks on Bear Creek and several of its tributaries, 4) sediment catchment dams were installed in the creek to raise the creek, 5) springs were developed on upland sites for livestock watering, 6) a new AMP was developed to reduce the impacts of grazing on riparian areas. The old plan allowed season long grazing on a rest rotation basis. Under the new plan, allotments were divided into a greater number of pastures and a deferred grazing system (20 day rotation period) utilized. Grazing permittees and local landowners constructed the pasture fencing and also installed some rip-rapping.

Project Monitoring or Evaluation:

Monitoring includes: 1) photo points on riparian and upland sites, 2) soil surface factor transects (to rate erosive potential), 3) macroinvertebrate analysis, 4) cross section stream channel measurement, 5) riparian habitat inventories, 6) stream channel evaluation, and 7) water quality sampling.

Final Results of Treatment:

Upland juniper populations have been effectively reduced and herbaceous species are more prevalent. As a result, less bare ground now exists, erosion rates have declined, and water absorption has improved - as evidenced by the appearance of new springs. Seventeen miles of stream now support vigorous riparian growth (primarily herbaceous), bank erosion has declined, and sediment deposition (behind catchments) has controlled stream incision by elevating the stream bottom. The new AMP provided sufficient protection of the riparian areas to allow their regrowth. In addition, forage productivity increased from 70 AMU's to 340 AMU's.

Project Participants:

The U.S.D.I. Bureau of Land Management, private landowners, and livestock operators.

Funding Sources and Estimated Costs:

The Bureau of Land Management funded the project with $650,000. Additional costs were borne by private land owners and livestock grazers in the watershed.

Comments on Project Success:

Project successes resulted from the whole watershed approach adopted by the BLM to reduce sedimentation and restore the health of the entire drainage. Intensive inventory and study of the area prior to treatment was essential for developing the project design, and deciding how it should be implemented and monitored. In addition, prior study helped the BLM identify critical sites requiring the greatest attention and those with the greatest potential for rehabilitation. Strong enthusiasm of BLM personnel and cooperation of local landowners and grazing permittees also aided the restoration process.

Camp Creek Restoration Project*

Location:

Camp Creek is located 40 miles southeast of Prineville in Crook County, Oregon. It originates in the Maury Mountains of the Ochoco National Forest and drains to the east.

Reported By:

Dick Cosgriffe, U.S.D.I. Bureau of Land Management, P.O. Box 550, Prineville, Oregon 97754. (503) 447-4115.

Watershed Setting and Description:

The Camp Creek Watershed drains approximately 110,710 acres of rangeland (consisting of sagebrush, juniper, and bunchgrass) and coniferous forest habitat (elevations range between 3,665 to 6,121) feet. The drainage basin consists of fluvial valleys surrounded by more resistant basalt buttes and hills. Soils consist of highly erodible bentonitic and montmorillanitic clays. The climate is semiarid with 12-14 inches of precipitation annually, 20 percent occurs as snow. Approximately 59,000 acres of the watershed resides on public land, the remainder is held by private landowners. Land-use within the basin includes livestock and hay production.

Problem Statement and Objectives:

Overgrazing, mismanagement of livestock, fire control, and intensive road/logging development since the late 1800's have accelerated streambank and upland erosion, channel incision, dendritic gully spread, and riparian degradation - resulting in a drop in the local watertable. As a result, sagebrush and juniper have since invaded the area, replacing native grasses and forbs and reducing available forage. In response to these disturbances the BLM (Prineville District) initiated the Camp Creek Restoration Project (which began in 1965 and is ongoing). Project objectives included: 1) stabilizing the stream channel and raising the watertable on 31.6 river miles and 383 acres of riparian habitat, 2) improving stream water quality and reducing sediment discharge, 4) restoring the Camp Creek channel to 60 percent of its potential condition, and 5) increasing the forage resource base for wildlife and livestock.

Treatments Implemented at the Site:

In 1964 the BLM developed an initial Camp Creek watershed plan. Following this: 1) several detention dams were constructed, 2) 2.7 miles of Camp Creek were fenced off, 3) 1000 russian olive seedlings and willow cuttings were planted along the upper portion of the creek, 4) severely disturbed areas were reseeded with tall wheatgrass and sweetclover, 5) streambanks were rip-rapped with juniper trees, 6) juniper and sagebrush were removed from several upland sites by cutting, chaining, and burning, and 7) low-rock structures and gabions were installed in the creek to trap sediment and raise the watertable. In 1978 an intensive water quality and macroinvertebrate sampling survey was initiated. Following continued watershed surveys, a revised watershed plan was drafted (1985) which initiated a new rest-rotation grazing plan (prior to this grazing was year round on open range). Private land owners have also removed juniper and rip-rapped along the creek on their property.

Project Monitoring or Evaluation:

Monitoring of Camp Creek includes: 1) establishment of permanent photopoints on riparian and upland sites, 2) stream channel studies (initiated in 1978) which included water quality and macroinvertebrate surveys, 3) permanent range condition transects, 4) upland erosion study plots, and 5) an intensive riparian zone hydrology study (initiated in 1985).

Final Results of Treatment:

Two to eight feet of sediment has been deposited behind instream structures. One livestock crossing has effectively acted as a check dam. Beaver activity has also increased sediment deposition. Collectively, these treatments have elevated the stream bottom and raised the watertable within the floodplain. Juniper removal and prescribed burning enabled grasses and forbs to reestablish on upland sites - increasing available forage and augmenting infiltration of precipitation into the soil. Juniper rip-rapping stabilized streambanks and increased sediment deposition - allowing reestablishment of riparian plant species. Gabions were damaged by heavy flooding one year after installation - three have been repaired. Russian olive and willow plantings were unsuccessful; they were drowned out by the rising watertable. Fenced enclosures have only been partially successful in limiting access of livestock to the creek. Several grazing permittees have failed to prevent their cattle from damaging fencing and grazing within the enclosures. The new AMP plan has not been fully implemented at this time.

Project Participants:

The U.S.D.I. Bureau of Land Management, Oregon State University students and professors, the Oregon Dept. of Fish and Wildlife, Oregon Watershed Improvement Coalition, Oregon Cattleman Association, U.S.D.A. Forest Service, and local landowners.

Funding Sources and Estimated Costs:

Financial support was appropriated from congressional funds, the Oregon Dept. of Fish and Wildlife, Oregon State University, range improvement funds returned from grazing permits, and local landowners.

Comments on Project Success:

Juniper removal and reintroduction of fire into the ecosystem have been essential to the natural reestablishment of herbaceous plant species. Post-treatment structural maintenance has been necessary to achieve project objectives. Shift from year round grazing to spring and late fall grazing adjacent to the riparian zone will protect fencing from damage incurred as cattle seek shade and water during the summer months. Greater supervision of the site by the BLM and grazing permittees will be necessary to keep cattle out of the riparian enclosures. Periodic surveys and monitoring have revealed unexpected changes in the riparian habitat - allowing the BLM to adopt new BMPs in response to these changes (and discontinue ineffective treatments).

Chewaucan River Project

Location:

Chewaucan River is located in Lake County, Oregon approximately 10 miles SW of Paisley.

Reported By:

Bill Schrader, Soil Conservation Service, 100 N. D. Street, Lakeview, Oregon 97630. (503) 947-2202.

Watershed Setting and Description:

The Chewaucan River Watershed drains approximately 30 square miles of grassland/forest habitat (average elevation is 6000 feet). The upper portion of the watershed is a grassland meadow - in this area Dairy Creek and Elder Creek join to form Chewaucan River. Downstream, Chewaucan River drains several steep sided canyons separated by open meadows. Soils consist of alluvial material derived from adjacent highlands. The climate is semiarid with 20 inches of precipitation annually, 50 percent occurs as snow. The river basin is used for cattle grazing; several instream irrigation structures are present in the upper meadow (Schrader 1991).

Problem Statement and Objectives:

Overgrazing throughout the drainage basin degraded riparian habitat and reduced streambank stability. The confluence of Dairy Creek and Elder Creek was very unstable and highly eroded. Spring flooding accelerated bank erosion throughout much of the upper basin. In 1964, a flood event deposited large trees in the lower portion of the river which directed flow out of the main stream channel, causing bank blowouts. A new landowner recognized these problems and enlisted the help of the SCS to obtain funding and expertise to rehabilitate the area. Together they initiated the Chewaucan River Project. Project goals included: 1) stabilizing streambanks, 2) enhancing riparian vegetation, 3) improving fish habitat, and 4) eliminating erosion caused by dead snags lodged in the lower portion of the river.

Treatments Implemented at the Site:

In 1988, approximately 2 miles of riparian area in the upper meadow (including portions of Dairy Creek and Elder Creek) and 1 mile in a downstream canyon were treated. Best Management Practices included: 1) rip-rapping streambanks with juniper, 2) rip-rapping the confluence of Dairy Creek and Elder Creek with stone material, 3) placing boulders in the river to enhance fish habitat, 4) removing dead snags from the lower portion of the river, 5) treating one highly disturbed stream corner with ENKAMAT (a geotextile) which was then seeded and watered, 6) fencing .25 miles of riparian pasture in the upper meadow, 7) planting willows throughout the basin, and 8), excluding the lower pastures from cattle grazing for three years.

Project Monitoring or Evaluation:

Five photopoints have been established along the river; they will be monitored annually for a period of 10 years. Willow growth will also be monitored annually for 10 years.

Final Results of Treatment:

Sediment deposition has increased in back-eddies caused by juniper rip-rap. Riparian vegetation continues to colonize this newly deposited sediment. Streambank stability has increased throughout the treated portions of the river. Streambanks which have sloughed onto rip-rapped sections are more sloped than previously. The ENKEMAT material worked very well to stabilize the adjacent streambank. However, it will not be used in the future due to its expense. Removal of snags in the downstream reach oriented the river back into the main thalweg, reducing bank erosion. Willow plantings were not as successful as other treatments. Survivorship in the upper meadow was approximately 10 percent (due to beaver cutting) and 40 percent in the lower meadow (Schrader 1991). No immediate benefits to the fishery from habitat enhancement have been recorded (Schrader 1991).

Project Participants:

The Soil Conservation Service, U.S. Forest Service, Lakeview Soil and Water Conservation District, J-Spear Ranch, Oregon Governor's Watershed Enhancement Board, and the Oregon Department of Fish and Wildlife.

Funding Sources and Estimated Costs:

The Chewaucan River Project cost in excess of $50,000. Funding was provided primarily by the Governor's Watershed Enhancement Board with additional help from - Oregon Department of Fish and Wildlife, Soil Conservation Service, U.S. Forest Service, and owners of the J-Spear Ranch.

Comments on Project Success:

Recognition of the degraded condition of the river basin by the new landowners (coupled with their desire to operate their ranch without harming the land) was necessary for the project's conception and implementation. Interagency coordination was important for funding acquisition and project administration. Successful completion of the project was aided by cooperation and communication between the agencies. Pretreatment surveys by the SCS helped to locate degraded areas and design treatment methods. A fishery survey by the Oregon Dept. of Fish and Wildlife (ODFW) revealed that fish habitat was severely degraded and needed improvement. Total exclusion of the lower riparian areas has aided their recovery.

Wall Creek Watershed Rehabilitation Project

Location:

The Wall Creek Watershed is located on the Umatilla National Forest in northeastern Oregon (Morrow and Grant County). The headwaters begin 9 miles northwest of Spray, Oregon and drain into the North Fork of the John Day River, 6 miles north of Monument.

Reported By:

Al Scott, Umatilla National Forest, Heppner Ranger District, P.O. Box 7, Heppner, Oregon 97836. (503) 676-9187.

Watershed Setting and Description:

The Wall Creek watershed drains 58,870 acres of mixed forest/ grassland habitat. Topography ranges from steeply sloped forests at the upper elevations of the drainage basin to open meadows at mid-elevations and deep canyons supporting grass/shrub habitat at lower elevations (elevations range from 2,000 to 6,000 feet). The climate is seasonal consisting of frigid winters and dry hot summers. Annual precipitation averages 8 to 24 inches and is concentrated between November and March, 75% occurs as snow. Land use in the Wall Creek drainage consists of timber extraction (upper elevations) and livestock grazing.

Problem Statement and Objectives:

Past land management practices such as grazing and timber harvest on public and private lands within the Wall Creek Basin have contributed to extensive degradation of riparian habitat and reduced fish production. Some indicators of riparian resource problems in the basin were low summer stream flows, loss of hardwoods, poor riparian species composition, low pool/riffle ratios, high water temperatures, streambank erosion and sediment loading, down-cutting in streams, and lack of fish rearing habitat. Long-term monitoring and analysis of the Wall Creek Basin led the USFS (Heppner District) to design and implement new grazing management practices and stream restoration work to initiate riparian recovery and reestablish anadromous fish runs. Project goals included: 1) achieving an overall restoration of watershed integrity and improvement of water quality, 2) rehabilitation of anadromous fisheries and wildlife habitat, 3) reestablishment of riparian vegetation, and 4) production of high quality forage on upland pastures.

Treatments Implemented at the Site:

Implementations to date included efforts to improve the whole watershed, to achieve a more uniform utilization of the project area by livestock, and to maintain water storage capacity in the uplands. Best Management Practices included: 1) construction of riparian enclosures, 2) creation of 5 riparian pastures, 3) planting of riparian hardwood and carex species, 4) construction of 30 pool- forming structures and 1000 deflectors and boulder clusters to provide fish habitat, increase channel stabilization, and intercept cooler subsurface flows, 5) road closures, 6) implementation of timber sale BMPs, 7) three AMP's to change grazing rotations, 8) construction of water holes on upland sites, 9) extensive burning, fertilization, and seeding on uplands to promote production of high quality forage away from riparian areas. By 1995 approximately 16 miles of stream will have been fenced and 15 miles of stream stabilization and habitat enhancement completed.

Project Monitoring or Evaluation:

Project evaluation includes: 1) fish counts, 2) transect monitoring for changes in riparian vegetation, 3) fixed closures for comparison monitoring, 4) photopoints, 5) stream profile monitoring sites, 6) water temperature measurement 7) turbidity measurement, 8) review of grazing utilization. Enhancement structures are inspected annually and repaired or removed when necessary.

Final Results of Treatment:

Complete riparian recovery will not be accomplished for many years. However, signs of recovery are already apparent. Erosion and stream siltation have been reduced and the pool:riffle ratio has increased in reaches where instream structural work has been completed. The riparian pastures show a 25-50 percent increase in streambank vegetative cover. Establishment of willows, carex, and other riparian species has stabilized streambanks along many segments of the creek. Native anadromous smolt production has increased. On average, 25 smolts are found per pool forming structure per year - where none occurred previously. Utilization of riparian vegetation by livestock is now 40 Percent of total production, compared to 80 percent before project initiation. Instream water temperatures and diurnal fluctuations have decreased where newly formed pools intercept subsurface groundwater flow. Other resource values which are anticipated to improve are visual quality, water quality, recreational fisheries, and habitat capability for riparian dependent wildlife and plant species.

Project Participants:

Specialists include: fisheries biologists, hydrologists, range conservationists, fire personnel, wildlife biologists, engineers, foresters, riparian ecologists, and botanists from the USFS. Other agencies such as the Oregon Department of Fish and Wildlife and the Morrow and Grant County Soil and Water Conservation Districts provided additional technical support. The Bonneville Power Administration, Izaak Walton League, Youth Conservation Corps, private contractors also participated in the project. Planning and implementation of sound management practices have been coordinated with the help of grazing permittees and private landowners in the basin.

Funding Sources and Estimated Costs:

Approximately $750,000 has been spent on the project to date. Of this, $500,00 was provided by the Bonneville Power Administration and the remainder from Forest Service KV funds.

Comments on Project Success:

Project implementation was aided by greater public recognition and awareness of proper land management practices. Pressure from environmental groups and political bodies concerned with the depleted fishery in Wall Creek provided pressure and opportunity to address the problems. Close cooperation and communication between the Forest Service and grazing permittees allowed successful adoption of the new grazing management plans. Enthusiastic grazing permittees helped to convince other permittees of the projects merit and economic benefits. Post treatment monitoring is allowing assessment of which "desired future conditions" are being met and which ones are appropriate for the site. Monitoring also allows assessment of the types, timing, and rates of improvements in the basin. Post treatment evaluation and maintenance of physical structures has helped maintain optimum effect. Flexibility in the use of BMPs and recognition of long term ecological trends has improved treatment effectiveness.

Willow Creek Enhancement Project*

Location:

The Willow Creek Watershed drains N.W. from the Ochoco National Forest through the town of Madras, Oregon before emptying into the Deschutes River.

Reported By:

Jesse Gregg, 6119 NW Columbia Drive, Madras, Oregon 97741. (503) 475-2758.

Watershed Setting and Description:

Willow Creek is located in the central part of Jefferson County extending from Lake Simtustus to the east along the Crooked River Drainage. The total watershed includes 116,000 acres. From Madras east to the upper end of the watershed lies 76,000 acres, of which 37,000 are publicly owned, the Crooked River National Grassland comprises the major ownership (36,600 acres). Local topography consists of rolling hills and valleys with some sharp relief in the form of deep canyons and buttes (elevations range from 2,241 to 5,634 feet). Soils are derived from Columbia River Basalt and lava rimrock. The climate is moderate with 9.5 to 15 inches of precipitation annually, 25 percent occurs as snow. Land-use in the watershed includes, commercial timber extraction, agriculture and livestock production, irrigation, and urban/suburban development (ie. Madras).

Problem Statement and Objectives:

In the upper portion of the watershed, Willow Creek was badly damaged by violent storms (in 1964 and 1978). The stream bottom dropped as much as 20 feet below its normal depth, bank erosion increased and stream head-cutting moved up the drainage, impacting upstream reaches. Grazing by wildlife and livestock exacerbated this problem. Local landowners (whose property was affected by stream degradation) contacted the Jefferson County

Soil and Water Conservation District (SWCD) office and together they initiated several public meetings to address these problems. A Willow Creek task force formed and drafted the Willow Creek Watershed Improvement Plan - designed to enhance the creek and manage the entire watershed. Specific objectives included: 1) stopping the head-cutting, 2) stabilizing the streambanks, 3) raising the stream-bottom, 4) reducing the impact of livestock grazing along the creek, 5) increasing riparian vegetation at the site.

Treatments Implemented at the Site:

The SWCD surveyed Willow Creek and recommended a treatment plan. This plan included: 1) installation of rock dams placed in the creek bed to a 3 foot height (to increase sediment deposition and raise the stream bottom), 2) planting willows along streambanks, 4) fencing 1.4 miles of riparian habitat along the stream to exclude livestock - approximately 0.5 miles of riparian corridor is still grazed during the spring and fall, 5) completing a coordinated Resource Management Plan to address land-use problems in the watershed.

Project Monitoring or Evaluation:

The SCS is responsible for project monitoring. Data gathered (from 10 pre-selected sites) includes: photo-points, stream cross section transects, water temperature, and timber and rangeland activities. This information will be evaluated every 5 years.

Final Results of Treatment:

The stream bottom has risen up to 3 feet (from sediment deposition) behind the rock dams. The areal extent of streamside meadow has expanded - suggesting that the watertable is also rising. Riparian vegetation has increased within the enclosures. Willow plantings have helped stabilize the streambanks but require more time to become established. Plantings along the stream have been successful (approximately 80 percent survival) while those further from the stream have died. The SWCD and local cattleman provide tours of the area to show the benefits of restoration.

Project Participants:

The Soil Conservation District, Oregon Dept. of Fish and Wildlife, Jefferson County Soil and Water Conservation District, and the Jefferson County U.S. Forest Service provided technical consultation for the project. The Jefferson County Soil and Water Conservation District (with help from local landowners) designed the restoration plan. The rock dams were installed by private contractors. Additional labor was provided by the Youth

Conservation Corps, the Madras High School Forestry Class, and local citizens.

Funding Sources and Estimated Costs:

The project cost approximately $85,000. The Governors Watershed Enhancement Board was the major source of funding. The city of Madras, Jefferson County Road Dept., Jefferson County Soil and Water Conservation District, and local landowners provided additional support.

Comments on Project Success:

Pretreatment surveys provided information on site status and potential for rehabilitation. Public meetings allowed a diversity of people (with different skills and knowledge of natural ecosystems) to become involved in the restoration process. Attendants developed project goals during public meetings. Interagency coordination and cooperation throughout the restoration process helped to develop a holistic management plan for the watershed and avoid potential problems at the treatment site. Cost sharing programs allowed local landowners to support and contribute to work on their land. Post-treatment maintenance is the responsibility of these same landowners. Several people who have reviewed the site have developed restoration projects in other areas.

WASHINGTON

Burley/Minter Watershed Project*

Location:

The Burley and Minter Watersheds are located at the north end of Henderson Bay, 10 miles N.W. of Tacoma, Washington (in Kitsap and Pierce Counties).

Reported By:

Joy Garitone, Kitsap County Conservation District, 817 South Sidney, Port Orchard, Washington 98366. (206) 876-7171.

Watershed Setting and Description:

The Burley and Minter Watersheds drain approximately 10,000 acres of forest land characterized by moderate hills and valleys (local elevations seldom exceed 400 feet). Soils consist of glacial tills 1 to 50 feet deep (Burley/Minter 1988); a shallow hardpan underlays much of the area. The climate is maritime typified by dry summers and wet winters. Annual precipitation averages 45 to 60 inches, 52 percent occurs as snow. Population growth in the watersheds has resulted in increased subdivision of the land for housing development and agricultural use.

Problem Statement and Objectives:

Historically, Burley Lagoon and Minter Bay have provided highly productive oyster beds for commercial harvesting and are classified as AA Marine Waters (WAC 173-201-085(211)); the upland drainage basins maintain sensitive area designation. In 1984, the Department of Ecology (DOE) found that levels of fecal coliform exceeded the maximum limit of applicable standards in Minter Bay and Burley Lagoon by 58 and 20 percent, respectively (Burley/Minter 1988). As a result, these waters were closed to oyster harvesting. The DOE identified NPS pollution from agricultural development, poor land-use practices, and septic discharge into upland waterways as causes of poor water quality. In response to the closures, Pierce and Kitsap Counties established the Sensitive Area Technical Committee (SAC) to develop management plans for the protection of commercial shellfish operations and to bring water quality within acceptable levels (Burley/Minter 1988). Agencies enlisted in SAC consisted of: Pierce and Kitsap County Health, Public Works, and Planning Departments, as well as the DOE, commercial oyster growers, the Pierce-Kitsap Soil Conservation District, and the South Sound Land Use Association. In response to these charges, SAC created the Burley/Minter Drainage Basin water Quality Plan. Objectives of this plan included the reclassification of shellfish growing areas in Burley Lagoon and Minter Bay by eliminating poor land-use practices and enhancing riparian habitat in upland drainages.

Treatments Implemented at the Site:

The Kitsap County Conservation District has been responsible for implementation of BMPs to reduce NPS pollutants originating in upland drainages. These BMPs include: 1) exclusion of livestock from wetland and riparian habitats, 2) installation of riparian fencing, 3) riparian enhancements, 4) implementation of pasture management plans, and 5) community education.

Project Monitoring or Evaluation:

The Dept. of Health is responsible for monitoring water quality (ie. fecal coliform counts, dissolved oxygen, water temperature, sedimentation etc.) in the two watersheds. Water quality monitoring within the watersheds occur on a quarterly basis. Monitoring of marine waters occurs semi-annually (Burley/Minter 1988).

Final Results of Treatment:

Results of BMPs implemented by the Kitsap County Conservation District include: 1) decreased fecal coliform counts in upland drainages where BMPs have been initiated, 2) decreased bank erosion and instream sedimentation adjacent to project sites, 3) decreased fecal coliform counts in Minter Bay and Burley Lagoon, and 4) increased public sensitivity to water quality issues.

Project Participants:

County Planning Divisions, County Health Departments, County Public Works Departments, Soil Conservation Service, Conservation Districts, Department of Social and Health Services, Department of Ecology, Puget Sound Water Quality Authority, Department of Natural Resources, Washington Department of Fisheries and Washington Department of Game, and The Environmental Protection Agency.

Funding Sources and Estimated Costs:

The Department Ecology is responsible for project funding. Additional support has been provided by Pierce and Kitsap County and volunteer groups. Total project costs (to date) were not available at the time of this report.

Comments on Project Success:

Interagency cooperation has been essential to project initiation and implementation. Dedication of agency employees has also been important. The DOE has been a reliable source of funding. The Kitsap County Conservation District has worked successfully with private landowners to effect better land-use practices and riparian protection measures. However, compliance has not been 100 percent. Community interest in water quality and NPS has increased.

Chimicum Creek Restoration Project*

Location:

Chimicum Creek is located on the Olympic Peninsula several miles east of Port Townsend, Washington in Jefferson County.

Reported By:

Kerry Perkins, Soil Conservation Service, 111E 3rd, Rm 213, Port Angeles, Washington, 98362. (206) 457-5091.

Watershed Setting and Description:

The Chimicum watershed encompasses 24,000 acres of forest habitat in which valley floodplains have been developed for agriculture and dairy and beef operations. Topography consists of glacially derived hills and valleys; floodplain soils are peatland histosols. The local climate is maritime with 24 inches of precipitation annually, 5 percent occurring as snow. Chimicum Creek is a third order stream which empties into Port Townsend Bay, draining private lands except where county roads pass over the stream.

Problem Statement and Objectives:

During the 1900's heavy infestation of reed canary grass along Chimicum Creek has reduced instream flow velocities, limiting the sediment carrying capacity of the stream and increasing the deposition of fine sands and silts. In early 1980, logging activity (by Pope Resources) in the upper portion of the watershed resulted in landslides which deposited significant amounts of sediment downstream. These impacts impeded normal stream flow causing significant over-bank flooding during the winter months. Floodplain surfaces often remained saturated for several months after flood events, threatening spring planting and crop production. In addition, increased sedimentation reduced available habitat for salmon fry. Livestock grazing along the stream has also accelerated streambank erosion and reduced bank stability. In response to these impacts, local landowners worked with the SCS, Washington Department of Fisheries (WDOF), and the Jefferson County Conservation District, to improve conditions along Chimicum Creek. Project objectives included: 1) removing canary grass and sediment from the stream, 2) fencing the stream corridor to limit access to livestock, 3) increasing woody vegetation on the site, and 4) improving fish habitat.

Treatments Implemented at the Site:

In an effort to reduce winter flooding, local dairy farmers asked officials from the SCS and Jefferson County Conservation District to survey Chimicum Creek and to assist them in obtaining a hydraulics permit to remove reed canary grass from the stream. Initial efforts to work with the WDOF to obtain a permit were hindered by a failure on the part of the WDOF to develop and communicate permit requirements. After meeting with a representative from the governors office (whose help had been requested by a local landowner), the WDOF developed permit requirements, which the landowners complied with. The SCS worked with the landowners to: 1) fence portions of the riparian corridor and create specific access sites for livestock, 2) plant red alder along the stream (to shade out the reed canary grass), 3) install instream sediment basins, and 4) develop better pasture management programs. In addition, the landowners dredged Chimicum Creek along their property (to remove existing canary grass) and convinced Pope Resources to seed areas (with lupine) deforested by landslides. Seeding was carried out with help from the Dept. of Natural Resources - Conservation Corps.

Project Monitoring or Evaluation:

No formal post-treatment monitoring has been conducted on Chimicum Creek. Local landowners, the SCS, and the Conservation District have periodically reviewed the project site to determine need for sediment removal.

Final Results of Treatment:

Following treatment, winter flooding has been significantly reduced. Large amounts of sediment have collected in the sediment basins, increasing the relative percentage of pebble/cobble substrate. In addition, fish now have deep holes in which to feed and find protection. Riparian fencing has prevented livestock from grazing along the creek, resulting in reduced bank erosion and increased bank stability. Lupine has become well established on the landslides and native woody species are now occurring naturally at these sites. As a result, landslide areas have been stabilized and no longer confer heavy sediment loads to the stream. Dredging activity initially reduced reed canary grass along the creek (resulting in increased stream flow). However, the grass is beginning to invade the area again.

Project Participants:

Local landowners, The U.S.D.A. Soil Conservation Service,, the Jefferson County Conservation District, the Washington Department of Fisheries, Department of Natural Resources - Conservation Corps., and Pope Resources.

Funding Sources and Estimated Costs:

Total project costs amounted to approximately $15,000 and were paid for by local landowners, Pope Resources, and the Jefferson County Conservation District.

Comments on Project Success:

Initial project success resulted from: 1) landowner recognition of poor land-use practices which led to excessive winter flooding - prior community awareness and education programs were implemented to address land-use and water quality issues in the area, 2) willingness of landowners to become involved in the restoration process and work in cooperation with permitting agencies, 3) use of landowner designed sediment basins

APPENDIX A

Riparian Restoration Inventory

Project name:____

Name, address, and telephone of person completing form:__________

____

Start date:__________________ **Completion:**____________________

Location: nearest town __________________, state __ __

county or region __________________:

Type of Riparian Management Program: (check one)

____A. Single structure/treatment
____B. Multiple structures/treatments
____C. Comprehensive structure/treatment/education plan

Type of Riparian Ecosystem(s) involved: (circle)

Desert, grassland, forest, tundra, valley/riverine

Watershed description:

Watershed area:________________ **Elevation:**__________________

Aspect:___________________________ **Geology:**_______________________

Topography:____

Climate:____

Annual Precipitation:________________, __ __ percent as snow

Describe watershed setting (eg. landuse, physical structures etc.)

____

____

____

Description of treatment site:

Treated area in relation to watershed: ______________________________

____

____

Stream gradient: ____________ Stream order: ______________________

Vegetation cover prior to and after treatment (type(s) and density):

____

____

____

Problem statement (cause(s) of disturbance): ______________________

____

____

____

____

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____

____

Objectives of Project: ______________________________________

____

____

____

____

Activites:

Planning (why was this project selected): ________________

____

____

____

What actions were implemented at the site (or within the drainage basin): ______________________________

Project Monitoring or Evaluation (methods, duration, etc.):

Has the project site improved and have resource/public benefits been achieved? ______________________________

Project participants (agencies, groups, etc): ______________________________

Sponsors and funding sources (agency or group):______________________

____

____

Estimated costs: ______________________________

____

Land ownership (private vs public - explain):______________________

____

____

Access restrictions due to weather or owner:______________________

____

Publications, reports, and photographs describing project (please include if available):______________________

____

Contacts:

	Name	**Name**
	Address	**Address**
	Phone	**Phone**

Please Mail completed form to:

Sean Connin
Environmental Protection Agency
W.D. 139
1200 6th Avenue
Seattle, Washington
98101
Phone (206) 553-1601

- which enabled the landowners to solve part of the problem and feel that they had a significant role in the project, and 4) continuous mutual cooperation between the landowners and personnel at the SCS.

Clover Creek Restoration Project*

Location:

The Clover Creek watershed is located several miles from Tacoma, Washington in Pierce County.

Reported By:

Clair Denise, Washington State University Cooperative Extension, 3049 South 36th St. Suite 300, Tacoma, Washington 98409., (206) 591-7180.

Watershed Setting and Description:

The Clover Creek Watershed drains a low relief grassland/riverine ecosystem through both rural and suburban environments before reaching Puget Sound. Local topography consists of post-glacial landforms underlain by glacial till. The climate is maritime with 35 inches of precipitation annually, less than 2 percent occurs as snow. The watershed has been heavily impacted by farming practices and modern development during the past fifty years. Clover Creek itself has been channelized in several places to reduce spring flood events and diverted for agricultural and municiple uses.

Problem Statement and Objectives:

Poor land-use practices associated with farming and municipal development have reduced riparian habitat along Clover Creek, increasing bank erosion, sedimentation rates, and instream temperatures while reducing valuable fish habitat. In addition, invasion of reed canary grass has reduced instream flows and accelerated sediment deposition. Other impacts include habitat loss due to channelization, intermittent flow resulting from disturbance of the stream seal (in selected areas), influx of pollutants (into the stream) from nonpoint sources and dumping of refuse within riparian areas, and diversion of flow by landowners for private use. To address these disturbances and enhance the stream ecosystem, local landowners and the Pierce County Cooperative Extension initiated the Clover Creek Restoration Project. Project objectives included: 1) reestablishing perennial flow throughout the stream basin,

2) increasing riparian habitat 3) reintroducing fish runs, 3) and increasing community awareness of stream/riparian ecosystems.

Treatments Implemented at the Site:

In 1986 concerned landowners asked the Pierce County Cooperative Extension to review impacts affecting Clover Creek and devise methods to protect and enhance the stream environment. Subsequently, the Cooperative Extension held meetings for groups concerned with the health of Clover Creek - which resulted in the Clover Creek Restoration Project. This project involved private citizens, a school science club, and numerous interest groups in an effort to restore Clover Creek by: 1) increasing public awareness (through storm drain stenciling, public meetings, and creation of a Clover Creek task Force), 2) resealing sections of the stream bottom to reestablish natural flow, 3) sandbagging heavily eroded banks - to increase bank stability, 4) fencing selected areas to limit access of livestock to the stream, 5) removing garbage and canary reed grass along the stream, 6) planting woody vegetation, and 7) developing a "no herbicide spray program" in the streams vicinity (Denise 1991).

Project Monitoring or Evaluation:

The Clover Creek Council monitors project development and has established a Clover Creek hotline to support community participation and address concerns. In addition, the Cooperative Extension continues to support restoration efforts and may monitor water quality in the future.

Final Results of Treatment:

Approximately 16 tons of refuse have been removed from riparian areas adjacent to Clover Creek. Efforts to create an artificial stream seal have reestablished perennial flows within the treatment area. Plans to reseal additional segments of the stream have been delayed due to changes in county permitting requirements. Initially, sandbagging along streambanks and riparian fencing increased bank stability and limited access of livestock to the stream, respectively. However, refusal of one local renter to prevent her horses from destroying fencing and watering at the creek have undermined these efforts. Plantings in 1990 have been unsuccessful due to poor survival rates; Spring 1991 plantings do not appear healthy and may not survive. Infestation of canary reed grass continues to alter natural stream flow. Public awareness has increased, resulting in a heightened sense of responsibility for the streams health. For instance, development is no longer permitted within 50 feet of the creek (Denise 1991).

Project Participants:

The Boy Scouts, Clover Creek Highschool Science Club, Parkland Lions Club, Pierce County Conservation District, W.S.U. Cooperative Extension, Clover Creek Council, Puget Sound Bank, Fly Fishers of Puget Sound, Department of Emergency Management, Lemay Disposal Service, and local citizens.

Funding Sources and Estimated Costs:

Project materials and labor were donated by: LeMay Disposal, the Washington Department of Fisheries, Clover Park High School Science Club, North Star Glove Co., Puget Sound Fly Fishers, Puget Sound Bank, Isaak Walton League, and the Pierce County Conservation District.

Comments on Project Success:

While several project treatments have been unsuccessful, the restoration of Clover Creek is ongoing. Community education and participation appear to be the cornerstones of project success. Strong leadership from individuals associated with the WSU Cooperative Extension and from several landowners was essential to effect project initiation and development. Continued participation by the Clover Park Highschool Science Club and the Parkland Lions Club has been important for successful project implementation and community outreach. Post-treatment upkeep by one local landowner has been necessary to prevent reinfestation of canary reed grass on her property. Unless a shoreline exemption permit can be obtained for future sealing efforts, Clover Creek will continue to flow intermittently. Similarly, greater attention to riparian plantings will be necessary to establish woody species along the creek.

Lacamas Lake Restoration Project*

Location:

The Lacamas-Round Lake Watershed is located in Clark County, Washington approximately 2 miles North of the city of Camas.

Reported By:

Allan Moore. Washington State Department of Ecology. WQFAP, M/S Pr-11 Olympia, Washington 98504-8711. (503) 459-6063

Watershed Setting and Description:

The Lacamas-Round Lake Watershed drains 42,956 acres of rural farmlands (elevations range from 182 to 2,225 feet). The combined surface area of Lacamas and Round Lake is 315 acres (Lafer 1991). Topography ranges from rolling foothills on the eastern half of the watershed to low gradient valleys on the western half. Soils consist of alluvium derived from adjacent highlands. The climate is maritime with 45 to 80 inches of precipitation annually. The watershed contains numerous dairy and hobby farms; the city of Vancouver is fast becoming a bedroom community for Portland, Oregon.

Problem Statement and Objectives:

A diagnostic water quality analysis in Lacamas and Round Lakes by the Intergovernmental Resource Center (IRC) (conducted in 1985) indicated that the lakes were hypertrophic. The primary nutrient affecting these lakes was phosphorus. Sources of phosphorus were identified as failing septic systems and agricultural operations within the Lacamas Creek drainage basin. The analysis also indicated that a watershed management plan directed at controlling those sources would be the most appropriate restoration strategy to pursue (Intergovernmental Resource Center 1990). In 1987, IRC conducted a complete watershed inventory to identify poor land-use practices on area farms and to develop BMPs to reduce the input of phosphorus (and other nutrients) from NPS sources. The IRC then completed the Lacamas Lake Restoration Plan and after receiving funds from the DOE, began to implement BMPs. Project objectives included: 1) reducing phosphorus loading in Lacamas Lake by at least 84 percent, 2) improving recreational opportunities within the lake, 3) Providing opportunities for involvement and participation in the restoration process, and 4) addressing potential health threats associated with the handling of domestic waste-water. Specific BMP goals included: 1) enhancing and protecting riparian habitat within the watershed, 2) increasing community awareness of water quality and NPS pollution issues, and 3) improving farm management practices.

Treatments Implemented at the Site:

Best Management Practices included: 1) Extensive community outreach (through public meetings, interaction between the IRC and area farmers, and quarterly newsletters), 2) development of pasture management plans for individual farms, 3) riparian fencing, 4) creation of stream crossings, 5) installation of off-site watering facilities, and 5) planting woody species in riparian zones.

Project Monitoring or Evaluation:

The IRC monitors water quality throughout the watershed and in Lacamas and Round Lakes. Maintenance of structural BMPs are the responsibility of individual landowners (for a period of 10 years) as stipulated by contract.

Final Results of Treatment:

Water quality measurements in Lacamas and Round Lakes do not suggest improvement. However, water quality in several headwater drainages has improved. Continued improvements are expected. Riparian habitats have recovered rapidly in project areas and are now providing adequate shade and bank stability. Overgrazing and access of cattle to drainages on project sites has decreased. Community awareness has increased. For instance, the local community recently established the Lacamas Lake Protection Agency (a watchdog group that provides support to the IRC).

Project Participants:

The Intergovernmental Resource Center, Clark County, City of Camas, Southwest Washington Health District, Clark County Conservation District, Washington Department of Ecology, Washington Department of Wildlife, USDA Soil Conservation Service, and individual landowners.

Funding Sources and Estimated Costs:

The Washington Department of Ecology has provided 2.2 million dollars to support the project. Approximately $855,136 has been allocated for BMP implementation. The IRC cost shares with private landowners (75 to 25 percent, respectively) to install BMPs on their property.

Comments on Project Success:

Cooperation of local landowners has been fundamental to the implementation of the Lacamas Lake Restoration Plan and use of BMPs. Community outreach and education continues to be important to this process. Interagency cooperation has enabled the IRC to obtain project permits without delay and to carry out the restoration plan effectively. A reliable funding source (ie. the DOE) allowed the IRC to work without financial constraint. Intensive water quality testing and inventorying by the IRC enabled them to accurately estimate project costs and to produce a very thorough restoration plan.

REFERENCES

Bauer. S.B. 1989. Idaho Nonpoint Source Management Program. Division of Environmental Quality, Water Quality Bureau. Boise, Idaho. p 10.

Burley/Minter Drainage Basin Water Quality Plan. 1988. Prepared by Pierce County Planning and Natural Resource Management and Kitsap County Department of Community Development. Port Orchard, Washington.

Chaney, E., Elmore W., and Platts, S. 1990. Livestock Grazing on Western Riparian Areas. Northwest Resource Information Center. Inc. Eagle, Idaho.

Chard, Jim. United States Forest Service. Burley, Idaho. Personal Communication. July 1991.

Code of Federal Regulations. 1990. Vol. 40. Sec 130.2 (m).

Curry, R.R. 1984. Water quality protection in forest management: are best management practices working? In: (Hendrix K.M. and R.E. Warner eds) California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press. Berkeley, California. pp 55-61.

Denise, Clair. W.S.U. Cooperative Extension. Everett, Washington. Personal Communication. July 1991.

Dewitt, Floyd. Bureau of Land Management. Shoshone, Idaho. Personal Communication. July 1991.

Environmental Protection Agency. 1989. "Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish.EPA 444 4-89 001.

Garitone, Joy. Kitsap County Conservation District. Port Orchard, Washington. Personal Communication. July 1991.

Gregg, Jesse. Jefferson County Soil and Water Conservation District. Madras, Oregon. Personal Communication. July 1991.

Intergovernmental Resources Center. 1990. Lacamas Lake Restoration Project: Quality Assurance Project Plan for the Water Quality Monitoring Program 1990-1995. Vancouver, Washington.

Kauffman, J.B. and W.C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications. A review. Journal of Range Management 37:430-437.

Lafer, Jeff. 1990. Lacamas Lake Restoration Project: Quality Assurance Plan for the Water Quality Monitoring Program 1990-1995. Intergovernmental Resource Center. Vancouver, Washington.

Masinton, Barbara. Bureau of Land Management. Fairbanks, Alaska. Personal Communication. June 1991.

Odum, E.P. 1971. Fundamentals of Ecology, third ed. W.B. Saunders Co., Philadelphia. Pennsylvania. 574 p.

Oregon's Watershed Enhancement Program. Program Status 1987-1990. Governor's Watershed Enhancement Board. Salem, Oregon.

Rangeland Management: Some Riparian Areas Restored But Widespread Improvement Will Be Slow. Government Accounting Office, June 1988. Report # RCED-88-105.

Rasmusen, D. 1991. Environmental Protection Agency - Region 10 Riparian Area Management Policy.

Schrader, Bill. Soil Conservation Service. Lakeview, Oregon. Personal Communication. July 1991.

Shoshone District. 1987. Pilot Management Grazing Plan. Thorn Creek.

Smart, Alan. Environmental Protection Agency - Region 10 Headquarters. Seattle, Washington. Personal Communication. June 1991.

Stevens, L.E., B.T. Brown, J.M. Simpson, and R.R. Johnson. 1977. The importance of riparian habitat to migrating birds. Pp. 156-164 In R.R. Johnson and D.A. Jones (Tech. Coord.) Importance, Preservation and Management of Riparian Habitat: A Symposium. U.S. For. Serv. Gen. Tech. Rep. RM-43. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colorado.

Swanson, F. J., S.V. Gregory, J.R. Sedell, and A.G. Capbell. 1982. Land-water interactions: the riparian zone. In: Analysis of Coniferous Forest Ecosystems in the Western United States. Hutchinson Ross Publishing Co., Stroudsburg, Pennsylvania. pp.267-291.

Thomas J.W., C. Maser, and J.E. Rodiek. 1979. Riparian zones. In: J.W. Thomas (ed.) Wildlife Habitats in Managed Forests-The Blue Mountains of Oregon and Washington. U.S. For. Serv., Pac. Northwest For. and Range Exp. Stn., Portland. Oregon.

Wildland Resources Center. 1990. Case Studies and Catalog of Watershed Projects in Western Provinces and States. Division of Agriculture and Natural Resources, University of California. Berkeley, California. Report 22.

Windell, J.T. 1983. Stream, Riparian and Wetland Ecology. University of Colorado, Boulder Colorado. Unpublished. p 51-65.