STREAM SYSTEMS TECHNOLOGY CENTER

STREAM NOTES

To Aid in Securing Favorable Conditions of Water Flows

October 1995

Artificial Stream Restoration

Money Well Spent Or An Expensive Failure?[1]

INTRODUCTION

Although artificial stream restoration for improved fisheries habitat has been in vogue for at least a century, these endeavors have been insufficiently studied, and failures and successes inadequately demonstrated (Hall and Baker 1982, Platts and Nelson 1985, Platts and Rinne 1985, Beschta and Platts 1986, Elmore and Kauffman 1994). The lack of data has occurred at a time when native fish populations are declining and political pressures (e.g., Endangered Species Act, Pacific Northwest salmon issues) are increasing to provide additional amounts of money for restoring damaged streams and preventing the extirpation of species. Although the Bonneville Power Administration (BPA), the US Forest Service (USFS), the Bureau of Land Management (BLM), and the Pacific Northwest States are spending millions of dollars annually for the improvement of salmonid habitat, this financial effort may not be providing the desired benefits.

Credible scientific, economic, and social evaluation of the various types of stream alteration projects are critically needed to guide future decisions. However, major information gaps exist because the scientific community has not evaluated the ecological effects of various types of restoration projects. In addition, economic evaluations of the benefits resulting from project costs are of critical importance yet have received little attention (Reeves and Roelofs 1982). Although the research necessary to implement successful rehabilitation of riparian-stream environments is in its infancy, Everest et al. (1991) have alerted the fisheries profession and other natural resources managers that estimates of cost-effectiveness and total biological benefits are needed to help set priorities for future habitat alteration projects. Furthermore, it is possible that many previous "restoration" or "enhancement" projects have actually resulted in further degradation of the ecological functions of streams (e.g., Beschta et al. 1992, Kauffman et al. 1993).

[1] This article contains portions of a paper originally presented at the 1994 Universities Council on Water Resources Symposium, "Environmental Restoration."
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STREAM NOTES *is produced quarterly by the Stream Systems Technology Center, Fort Collins, Colorado.*

The PRIMARY AIM *is to exchange technical ideas and transfer technology among scientists working with wildland stream systems.*

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IN THIS ISSUE

- **Artificial Stream Restoration - Money Well Spent or an Expensive Failure?**
- Historical Setting
- Habitat Modification in an Ecological Setting
- What Works and What Needs Fixing
- Conclusions and Recommendations

In this paper, we discuss the historic and present status of stream restoration in the western United States. Most of these projects were undertaken with the express purpose of improving or enhancing fisheries habitat. Case histories with a sufficient data base or study intensity to develop a better understanding of their effects are reviewed although detailed statistical evacuations are not included. Our objective is to provide improved insights to project decision makers for reevaluating whether expenditures have achieved desired results.

HISTORICAL SETTING

During most of this century, the desire to provide sport fishing opportunities through artificial stream restoration experienced a series of fits and starts (Hunter 1991). By the 1930s, professionals and lay people were deep in modifying streams and their banks. H.S. Davis, Chief of the U.S. Bureau of Fisheries, commented in the 1930s that "...hardly a foot of stream has been left in its original condition... Of what benefit to a stream is it to construct cover (artificial) for many times the number of fish the stream (food resources) can support?" Seventy years ago, biologists were pointing out that money and time spent does not equal products received (Hunter 1991). Those critics, were largely ignored by the fisheries profession as evidenced by the large stream repair projects that followed over the next 70 years. Because only a small fraction of the tools and ecological knowledge of stream systems known today was at their disposal, it's understandable why fisheries specialists in the 1930s were enthralled by the concept that people could construct a better stream. They believed they were breaking new ground (Hunter 1991). However, given our current knowledge-base, it is ironic that many fisheries biologists and other natural resources specialists continue to subscribe to the idea that the physical alteration of a stream provides a simple mechanism for improved or restored habitat conditions.

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In 1952 the US Forest Service published its first major handbook on improving stream habitat (USDA Forest Service 1952). A second major handbook followed in 1985 (Seehorn 1995). This cook-book approach to habitat management admitted that many mistakes had happened in the past but it also concluded that much has been learned (Hunter 1991). The manual, however, did not dwell on what those past mistakes were or what had been learned. In 1992, the USFS published its latest Stream Habitat Improvement Handbook (Seehorn 1992) which superseded the 1985 version. The 1992 handbook provided an excellent primer on how to be a "water carpenter." However, the manual did not expand on anything learned from past modes of operation and there was nothing in the manual regarding the effectiveness of past projects or benefit cost ratios to be expected. The manual identified a large number of instream projects but little understanding or background on whether these proposed practices actually provided any benefits or how to consider proposed habitat alterations within the ecologic and geomorphic context of a particular stream reach or watershed. Similar comments apply to a stream rehabilitation manual presented by House et al. (1988).

White and Brynildson (1967) moved the understanding of stream restoration forward with their 1967 trout management manual. Perhaps their most important conclusion was "if a stream is already in good shape leave it alone." They emphasized that remaining unspoiled waters were highly valuable, and the main stream management effort today was to guarantee their preservation for the future. White and Brynildson (1967) were one of the first to emphasize that vegetation should be managed first before implanting hard structures such as dams, deflectors, and rip-rap.

HABITAT MODIFICATION IN AN ECOLOGICAL SETTING

The desire to artificially alter instream fish habitat has resulted from a variety of reasons. In many instances, stream habitat degradation has proceeded to the point where one or more limiting factors, such as high water temperatures, excess fine sediment, lack of pools, insufficient cover, limited allochthonous inputs have contributed to declines in fish populations. Once limiting factors have been delineated, an in-channel habitat alteration project is often developed. Such alterations have occurred even if the limiting factors are unrelated to inchannel problems (i.e., the loss of cover and streambank stability due to livestock grazing, logging, agricultural practices, etc.). The focus of these projects is usually directed toward **in-channel alterations** for a variety of reasons including:

- An inadequate understanding of riparian/stream ecosystems (e.g., many stream biologists may not understand the ecological functions of streamside vegetation or the natural disturbance patterns that shape both channels and an array of habitat features)
- Political purposes (e.g., it is socially or politically unacceptable to change ongoing land use practices that are causing degradation)
- Limitations of project funding (e.g., the available money can only be spent on instream habitat features and not on improving stewardship of riparian systems)
- Management styles that emphasize quantifiable project results (e.g., building a specific number of structures during the fiscal year can have a much higher priority for many resource managers than improved stewardship decisions)
- A focus on structure and not process (e.g., blindly accepting the concept that one can never add too much large woody debris to a stream while totally ignoring those factors limiting or reducing the natural recruitment of large wood debris)
- The desire to create a better system than can occur naturally by simplistic alteration of a specific habitat feature (e.g., adding large wood, boulders, spawning gravels in areas where non naturally exist)
- A belief based on an inadequate understanding of the complexity of riparian/stream interactions that structures can mitigate for management practices that degrade riparian/aquatic habitats (e.g., structures are installed while allowing the continuation of abusive grazing, logging, or other land use practices)
- Land ownership (e.g., while water and fish are usually considered public resources, the land on either side of the channel may be in private ownership and thus the permission and cooperation of landowners is required for out-of-channel restoration efforts)
- A reductionist perspective of how to manage stream ecosystems (e.g., altering the in-channel environment can be perceived as a simplistic cause-and-effect approach with definite beneficial outcomes whereas ecosystem management may be a more difficult concept to apply because there are often multiple and indirect causes-and-effects interacting over time and space)

Because of these often overriding political, social, institutional, economic, and technical limitations, most habitat alteration projects focus on activities that can be undertaken within the active channel (i.e., between streambanks). And by doing so, they perpetuate and reinforce a “channel vision” perspective. In contrast to an ecosystem perspective, a channel approach tends to focus solely on physical habitat components and has dominated stream habitat projects for decades.

Streambanks and channels that have been “hardened” by structural additions can lose their capability to respond and dampen the continually changing flow and sediment regimes of natural stream systems. Conversely, when channel changes occur after structural treatments have been applied, the effects to stream systems, channel morphology, soils, and vegetation can be substan-

tial (Frizzell and Nawa 1992). A dramatic example of such changes occurred in Meadow Creek, a tributary to the Grand Ronde River in eastern Oregon, after large amounts of large woody debris were added to a reach that had been previously impacted by logging and long-term grazing. During a large flow event, the majority of these structures were displaced downstream and contributed to a major loss of riparian soils and redistribution of stream gravels (Beschta et al. 1992). While vegetation recovery has been encouraging following the high flow event and the cessation of grazing, the loss of riparian soils may affect the ultimate capability of this riparian/aquatic system to recover.

Many structural features are placed in stream systems where they are geomorphically inappropriate (e.g., the use of boulder or wood in stream systems where such materials never occurred naturally). In other instances, the use of gabions, tires, geotexile fabrics, or other foreign materials have been used. It is ironic that foreign or artificial habitats are being implemented to save wild or native fish populations.

> "Pouring time and money into a degraded stream that is continuously perturbed by human land use activities is not only futile, but it raises false public expectations that aquatic conditions will be improving."

Ecosystem management concepts are increasingly being discussed and implemented with regard to a wide range of forest land and animal species, including aquatic components (FEMAT 1993). However, these concepts have not been incorporated in the vast majority of stream improvement or restoration projects. Similarly, ecosystem approaches to the management of rangeland, agricultural, and urban stream systems are not prevalent at present.

CASE HISTORIES

The original paper includes 7 pages summarizing the results of studies and recent field reviews of fisheries enhancement and restoration projects including Oregon streams (Fish Creek, the Grand Ronde and John Day River basins, Fifteenmile Creek, and Trout Creek Basins), Idaho structural activities (natural barrier removal, riparian revegetation and sediment reduction, instream structures, and off-channel developments), Utah (Big Creek), Arizona, New Mexico, and California (Mono Basin streams). Refer to the original paper for complete details.

WHAT WORKS AND WHAT NEEDS FIXING

Increasingly, the realization is developing in the scientific community that complex ecosystems and associated habitat features cannot be achieved via the simple and artificial manipulation of selected components. For example, the habitat deficiencies associated with low numbers of pools in a stream cannot be simply satisfied by digging more pools. Instead, the functional attributes of the entire system need to be reestablished along with the appropriate physical, chemical, and biological processes. Thus, habitat restoration "..is a holistic process not achieved through the isolated manipulation of individual elements" (National Research Council 1992). Furthermore, the objective of restoration "..is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs" (National Research Council 1992). Herein lies a basic conflict associated with most structural programs of habitat alteration. Structural approaches usually have short-term objectives (i.e., stabilize a streambank or create a pool) but fall far short of the long-term ecological requirements of habitat restoration. Structures often do not create features associated with intact riparian plan communities.

An ecological view of habitat restoration requires not only a long-term perspective, but a comprehensive understanding of riparian/aquatic systems. Such concepts as hydrogeomorphic distur-

bance patterns, patterns of vegetation establishment and succession, use of reference sites, and an understanding of land use history are generally needed to assist in identifying restoration needs. Perhaps even more importantly, without the removal or significant reduction of anthropogenic activities that are currently having adverse impacts to riparian/aquatic ecosystems, the restoration of aquatic habitats for fisheries and other organisms cannot be expected.

Many studies and field reviews of fisheries enhancement projects (refer to the original paper for details) echo several common themes.

CONCLUSIONS AND RECOMMENDATIONS

- The removal or elimination of land use activities that cause adverse impacts to riparian and aquatic ecosystems are of the highest priority if restoration is to be accomplished.
- Abusive land use practices cannot be mitigated by structural additions or modifications to stream channels.
- The restoration of healthy riparian vegetation is a necessary requirement for improving a wide range of riparian functions and aquatic habitats; such restoration requires that the dynamic processes of establishment, growth, and succession of riparian plant communities be allowed to occur.
- Natural disturbance patterns and processes (e.g., high flows and sediment transport) are an important component of riparian/aquatic ecosystems; they interact in non-deterministic ways with vegetation and channel morphology during the restoration of functional riparian/aquatic systems and habitats.
- Ecological recovery and improvement requires time for the influence and functions of riparian vegetation to be expressed in conjunction with natural disturbance regimes, thus restoration requires a long-term perspective.
- Projects which relied on the use of instream structures often severed ecological linkages between terrestrial, riparian and aquatic ecosystems; because of their size and permanence, many of these structures will cause a long-term shift in channel morphology and loss of instream functions.
- Even though major enhancement programs have been underway for 10 years or more, rigorous monitoring or evacuation has seldom been initiated or accomplished, thus their biological importance for improving or sustaining fisheries productivity has seldom been documented.
- Existing monitoring of fish population trends has not provided evidence that structural approaches to improving fish habitat are attaining desired goals.
- The use of non-natural materials (e.g., goetextiles) should be eliminated from instream projects directed at improving or enhancing the habitats of wild or native fishes.

Restoration of aquatic habitats is obviously a critical need for streams throughout the American West. However, efforts should focus on those streams in which the potential to return to a near natural state is possible (Platts and Rinne 1985). Furthermore, artificial stream enhancement cannot be utilized to circumvent the causations of stream degradation. In other words, artificial structures are not a suitable alternative or mitigating factor to land use activities which degrade riparian ecosystems. If abusive land use practices are creating habitat degradation, the alteration or elimination of those practices should be undertaken with a sense of urgency. This is clearly the first and most important step in riparian/aquatic restoration (Figure 1). Pouring time and money into a degraded stream that is continuously perturbed by human land use activities is not only futile, but it raises false public expectations that aquatic conditions will be improving.

The rationale behind many stream habitat projects appears to parallel that of trout-stocking programs. These expensive put-

and-take operations have facilitated a fishing experience by the public, even in extremely degraded streams. Unfortunately, put-and-take stocking programs thus become a substitute for good land and water stewardship at the expense of native fisheries and the inherent biological diversity of western riparian/stream ecosystems. Artificial stream restoration must never substitute for a vigorous, responsible stewardship of riparian systems and their surrounding watershed.

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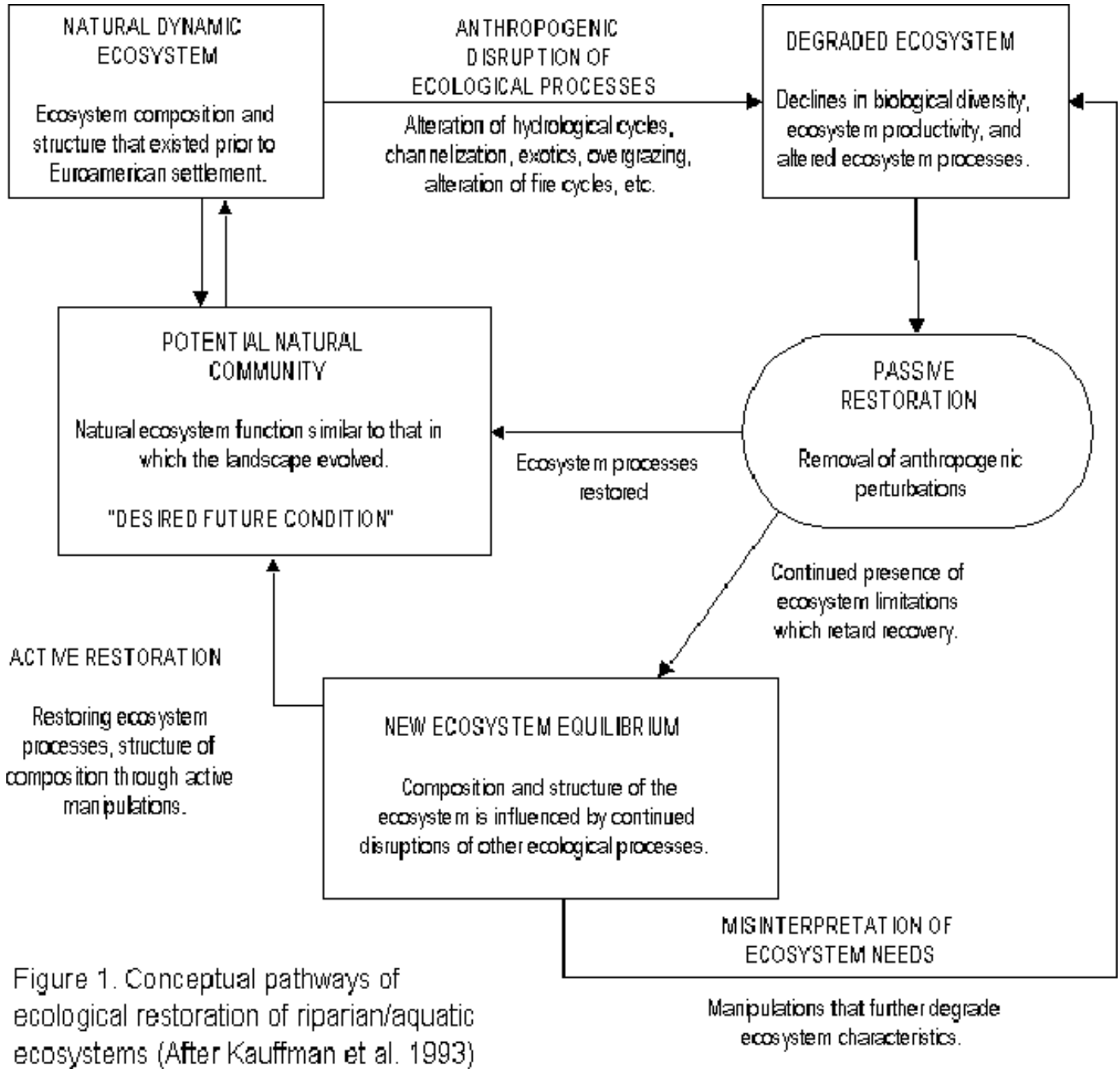

Figure 1. Conceptual pathways of ecological restoration of riparian/aquatic ecosystems (After Kauffman et al. 1993)

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Stream Systems Technology Center Receives Award

Larry J. Schmidt, Program Manager of the Stream Systems Technology Center, accepted a Merit Award from the Soil and Water Conservation Society at their 50th Annual Meeting in Des Moines, Iowa on August 8, 1995. The merit award recognized the STREAM TEAM for its influence in supporting studies, developing partnerships with university scientists throughout the country, and developing new procedures which provide guidance to land managers in stream channel and related ecosystem processes. The Soil and Water Conservation Society commended the Center for bringing needed focus to the stewardship of streams and adjacent riparian areas.

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IN THIS ISSUE

- **Zig-zag Pebble Count Procedure**
- **Geomorphic Risk Assessment**
- **Ask Doc Hydro — Boils in Rivers**
- **Reducing Tire Pressures Decreases Sediment**
- **Fluvial Processes in Geomorphology**