18. Restoration of Puget Sound Rivers: Do We Know How to Do It?

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> A woodsman riding through the woods spots a herd of pigs rooting for acorns beneath an oak tree. The woodsman notices that the pigs have unearthed and damaged the roots of the oak tree. He warns the pigs "Be careful, you are killing the tree." The pigs reply, "We don't care about the tree, we only care about the acorns."

As is so common in scientific endeavors, the answer to the title question is "it depends." It depends on what we mean by restoration and whether that goal is even attainable for the river and the watershed under consideration. If the goal *is* attainable, then it further depends on the chosen approach; on who undertakes the project; on how certain we wish to be that we will be successful on the first attempt; and on how soon we expect results.

Fish are often regarded as the target for river restoration, but focusing on fish disregards the necessary role of the ecological processes that sustain the fishery and often results in neglecting the role of the processes that sustain the system (Tockner and Schiemer 1997). Single-interest "restoration," especially those that focus only on fish, may appear to provide local improvements to habitat structure but are likely to prove unsustainable (Boon 1998).

For at least a decade, calls have been made for addressing causes and not symptoms, assessing watersheds as a whole before beginning restoration projects, restoring ecosystem processes, and using monitoring to learn and improve on what we do (e.g., Stanford and Ward 1992; Ziemer 1996; Frissel 1997). Yet widespread, on-the-ground implementation of these ideas has not taken hold. The difficulties of implementation are many, but the costs of continuing with uncoordinated "restoration" projects are huge.

Humans depend on a wide range of natural goods and services provided by the structure, function, diversity, and dynamics of ecosystems (Wyant et al. 1995). Inordinate focus on single species can blind us to our dependence upon intact ecosystems and the goods and services they provide. Despite calls for ecosystem or watershed restoration, rather than single-species restoration, some in the region call for more explicit proof that restoration actions increase salmon productivity. If this means continuing to do research to understand ecosystem processes more completely, then it serves as a valuable reminder to continue learning more about our systems. If it used as an excuse to delay implementing the required changes in institutions and society that are needed to restore aquatic ecosystems, then it is a policy and value statement masquerading as science.

IMPLEMENTING RIVER RESTORATION

This volume brings together current thinking and methodologies for river and watershed restoration developed for the Puget Sound region. Several messages are repeated throughout various chapters in this volume: integrate ecological knowledge into design and monitoring of projects, restore ecosystem processes and not individual species, and have clear and measurable objectives. In 1992, Naiman et al. (1992) identified five factors that define the fundamental elements of ecologically healthy watersheds in the Pacific Northwest: geology, hydrology, water quality, riparian forests, and habitat features. These factors have been expanded on here to bring the current knowledge of watershed processes and river restoration together in one place for use by scientists, managers, and policy makers. The methodologies can be used in any watershed in any region, but in this volume we have used local information to provide a template for local restoration.

The answers to several questions should guide any approach to restoration, and they will determine the likelihood of success.

What Is the Physical Template Upon which Restoration Will Take Place?

Booth et al. (Chapter 2) reminds us of the complex effects of recent glaciation on the region and of the importance of this glacial legacy on evaluating the effects of human actions on contemporary channel processes and conditions. For example, the use of geologic maps can help locate areas of low versus high soil permeability (high infiltration) and areas where groundwater influences are more or less likely to occur. Buffington et al. (Chapter 3) describe the

range of fluvial processes that are encountered in Puget Sound. They address how the type and setting of a channel set bounds on channel characteristics, and they show how these constraints can help in developing restoration objectives for specific channel reaches. The unique functions of woody debris in the forested and once-forested rivers and streams of the Pacific Northwest (Chapters 10 and 14) are particularly important in these assessments and subsequent actions.

Is the Watershed Urbanized, Agricultural, or Forested?

The mix of land use in a watershed will affect the extent to which restoration versus rehabilitation can be realized. Urban streams are limited to rehabilitation, because project approaches and goals will be constrained by concerns for human and infrastructure safety. Unless the changes in flow regime caused by urbanization can be corrected, the highest goal of urban stream rehabilitation is probably to provide sustainable habitat under the new flow regime (Chapter 11). Agricultural lands in Puget Sound are largely located on lowland areas adjacent to large rivers and have also been substantially modified (Chapters 4 and 10). Basin-by-basin identification of current stream conditions, critical fish habitat, and changes in habitat availability over time will help guide stream and habitat improvement in these areas (Chapter 8). Forestry has altered the structure of regional forests, which in turn has changed many aspects of watershed processes. Much of the past regulatory effort for protecting aquatic systems has focused on forestry (Chapter 1). Other than national parks and wilderness, however, forestry is also the land use that retains the landscape most similar to its original state. Compared to agricultural and urban settings, more habitat-forming processes are intact in forested areas, and so restoration is much more feasible here.

Is the River Being Restored Large or Small?

Due to the extensive channel migration that large rivers typically exhibit in their natural state, extensive restoration is much less common on large rivers, and mostly local rehabilitation projects are undertaken. Most restoration and rehabilitation projects have taken place on smaller streams and rivers, and therefore more information exists for these types of sites (Gore and Shields 1995).

This dichotomy is evident in this region's practice. In Puget Sound, many projects on small streams are completed or underway (Chapter 15), but the number of projects on large rivers is much smaller (Chapters 16 and 17). On

small streams, direct intervention and establishment of riparian buffers may substantially address restoration concerns, and the level of engineering design is relatively low compared to that needed on large rivers.

Is There a Thorough Watershed Assessment that Identifies Historic and Current Habitat-Forming Processes and Fish Distribution?

Without knowing what condition our watersheds are in, we cannot formulate how to improve them. Information on historic and current conditions including vegetation and fish distribution can be used to identify priorities for restoration and rehabilitation. Methodologies have been developed that can be widely applied to acquire this information (Chapters 4, 5, and 8). The current state of our rivers and streams, and of their associated fauna, is the result of more than a century of human activity; it will take time to recover some of the lost ecosystem functions.

Has a Monitoring Plan Been Developed in Concert with the Planned Restoration Action?

Given the complex and dynamic nature of stream ecosystems and the added complexity of salmon anadromy, all stream enhancement projects are experiments. Acknowledging the experimental nature of restoration actions allows us to learn from our actions and improve on them in the future (Chapter 9). Without having measurable objectives (i.e., quantifiable outcomes, such as 100 m^2 of spawning area instead of 'improve habitat quality'), we cannot rigorously evaluate the effectiveness of our efforts. Miller and Skidmore (Chapter 13) describe ways to improve project designs and implementation through the development and standardization of design criteria. Using measurable performance criteria in project design, rather than prescriptive criteria, should allow innovations in restoration to continue. Roni et al. (Chapter 12) describes methods that may allow us to evaluate projects that were not initially implemented with such criteria in mind, or indeed with any monitoring component at all. "Adaptive management" is the rubric under which such monitoring falls, but many have questioned its implementation to date (e.g., Fischer 1990; Moir and Block 2001). Ralph and Poole (Chapter 9) make a case for reviving the original meaning of this term and for integrating monitoring into a project before its implementation, not afterwards.

Lessons from Past Experiences

"Resource problems are not really environmental problems," but rather they are *human* problems that have been created at many times in many places under a variety of political, social, and economic systems (Ludwig et al. 1993). Yet the history of fisheries management does not bode well for recovery efforts based on voluntary behavior and unenforced regulations (Chapter 1). However, government cannot do it all. There are many conflicting social needs and demands (Chapter 7), and individuals must take an active role for restoration to be successful (Chapter 6). Moreover, solutions to many of society's most pressing resource and restoration issues (e.g., population growth, over-consumption, endangered species, and pollution) are more social than technical in nature (Wood et al. 1997).

It is wise to remember that all decisions and actions are based on facts (science) *and* values (ethics). This may not appear to be the case in routine natural resource management decisions, because the values are widely shared and go unnoticed. When a new way of resource allocation or management is suggested, however, it is often labeled as an ethic (value judgement) and then dismissed as insubstantial or a matter of opinion (Callicott 1991). For example, the National Research Council (1996) identified a number of outmoded institutions that control water and water rights, including subsidized federal reclamation projects, whose special interests are not always the same as the larger public interests (Johnson 1989). Deciding whose interests take priority in policy changes, or choosing to implement restoration actions that often result in gains for some and losses for others, cannot be resolved by science alone (Chapter 6).

Popular and political support for cleaning up environmental catastrophes such as the Exxon Valdez oil spill is generally easier to rally than support for long-term chronic degradation of watersheds and local species (Wood et al. 1997). In the Pacific Northwest, however, we do have a rich opportunity to accomplish restoration. The combination of cultural, economic, and ecological value of salmon creates a setting for restoration that is broadly supported. Many tribal cultures and livelihoods rely on salmon; commercial and recreational fisheries depend on salmon; aquatic and terrestrial organisms use salmon carcasses and their decomposition products for food. There are few, if any, other places where an ESA-listed species can generate support across such a diverse group of interests. That does not mean conflicts do not exist—they do. But if river restoration in concert with recovery of salmon cannot happen here, where can it?

TIME TO ACT

We have a good, basic understanding of the ecological processes in aquatic systems, and we know enough to be acting effectively now. Five years ago, the National Research Council stated that "Because habitat loss is widely acknowledged to have contributed to the decline of virtually every species of Pacific salmon in western North America (Nehlsen et al. 1991), the lack of precise knowledge of relationships between various types of habitat change and salmon populations need not be a barrier to improved environmental management" (NRC 1996, pp. 165-166).

The template for recovery is well described for Puget Sound. The preceding chapters bring together a suite of information that is directly relevant to Puget Sound river and stream restoration efforts. It is clear that we don't know everything, but it is equally clear that we know enough to make progress. Many enhancement options exist, ranging from preservation of existing systems that are still intact, to better methods of re-establishing floodplain forests, to "habitat-friendlier" bank stabilization. Key to all methods used to restore or to rehabilitate our streams and rivers, and the species that depend on them, is to identify current and former conditions in the watershed wherever possible; to focus on addressing the causes of stream degradation and not just the symptoms; to move the system in the direction of being more self-sustaining; and to integrate monitoring into the design and implementation of restoration actions.

Our hope is that the time is right to finally incorporate current scientific thinking into restoration actions. Much of what we call for has been called for before (e.g., NRC 1996, 1999; Williams et al. 1997), but only in a few select locations has the vision been fully implemented. To date, that has largely *not* happened here.

Yet restoration must be undertaken with humility; precise future trajectories of complex natural systems are impossible to predict (McQuillan 1998). The unbridled technological optimism of the nineteenth and twentieth centuries did not solve ecological problems. As Angermeier (1997) notes, technological fixes often lead to unanticipated ecological damage even as they sustain the myth that technology can solve complex ecological problems. Thus a better question about restoration than "Do we know how to do it?" may be "Will we try our best to do it?" And if not here, where? And if not now, when?

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