MAKING AMENDS

South Florida Water Management District

South Florida Water Management District

Ecological Restoration in the United States

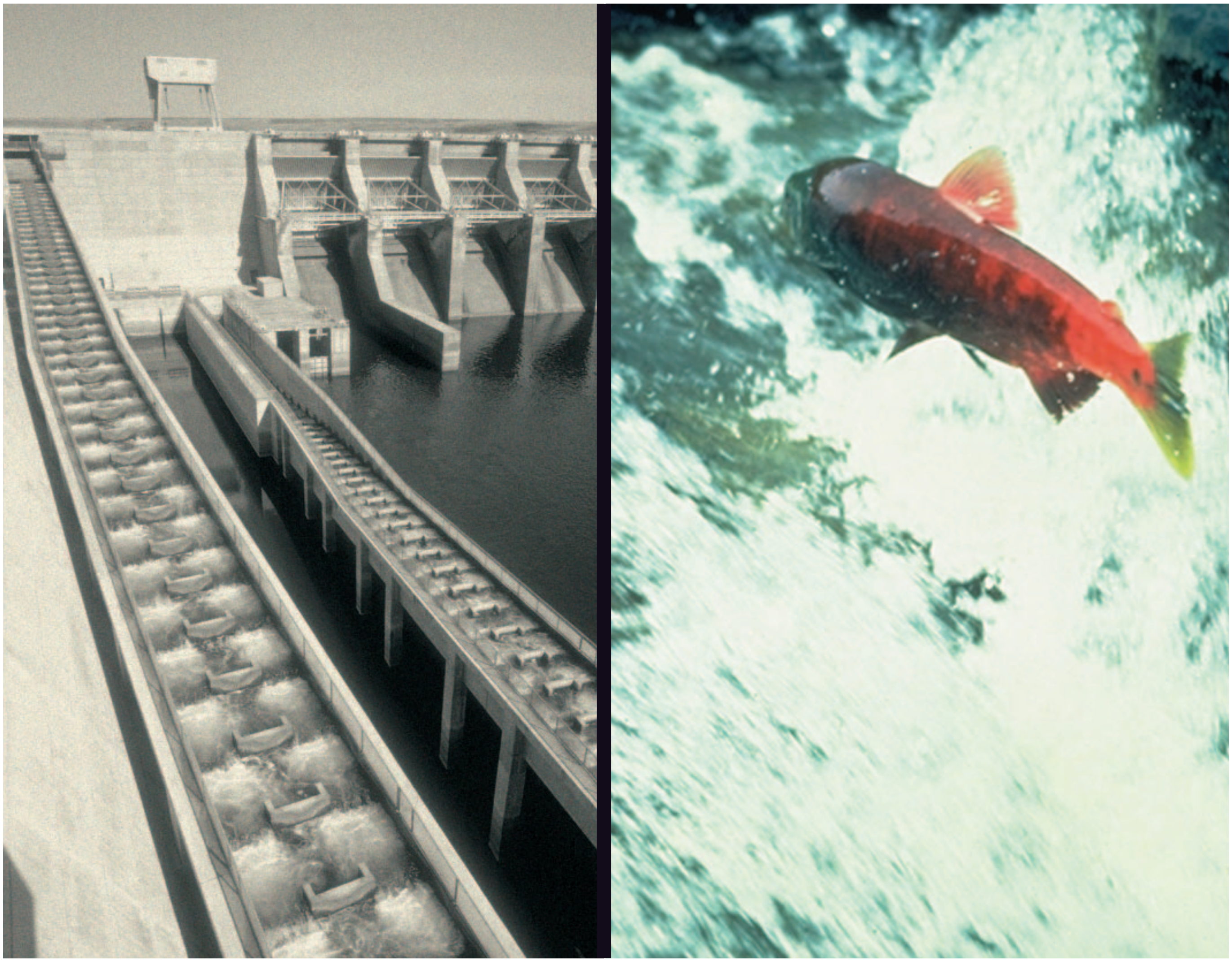
It's a daunting task to build new interpretations of lost or degraded ecosystems. The great majority of restoration projects put a high priority on the biological requirements of endangered species, often drawing ecologists into intricate political controversies and negotiations among environmentalists, private landowners, industry, and agriculture. Meanwhile, resource managers struggle to gain enough information about historical ecosystems to reconstruct them successfully. There are often difficult judgment calls when scientists try to redesign something that has been degraded over many generations. And some critics argue that restorationists put wildlife interests before those of humans, sparking conflicts over how resources should be used.

Turning back the clock. Extensive reworking of the Everglades ecosystem, including cutting down sawgrass to speed water flow in the 1960s (left top) has left wildlife such as these whooping cranes (left bottom) struggling—with little success—to adapt to their new environment. Today's restoration efforts include reverting the channelized Kissimmee River (right top, in 1965) to its original state (right bottom, in 1961).

But perhaps the greatest problem of restoring ecosystems is that, once modern society has dramatically altered an ecosystem—for instance, by damming a river to provide hydropower—it can be difficult to restore that ecosystem successfully, partly because so many people rely economically on its altered state. Asking local residents to sacrifice their pocketbooks to restore an ecosystem is often a tough political sell. And the more people who are asked to sacrifice, the more complex restoration becomes. The science of restoring ecosystems is demanding, but any restoration on a large scale is also a social, economic, historical, and cultural process. A grand-scale ecological restoration has to address the economic demands of virtually every kind of interest group that uses that ecosystem. Government agencies lead most large-scale restorations, but those agencies must first have widespread political support from people who rely on the ecosystems. Consequently, successful large restoration projects are often half measures; like most new laws or regulations, they are the results of compromises and negotiations. Turning back an ecosystem's clock to a preindustrial era can therefore be very difficult or impossible.

Although the process of ecological restoration puts a high priority on wildlife habitat requirements, human needs also must be factored into the equation of any restoration project, notes Dave Egan, co-editor of the journal *Ecological Restoration* and of a soon-to-be-published book titled *The Historical Ecology Handbook: A Restorationist's Guide to Reference Ecosystems*. "There are people who want to recreate what some might call 'pristine environments' and separate those areas from the rest of the world," he says. "But the human element must also be considered when doing a restoration project: how much wealth or human effort is needed to restore and maintain a particular ecosystem over time? Restorationists are not trying to take humans out of ecosystems, but rather are offering the act of restoration as a way for people to recognize their proper role in the ecosystems they inhabit."

Large-scale restoration projects usually require public funds and widespread voter support. To be successful, restoration projects must address the history of the ecosystem. "The goal of a restoration project should be to return an ecosystem to predisturbance conditions that reflect its historic



U.S. Army Corps of Engineers

U.S. Fish and Wildlife Service

An upstream battle. Fish ladders such as that found at the Ice Harbor Dam on Washington State's Snake River (left) are designed to help salmon (right) reach their ancestral spawning grounds. Despite such efforts, however, many anadromous fish populations continue to decline. Today, the government is considering tearing down dams like the Ice Harbor to help restore populations of endangered fish species.

range of variability," says Egan. "When restorationists bring history and science together, they produce valuable information about how an ecosystem operated in the past and what it will take to restore it, given the current conditions. They also develop a powerful tool for building community participation and support. To implement and sustain a meaningful ecological restoration, you must have community support; otherwise, over the long run, it's all for naught."

It's often confusing to decide which period of history to restore an ecosystem to. That is, how far back should ecologists look for historical models? They can't go back too far. Researchers, for example, couldn't recreate the state of nature that existed about 15,000 years ago because it would be impossible, for example, to bring back the long-extinct saber-toothed cats and mammoths that lived in those days.

In the United States, restorationists aim to rebuild habitats that existed before Europeans arrived in North America. (This is in contrast to Western Europe, where efforts generally attempt to reinstate conditions that were prevalent some 50–100 years ago.) After 1500, Europeans brought in exotic plants (such as wheat), animals (such as cattle), and microorganisms (such as the virus that causes smallpox) that transformed the landscape. Other factors have also helped change the environment. Modern agriculture, for instance, involves widespread draining of wetlands and other alterations of natural processes, intensive forestry includes clear-cutting entire forests, and urban development includes pollution from industry as well as habitat alteration from suburban sprawl.

To find a model ecosystem, scientists study the history and biology of a particular place for clues about the period in which human society most dramatically altered a landscape's ecology. Restorers then try to recreate the environment that existed before the great disruption. Once restorers know which environment they want to revive, then they must try to recreate forests or wetlands that were transformed long ago. But as the physical climate changes and as people dramatically alter the landscape, plant and animal life change, too. As ecosystems change, species migrate or die out in certain areas. So an ecosystem that once thrived in a particular location might not be able to survive intact today.

Florida Everglades

In south Florida, government agencies have proposed the largest and most expensive ecological restoration ever attempted—repairing the entire south Florida Everglades ecosystem and adjacent Florida Bay at a cost of $7.8 billion. The project, drawn up by the U.S. Army Corps of Engineers (USACE), calls for a 20-year overhaul of south Florida's water management system, affecting a massive network of swamps, forests, and estuaries.

When scientists began studying restoration of the Everglades, they tried to understand the ecosystems encountered by the first European settlers in the late nineteenth century. Until Europeans arrived, south Florida was a subtropical wilderness dominated by one of the largest wetlands in the continental United States—the Everglades. The Everglades was part of the Kissimmee–Okeechobee–Everglades watershed that covered the southern half of the Florida peninsula. The Kissimmee River system flowed south into Lake Okeechobee, the second largest freshwater lake wholly in the United States, providing fresh water for the Everglades, which was once a shallow sheet of water 100 kilometers wide moving slowly but steadily to Florida Bay.

Starting in the early 1880s, settlers began draining portions of the Everglades for farms. Since then, more than half of the wetlands system has been converted to farms and urban development. But in the 1920s, two massive hurricanes caused extensive flooding, killing some 2,100–2,800 people. To prevent further loss of life, President Herbert Hoover approved a bond issue for the USACE to build levees around the northern and southern portions of Lake Okeechobee. In the late 1940s, after two more catastrophic hurricanes, Congress ordered the USACE to drain half a million acres south of Lake Okeechobee with a vast network of levees, canals, and pumping stations. These structures channeled floodwaters away from the rapidly developing eastern shore of Florida. They also supplied drinking water to growing cities, and the drained wetlands provided rich agricultural land for the state's sugarcane industry and for cattle and winter vegetables.

The massive flood control system has also blocked the flow of fresh water south from the lake, choking off the top part of the watershed from the bottom part, so the Everglades has become much dryer. This system diverts 1.7 billion gallons of fresh water daily into coastal estuaries to the east and west, which have had their salt balance disturbed, disrupting estuarine systems.

As agriculture and urbanization have intruded upon the Everglades, this ecosystem has shrunk by more than half over the past 120 years. Populations of wading birds have dropped by more than 90% since the turn of the century. Sixty-eight wildlife species in the Everglades have been designated endangered by the U.S. Fish and Wildlife Service. Meanwhile, south Florida's human population keeps growing. Six million people now live in the region, and this figure is expected to double over the next 50 years.

As the Everglades became increasingly degraded, there were calls to rescue it. In 1992, Congress authorized the Central and Southern Florida Comprehensive Review Study (the "Restudy"), which was begun by the USACE in 1993. The Restudy was designed to review the water management system within the Everglades. Then, in 1994, the state of Florida passed the Everglades Forever Act, which primarily deals with water quality issues, and established a planning process to restore the publicly owned lands of the Everglades. The USACE and the South Florida Water Management District became partners in the effort. For the past six years, federal and state agencies have been pursuing smaller steps in the process of restoring the Everglades through memorandums of agreement with the local water management district and local municipalities, says Jacquelyn Griffin, chief of public affairs for the USACE Jacksonville [Florida] District. On 1 July 1999, the USACE sent a comprehensive Everglades restoration plan to Congress outlining the $7.8 billion project. The federal government and the state of Florida would split the cost. Congress has not authorized funding for the plan yet. But on 16 May 2000, Florida governor Jeb Bush signed a landmark bill committing $2 billion to the planned restoration, enough to launch the project. Bush also signed into law a new $38.5 million program aimed at starting a cleanup of Lake Okeechobee. The program will buy land and build large reservoirs and marshes for cleaning agricultural runoff from farms.

To restore the Everglades, USACE engineers, in partnership with the South Florida Water Management District, would have to build dozens of giant reservoirs to store water that today gets flushed into the ocean. The two agencies would have to revamp and relocate the canals and dikes to route water flow southward through the Everglades. The agencies would also need to build artificial marshes to filter pollution from cities and farms. Land would have to be purchased for buffer zones between the Everglades and farms and cities. Overall, the USACE's plan would replumb the watershed's system, reconnecting it from the Kissimmee basin above Lake Okeechobee through Florida Bay at the southern end of the Everglades.

In each stage of the restoration, the project must also address a complex set of water demands from agriculture, booming cities, and wildlife agencies. Even if water that is now flushed into the ocean can be recaptured, there will be ongoing conflicts over how to use the water. Resource managers will have to find ways to manage flood control for the region, provide drinking water for urban areas and irrigation for farms, and reestablish enough water flow to replenish the Everglades, according to Benjamin F. McPherson, a supervisory hydrologist with the U.S. Geological Survey.

McPherson is an investigator for the South Florida Ecosystem Program, an intergovernmental effort to establish a scientific basis for resource decision making in the region. The program provides multidisciplinary hydrologic, cartographic, and geologic data for the entire watershed. One of the program's tasks is to learn about the hydrologic conditions of south Florida in the 1880s—just before modern Americans began to drain the vast swamps. "We're attempting to understand what the water levels and flows were like in predevelopment days so those conditions could be restored in the conservation areas and public lands in the region," says McPherson.

River Restoration

On the other side of the North American continent, attempts to restore four rivers in the Pacific Northwest have turned into a nightmare for the region's resource managers. Federal agencies are enmeshed in a dispute over whether to take down four huge hydroelectric dams on the Snake River, the largest tributary of the Columbia River, to restore salmon and steelhead migration through Washington State into Idaho. (None of these dams are used for flood control.) It would cost $1 billion to remove the Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams, which date from the 1960s and 1970s.

The dams helped to cause the extinction of the coho salmon and to bring 25 other species of salmon and steelhead to the edge of extinction, reducing populations by 90%, according to American Rivers, an advocacy organization based in Washington, DC. The Snake River was at the top of American Rivers' listing of the most endangered rivers in the United States for the year 2000.

The problem goes back a long way. Beginning in the nineteenth century, the Pacific Northwest's early lumber mills created huge amounts of sawdust that covered river bottoms and clogged the gills of salmon. Clear-cutting of forests poured more silt into rivers, and cattle grazing caused erosion, which led to increased soil runoff.

In the midst of the Great Depression, President Franklin Roosevelt saw an opportunity to industrialize the Pacific Northwest by building hydroelectric dams in the Columbia basin. Engineers began work on the first federal dams in the region in 1933. By 1975, there were 18 giant dams across the Columbia and Snake Rivers. Dams have been successful stimulants to economic development in the region, but they have also dramatically altered ecosystems and fish species dependent on them. The recent public controversy has been focused on the impact of dams on Snake River salmon.

In rivers around the country, salmon and other anadromous fish (those that hatch in freshwater, migrate to the sea, then return to freshwater to spawn) have to navigate over dams to reach their spawning grounds. But this struggle often has proved too difficult for the fish, even when dams are redesigned to help them migrate.

For decades, federal agencies were required to put economic interests first when they reviewed existing dam licenses or granted new ones. But in 1986, Congress instructed federal agencies to also consider wildlife, recreation, and environmental quality. Since then, hundreds of small dams have been demolished. In 1999, an aging hydroelectric dam on Maine's Kennebec River was demolished under a federal order, the first major dam to be taken down to protect migrating fish. As dams age and licenses expire, numerous other major dams could be similarly breached as part of a major effort to restore America's rivers and their fisheries. Removing a dam can restore the natural fish habitat, allows the river to resume the natural variations of its flow, eliminates unnatural temperatures downstream, and removes propellor-bladed turbines that kill juvenile fish that attempt to pass through their shafts.

Some dam operators recognize that they can't bring their dams up to current environmental standards, especially those of the Endangered Species Act, so the operators are removing these structures. The Condit, a Washington State dam that blocks fish passage on the White Salmon River, a tributary of the Columbia, will be removed starting in 2006 by its operator, PacifiCorp, at a cost of $17 million. And to restore chinook salmon and steelhead populations, five Pacific Gas and Electric Corporation dams will be taken down on Battle Creek, a tributary of the Sacramento River in northern California, at a cost of $50.7 million.

Nevertheless, arguments over the Snake River dams have turned explosive. Critics have pointed out that removing these structures would take away a significant source of energy to the entire region—4% of the Pacific Northwest's electricity, the equivalent of that used by the Seattle metropolitan area—and raise utility rates. Industry relies on the placid waters of the dammed river for shipping. And the Snake River dams provide water to irrigate 36,000 acres of farmland in Idaho and Washington State; taking them down could potentially put some farmers out of business.

The nine federal agencies involved in the dam issue have various opinions about what to do next. The U.S. Fish and Wildlife Service says that taking down the dams is the best way to save the fish. The U.S. Environmental Protection Agency concluded in April 2000 that the dams' manager, the USACE, must address the river's water-quality problems—specifically, dam-caused warmer water temperatures that harm chances of survival for young salmon by decreasing their energy levels, diminishing their food supply, and making them more susceptible to predators and disease—if the dams are to stay up. The National Marine Fisheries Service, the lead agency for ensuring salmon's protection under the Endangered Species Act, recently suggested that the dams should stay in place for 5–10 years while other salmon recovery options could be explored. The federal agencies are currently studying what could be done to help salmon in terms of the so-called "four Hs" of endangered fisheries—hydropower, habitat, hatcheries, and harvesting.

The USACE has tried numerous techniques to help fish get past the Snake River dams. But the fish populations are still falling, though USACE research suggests that the dams may not be the main cause of the fisheries' decline. Ninety-eight percent of juvenile fish are either shuttled around the dams—loaded onto barges and sent downstream—or they swim over the spillways on their way to the ocean, says Adele Merchant, fish program planner with the USACE Northwestern Division in Portland, Oregon. "There must be other factors causing the fish not to return," she says. "There are still a lot of private activities in the watershed. There is industry up and down the river. Cattle grazing can cause erosion that silts in gravel stream beds and affects the good spawning habitat."

In July, the Clinton administration indicated that it will delay its decision on removing the Snake River dams for at least five years. Within coming weeks, the administration is scheduled to release full details of its draft plan to recover the endangered fisheries in the Snake River, including steps to recover the salmon without removing the dams such as habitat improvements, harvest restrictions, and modifications to hydroelectric dams. In a 22 July 2000 letter to President Clinton, the Washington, DC–based National Hydropower Association commended the administration for delaying its decision on removing the dams and for encouraging modifications to dams as part of a salmon recovery plan. "As you know, hydro projects are not the only problem salmon face," wrote Linda Church Ciocci, executive director of the association. "We believe that the decline of the salmon is a problem that reaches far beyond the hydro industry."

Burning the Forest

Some researchers promote fire as an agent of restoration in forests and prairies. In the U.S. Southeast, for example, foresters are using fire to bring back longleaf pine stands, which have suffered from clear-cutting and a lack of controlled burning. When longleaf trees are young, they have balls of long, dense, succulent needles. The trees' buds are buried deep within these protective needles. Controlled fires, when done correctly, are of low intensity and, while such fires can kill off most species of southeastern hardwoods and pines, the longleaf pine's thick bark and dense needles provide layers of armor that allow the longleaf to survive and thrive. Other species of pine thrive under fire, too, generally needing burning every 3–4 years, once trees are past the juvenile stage, says Dale Wade, a fire researcher with the U.S. Forest Service.

Another important reason for controlled burning is to reduce the possibility of wildfires that destroy forests and valuable timber along with homes and communities in their path. In the absence of controlled fires, shrubs and ground cover grow very thick, providing fuel for catastrophic blazes.

In South Carolina's Francis Marion National Forest, resource managers are burning the woods under a stipulation of the Endangered Species Act, which requires that the U.S. Forest Service restore and sustain older longleaf pine trees in the forest to protect the endangered red-cockaded woodpecker. This tiny bird nests exclusively in the holes of older pine trees, which are increasingly rare, edged out of existence by a lack of fire and faster-growing trees such as the loblolly pine and sweetgum.

Resource managers say that the woodpecker and other rare plants and animals could die out unless public and private landowners reconstruct their fire-dependent habitat. Still, a reconstituted longleaf pine forest cannot replicate the biological diversity of an ecosystem that evolved over centuries. "We'll never get the original longleaf forest back," says Bill Twomey, fire program manager for the Francis Marion. "We've lost too many species."

Before Europeans arrived, fire was the native Indians' most important tool for manipulating the landscape. Indians intentionally burned forests for hundreds—perhaps thousands—of years. Through regular burning, Indians replaced dense forests with thinner woodlands, and they dramatically altered the composition of forest ecosystems, encouraging fire-tolerant plants, such as longleaf pine, and discouraging others. The early European settlers in the Southeast maintained these clearings and extended them through fire, according to Stephen J.

Traffic: USDA Forest Service, Francis Marion and Sumter National Forests; red-cockaded woodpecker: Derrick Hamrick

Burning the forest for the trees. Although controlled forest burning can be inconvenient for people such as these drivers (left), stalled on a road near Francis Marion National Forest by a dense cloud of smoke, the red-cockaded woodpecker (right) depends upon such burning to maintain the pine forest it calls home.

Pyne, a fire historian at Arizona State University in Tempe. “[Along the South Carolina coastal plain,] there was a tradition of setting fire to the woods every spring for free-ranging cattle that would feed on the lush growth of green grass,” says Twomey.

Then in the 1870s, steam-powered locomotives arrived in the forests of the Deep South, bringing industrial-era logging. By the 1930s, most of the original 60–90 million acres of original longleaf pine forests were gone. (Today, there are less than three million acres of longleaf pine forests in the Southeast.) In the early twentieth century, federal agencies established a nationwide suppression of forest fires. That was a terrible mistake, foresters say now. “Fire is an integral part of the Southern pine system,” says Wade. “For decades, all fires were considered bad and we put them out,” says Dean Gjerstad, a forestry professor at Auburn University in Alabama. “Now we know differently,” he says. “We know that we need more fire in the system.”

By the 1950s, foresters began to burn Southern pinelands again after realizing that these woods need frequent fire. But in recent years people living at the growing suburban edges complained about smoke. Even controlled fires can harm nearby residents who suffer from emphysema and other respiratory diseases. And property owners worried about getting sued if their fires got out of control and hurt someone. Conflict between residents and foresters over burning “is becoming a more common problem,” says Gjerstad. “Restorers are at odds with local people. . . . People are building houses out in the forests, and a lot of people don’t like smoke from controlled fires.” But without controlled fires, he adds, “the undergrowth fuel builds up, and when a drought occurs, you can have catastrophic fires.”

Controlled burning in some sections of the Francis Marion is also becoming increasingly difficult as the Charleston metropolitan area sprawls closer to the national forest, bringing more traffic and new residents. Although the Francis Marion has an extensive program to warn local people when a controlled fire is scheduled and to provide checkpoints on highways, shutting down roads if smoke makes driving dangerous, blinding smoke from controlled fires led to six automobile accidents on highways through and adjacent to the forest from 1993 to 1996. A number of long-term residents who have emphysema and other respiratory diseases are affected by prescribed fires in the Francis Marion, says Twomey. As a result, some sections of longleaf pine forest have not been burned since 1996.

It seems clear that large-scale restoration projects can work best in places where modern society makes relatively few demands on the resource. In the case of Francis Marion National Forest, the longleaf pine ecosystem is being restored in parts of the forest farthest away from urban centers. But in stretches of the forest near roads and suburbs, resource managers have cut back on burning the woods. In south Florida, human demands for water could make restoration of part of the Everglades politically difficult, but control of public lands provides some flexibility to rebuild the ecosystem. In the Pacific Northwest, however, the Snake River has been used so intensively, in such a variety of ways, and for so many decades, that restoring the salmon habitat seems an extraordinarily complex task.

Each of these restoration projects must have political support of local residents, environmental groups, and economic interests. A wide range of stakeholders must come together in agreement on why a large-scale restoration is needed. Ambitious ecological restorations usually require some sacrifices by people living near those landscapes. In general, large restoration projects can succeed only with a combination of extensive scientific study and careful negotiations among people who would be most affected.

John Tibbetts