Ecosystem Restoration

MANAGEMENT OBJECTIVE – PRACTICE RESOURCE STEWARDSHIP

Photo caption. Mono Lake with tufas in the foreground.

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PRACTICE RESOURCE STEWARDSHIP

Chapter 22. Ecosystem Restoration

Ecosystem restoration improves the condition of our modified natural landscapes and biological communities to provide for their sustainability and for their use and enjoyment by current and future generations. Few, if any, of California's ecosystems can be fully restored to their condition before the Gold Rush. Instead, efforts focus on rehabilitation of important elements of ecosystem structure and function. Successful restoration increases the diversity of native species and biological communities and the abundance and connectivity of habitats. This can include reproducing natural flows in streams and rivers, curtailing the discharge of waste and toxic contaminants into water bodies, controlling non-native invasive plant and animal species, removing barriers to fish migration in rivers and streams, and recovering wetlands so that they can store floodwater, recharge aquifers, filter pollutants, and provide habitat.

Overview

This strategy focuses on restoration of aquatic, riparian and floodplain ecosystems because they are the natural systems most directly affected by water and flood management actions, and are likely to be affected by climate change. Today, water and flood planning must aim to prevent ecosystem damage and reduce long-term maintenance costs. Future water and flood management projects that fail to protect and restore their ecosystems will face reduced effectiveness, sustainability, and public support.

Restoration generally emphasizes recovery of at-risk species and natural communities, usually those whose abundance and geographic range have greatly diminished. These include several fishes, such as Delta smelt, longfin smelt, green sturgeon, Chinook and Coho salmon, and steelhead rainbow trout; and riparian and wetland habitats and their member species, including valley elderberry longhorn beetle, giant garter snake, and several migratory bird species.

California has lost more than 90 percent of the wetlands and riparian forests that existed before the Gold Rush. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends upon at least partial restoration of physical processes that are driven by water. These processes include the flooding of floodplains, the natural patterns of erosion and deposition of sediment, the balance between infiltrated water and runoff, and substantial seasonal variation in stream flow. Another barrier to ecosystem restoration—displacement of native species by exotics—results largely from the diminution of these same physical processes.

As an example, nearly all California waterways are controlled to reduce the natural seasonal variation in flow. Larger rivers are impounded to capture water from winter runoff and spring snowmelt and release it in the dry season. Many naturally intermittent streams have become perennial, often from receipt of urban wastewater discharges or from use as supply and drainage conveyances for irrigation water. The Sacramento-San Joaquin Delta (the Delta) has become more like a year-round freshwater lake than a seasonally brackish estuary. In each case, native species have declined or disappeared. Exotic species have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives.

Current activities

Important recovery efforts that affect water and flood management are described below.

The first example of recovery and restoration planning is in the Delta, where several efforts are under way. Water users are seeking to secure long-term assurances for Delta exports by formulating a Bay-Delta Conservation Plan (BDCP). BDCP will examine how to improve the design and operation of the State and federal water projects and restore and manage habitats in the Delta. A successful BDCP would protect and recover several fish species that have dropped steeply in abundance since 2000 as part of the Pelagic Organism Decline, or POD. The Interagency Ecological Program has identified several likely causes for the POD, including toxic chemicals, invasive species, and water exports from the Delta.

The Delta Vision Task Force is charting a set of strategies intended to reverse the changes in Delta ecology, so that native species and their habitats return to a level that can be resilient in the longer term. The Delta Vision group sees a need to incorporate enough of the natural variability of the estuary to provide a suitable physical environment for native species. Some proposed activities include acquisition and restoration or enhancement of land to tidal marsh and seasonal floodplains; acquisition of adjacent uplands to accommodate sea level rise and to preserve habitat mosaics; relocation of key water diversions to reduce or remove ecosystem interferences; shifting of highest water exports to wettest periods and lowest exports to driest periods; and provision of targeted flow increases for aquatic species.

The California Bay-Delta Authority's Ecosystem Restoration Program (ERP) has undertaken numerous projects in the Sacramento and San Joaquin valleys, the Delta, and northern San Francisco Bay Area to help recover threatened and endangered species and other species of concern. ERP has been particularly successful on tributaries to the Sacramento River (e.g. Battle and Clear creeks) to restore spawning areas for anadromous fish such as Chinook salmon. Near-term objectives of the ERP will be to restore critical ecosystem processes and habitats and ameliorate stressors in the Delta and Suisun Marsh, in concert with the BDCP planning effort.

Another example of restoration planning is the Central Valley Project Improvement Act (CVPIA) of 1992, which mandates changes in the management of the Central Valley

Project, particularly for the protection, restoration, and enhancement of fish and wildlife. One component of the CVPIA is the Anadromous Fish Restoration Program (AFRP). The AFRP has a goal of at least doubling the natural production of anadromous fish in Central Valley streams on a long-term basis. Since 1995, AFRP has helped implement nearly 200 projects to restore natural anadromous fish production.

A third example is the Central Valley Joint Venture (CVJV), which protects, restores, and enhances wetlands and associated habitats for waterfowl, shorebirds, and songbirds in the Central Valley, through partnerships with conservation organizations, government agencies, and private landowners. The CVJV Implementation Plan focuses on wetlands and the values they provide to birds and contains Central Valley-wide objectives, expressed as acres of habitat of seasonal and semi-permanent wetlands, riparian areas, rice cropland, and other waterfowl-friendly agricultural crops. The Wildlife Conservation Board, an arm of the California Department of Fish and Game, funds the purchase and restoration of land and waters suitable for recreation and wildlife habitat.

Fourth, the Southern California Wetlands Recovery Project, chaired by the California Natural Resources Agency and supported by the Coastal Conservancy, works to acquire and restore wetlands, watersheds, and streams in coastal Southern California. The aim is to reestablish a mosaic of fully functioning wetlands with a diversity of habitat types and connections to uplands, so as to preserve self-sustaining populations of species. About 120 projects are in process or complete, with over 2,700 acres acquired and protected and over 800 acres enhanced or restored. These include Tijuana Estuary, South San Diego Bay National Wildlife Refuge, Bolsa Chica, Ballona wetlands, and the Santa Clara River Parkway.

The final example is the Santa Ana River watershed program that successfully integrates habitat restoration and endangered species recovery with flood control, groundwater recharge, and water quality improvement. Prado Dam is a key component, serving both flood protection and water storage. Upstream of the dam lies a habitat area that has expanded over the last 20 years to support both the largest patch of riparian forest and the largest number of the endangered Bell's vireo (a songbird) in Southern California. The invasive giant reed (Arundo) displaces native vegetation along the river, impedes flow during floods, and is a heavy water user. An aggressive program of Arundo removal serves to improve habitat for the vireo, reduce flood risk, and reduce irrecoverable water. The river is the main source of recharge for the Orange County groundwater basin and consists mainly of treated wastewater from upstream cities. Constructed wetlands (shallow ponds) remove nitrogen from river water.

Numerous efforts are also under way to restore ecosystem processes and habitats that are more limited in geographic scope, such as processes for the Suisun Marsh, the Salton Sea, the Owens River, and the San Joaquin River. These local restoration efforts are covered in the regional reports of Volume 3.

Box 22-1 Acronyms and Abbreviations

AB	California State Assembly bill
AFRP	Anadromous Fish Restoration Program
BDCP	Bay-Delta Conservation Plan
CVJV	Central Valley Joint Venture
CVPIA	Central Valley Project Improvement Act
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
ERP	Ecosystem Restoration Program
NRCS	Natural Resources Conservation Service
POD	Pelagic Organism Decline
Prop.	Ballot proposition
SB	California State Senate bill
State Water Board	State Water Resources Control Board
SVP	Shared Vision Planning
USDA	US Department of Agriculture

Potential Benefits of Ecosystem Restoration

Reliability of Water Supply

As ecosystem restoration actions help recover the abundance of endangered species, there should be fewer Endangered Species Act conflicts, particularly in the Delta. These conflicts repeatedly disrupt water supplies. Thus, one result of ecosystem restoration should be a more reliable water supply.

An example of a more direct water supply benefit is the restoration of meadows that occur in the headwaters of rivers and streams. Meadows have wide, shallow, vegetated channels that spread flood peaks across the meadow floodplain and recharge the underlying aquifer. In contrast, gully erosion drains groundwater stored in meadows and eliminates meadow wetlands. Meadow restoration reverses gully erosion and returns the vegetation to wetland and riparian forms. The US Forest Service estimates that meadow restoration in National Forests in the Sierra Nevada could add 50,000 to 500,000 acre-feet of groundwater storage per year. See the forest management strategy in this volume for further discussion.

Water Quality

The numerous ways that natural ecosystems contribute to water quality improvement are described in other resource management strategies in this volume. For the role of wetlands and riparian forests in filtering contaminants from runoff, see the chapters on pollution prevention and forest resource management. For the role of forests in preventing erosion and subsequent sedimentation of streams, refer to the forest resource management strategy. Finally, the watershed management strategy explains that drinking water drawn from forested land requires less treatment (i.e., is less contaminated) than water derived from agricultural or developed land.

Sustainability

Water and flood management projects that incorporate ecosystem restoration are likely to be more sustainable than those that do not. Projects are more sustainable (that is, they operate as desired with less maintenance effort) when they work with, rather than against, natural processes that distribute water and sediment. To include ecosystem restoration in a project usually requires a degree of return to more natural patterns of erosion, sedimentation, flooding, and instream flow, among others. This, in turn, makes such projects harder for natural processes to disrupt and easier to maintain. An expected benefit is cost savings over the life cycle of such projects because repair and maintenance should cost much less.

Sustainability in water and flood management projects is analogous to resilience in ecosystems. Resilience is the capacity of an ecosystem to tolerate disturbance without changing into something qualitatively different and controlled by a different set of processes. A resilient ecosystem resists change and rebuilds itself after disturbance. Some specific aspects of biological diversity that support resilience are multiple functional groups (groups of species that perform a similar task, e.g., occupy the same place in a food web); number of species within functional groups; overall diversity of species; and abundance and connectivity of habitats in space and time. Seen this way, ecosystem restoration is both successful and sustainable when it increases the diversity and connectivity of species, functional groups and habitats, and not otherwise.

Projects that integrate flood or water management and ecosystem management are sustainable only if both their flood/water components and their ecosystem components are sustainable. As discussed above, the two are interdependent in their degree of sustainability. Conditions that increase the resilience of ecosystems also promote the sustainability of infrastructure projects. Projects that incorporate ecosystem restoration should be more sustainable (and cheaper in the long run) than those that do not.

Interaction with Climate Change

Perhaps the most important effect of climate change on California ecosystems is a decline in the availability of moisture. A combination of rising temperatures, more intense and perhaps more frequent floods, a smaller snowpack, and more frequent droughts and wild fires will reduce water storage on the surface and underground, as more water runs off or evaporates and less water infiltrates into the ground.

The expected changes in temperature and moisture will force species and natural communities to follow their preferred temperature and moisture regimes as the latter migrate uphill, northward and into cool canyons, until they meet topographic or other barriers. The result is that many species and ecosystems will occupy ever smaller and more isolated patches of physical habitat.

This forced migration thus contributes to the shrinkage and fragmentation of habitats that already result from human uses of land and water. In turn, these changes reduce the resilience and sustainability of ecosystems and their component species. This loss of resilience puts more species at risk of extinction and presents water and flood managers with more Endangered Species Act listings.

Alternatively, ecosystems might be managed to counter the undesirable effects of climate change. The State of California is developing strategies to reduce carbon emissions to the atmosphere and to adapt to expected changes in climate. Two examples below suggest possible roles for ecosystem restoration in these efforts.

First, plant growth depends on the capture and incorporation of atmospheric carbon into plant tissue. That is, trees and other plants sequester carbon. Growth rates of trees in low-elevation riparian forests in California are among the highest in the world, outside the tropics. Thus, significant expansion of riparian forest acreage in coastal and inland valleys could serve as a large carbon sink and contribute to the goal of net reduction of carbon emissions.

The second example concerns flooding. Our present-day capacity to manage floods relies on reservoir storage and valley-floor flood bypasses. These same reservoirs hold much of our water supply. Climate predictions point to increasing conflict between flood protection and water supply needs as the timing of runoff changes. This, in turn, creates a new impetus to look to floodplains to provide more flood protection.

One option to reduce flood damage is to increase the use of floodwater bypasses, by creating new ones or enlarging the existing set. Such areas could be managed simultaneously as rearing habitat for fishes, particularly salmon—a use, for example, of the Yolo Bypass today. The Yolo Bypass provides better growth and survival for juvenile salmon than do nearby channelized rivers that are now their main habitat. Because most expected effects of climate change would harm salmon and other cold-water fishes (as discussed in the section, "Major Issues Facing Ecosystem Restoration," below), actions to improve their condition will become even more important. Restoration or creation of rearing habitat on floodplains is one such way. Refer to the strategies for integrated flood management in this volume for further discussion.

Flood Management

The principal opportunities for improvement in both flood and habitat management occupy the same spatial footprint and are affected by the same physical processes that distribute water and sediment in rivers and across floodplains. Many actions taken for ecosystem restoration can also support more sustainable flood management.

Four major structural elements of flood management in California affect ecosystems: dams, levees, floodwater bypasses, and setback levees. Their flood management roles are clear. Dams impound floodwater and reduce peak flows. Levees keep rivers in their channels and off their floodplains. Bypasses allow controlled conveyance of floodwater across floodplains. Setback levees reduce water velocities and flood elevations, when compared to on-channel levees, and therefore sustain less erosion damage.

The combined use of dams and levees reduces the frequency and extent of floodplain inundation. In contrast, setback levees and bypass channels allow more frequent inundation of potential habitat space on floodplains. Native riparian and aquatic animal and plant communities of California are adapted to conditions of seasonal flooding. Thus, setback levees and bypasses are better tools to accomplish integration of habitat and flood protection objectives than are dams and on-channel levees.

Ecosystem restoration can improve flood protection by reducing levee erosion, increasing floodwater conveyance, deflecting dangerous flows away from levees, and strengthening levee surfaces. For example, levee erosion is a maintenance concern that often can be alleviated by slowing water velocity along the levee face. This can be done by setting the levee back and by growing plants on the lower levee slope and between the levee and the main channel. The vegetation reduces the force of water against the levee. Also, a new setback levee can be built with sound materials on a more stable foundation than many existing levees. The selection of an appropriate plant community is a key to reducing levee erosion while retaining the flood-carrying capacity of the stream channel.

A recent example of the use of suitable plant communities occurred at O'Connor Lakes on the Feather River downstream of Yuba City, where a right-angle bend in the levee had been subject to severe and repeated erosion. A technical analysis of the paths taken by floodwater identified areas of the river channel where forest could remain (instead of being cleared periodically), areas where restoration of native trees and shrubs would not interfere with flood flows, and areas where the vegetation needed to be low and flexible enough to smooth the way for floods. The latter area was planted with native grasses and herbs. Overall, the new design increased the area of native vegetation by 230 acres, protected existing habitat from removal, reduced the risk of levee erosion and the need for expensive levee repair, and reduced the cost of keeping the channel clear for floodwater conveyance. Thus, a cheaper and more effective way to maintain the flood channel was also better for fish and wildlife habitat.

Floodwater bypasses can be designed to allow restoration of grassland and shrub habitat that, when flooded, can be used by the juvenile stages of fishes, including salmon and native minnows. Similar fish habitat can also be developed with setback levees. One such project on the lower Bear River in Sutter County has restored floodplain habitat for fishes and is contoured to drain water and fish back to the river when floodwaters recede, thus preventing fish stranding. The project also created several hundred acres of forest and grassland habitat. The new, larger, more durable levee, set back from the erosive forces of the river, improved flood protection for the urban area behind it.

Environmental Water Use Efficiency

In recent decades, urban and agricultural water agencies have actively managed their water supplies and demands to increase water use efficiency, reduce cost and improve benefits. This has allowed them to stretch supplies to serve growing demand. Improvements in water use efficiency in all sectors, including environmental, helps reduce conflicts among users. The emphasis in environmental water use efficiency is to find ways to increase the benefits derived from a given allocation of water, rather than to attempt to maintain the existing environmental benefits with less water (Null, 2008). A major complication in assessing efficiency is the difficulty of measuring the effects of specific actions on the target species.

Current examples of efforts to improve environmental water use efficiency include environmental water banks, pulse flow releases, dam removal, temperature control devices in reservoirs and, as discussed above, combined-use flood facilities such as setback levees and flood-water bypasses. A recent modeling study (ibid.) on the Shasta River, a tributary to the Klamath River, examined how to improve the productivity and survival of coho salmon through habitat and other improvements aimed at reducing water temperature. The evaluated measures included the planting of trees on the bank to shade the river, redirection of warm agricultural return flows to a discharge point further downstream, and relocation of water diversion points.

Other Effects

The potential benefits of ecosystem restoration on water supply, climate change, flood management, etc. are complex and interactive. In the two examples below, the societal response to the effects of climate change influences our ability to integrate management of habitat with other land uses.

The first example concerns expansion of riparian forests onto the floodplains that they formerly occupied. This often requires an expansion of the area subject to flooding, that is, a return to a more natural floodplain function. This helps stabilize soils, increase groundwater infiltration and storage, and reduce flood velocities, bank erosion and sedimentation of streams. Furthermore, because a return to a more natural floodplain function makes more room for flood peaks in valley areas, it allows more reservoir capacity to be dedicated to water supply, rather than be set aside for flood storage. A negative effect on water supply is that riparian forests usually consume more water than the vegetation they replace.

A second example involves the interaction of habitat, flood management, and agriculture. Riparian habitat restoration often takes place on land previously cleared for agriculture. A predicted climatic regime of more frequent and larger floods will diminish the ability to continue to farm many areas because the increased cost of recovery from floods could make farming uneconomical. However, making a clear dedication of land to expand flood-carrying capacity will reduce the flood risk on the remaining farmland and thus make that land more secure for agriculture.

Potential Costs of Ecosystem Restoration

A comprehensive statewide summary of the costs of ecosystem projects does not exist. However, as of the end of 2007, the California Bay-Delta Authority's Ecosystem Restoration Program (ERP) had funded about 800 projects for restoration, including planning, monitoring, and education, at a total cost of over $950 million.

Several recent bond measures (including Props. 204, 13, and 50) have provided money for restoration of California's ecosystems. The largest current initiative is in Prop. 84. Almost $1.4 billion is set aside for protection and restoration of rivers, lakes, and streams and their watersheds and to protect, conserve and restore forests and wildlife habitat. The flood protection corridor programs of Props. 84 and 1E provide about $290 million for projects that, under various provisions, restore habitat, preserve farmland, or both. Another section of Prop. 84 provides for construction or reconstruction of corridors, bypasses, weirs and setback levees, much of which could provide opportunities for the development of floodplain habitat in multi-objective projects. The "Safe, Clean and Reliable Drinking Water Act of 2010", if approved by voters, will provide $1.8 billion for ecosystem and watershed protection and restoration.

Active or horticultural (as opposed to passive) restoration of land to riparian forest habitat in the Central Valley can cost $4,000 to $10,000 per acre, with difficult or risky projects closer to the upper end of the range. The Department of Water Resources (DWR) estimates that the flood protection corridor program funded by Prop. 13 spent about $37 million on the habitat aspect of various projects, at a cost of about $10,000 per acre. Props. 84 and 1E may provide about $165 million for habitat acquisition and restoration, presumably at a similar cost per acre. The US Forest Service estimates that meadow restoration on forested land costs $100 to $250 for each acre-foot of water stored.

The start-up costs of water and flood management projects that incorporate ecosystem restoration can be greater than for individual single-purpose projects. In other cases, inclusion of restoration features can lower the cost of project installation. The lower life-cycle costs of integrated projects yield an advantage over a series of single-purpose projects, which experience higher maintenance costs (as explained above in the section on Sustainability) and greater environmental mitigation expenses.

Major Issues Facing Ecosystem Restoration

Climate Change

Climate change will likely make preservation and restoration of habitat more difficult. The ecological requirements of cold-water fishes provide an example. Expected climate changes will yield a smaller snowpack, more rain, and a resulting shift in peak tributary runoff from spring to winter. Less of the peak winter flow is likely to be stored in reservoirs. The anticipated result is warmer rivers and streams, with less water available for ecosystem flow and temperature needs in spring and summer. In many low- and middle-elevation streams today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. Thus, climate change might require dedication of more water simply to maintain existing fish habitat. Plans to expand habitat will face stiffer competition from other demands on water.

Climate change is also expected to raise sea level. As this happens, the brackish and fresh aquatic habitats of the Sacramento-San Joaquin estuary that are critical to many at-risk species will shift upstream and inland. Growing urbanization on the eastern edge of the Delta will limit opportunities to acquire or restore lands that would provide suitable habitat. Threatened and endangered species could be increasingly squeezed between the inland sea and the encroaching cities.

Conflicting Objectives with Traditional Flood Management

Ecosystem restoration and traditional flood management often have conflicting objectives. Traditional flood planning assigns all the physical space in a river channel to floodwater conveyance and leaves little room for habitat values. Many of the greatest opportunities for ecosystem restoration, especially in the Central Valley and other valleys, require incorporation of habitat into the flood protection system. At this early stage in statewide flood planning, we lack consensus on how to design such an integrated system and on the desirability thereof. For example, many would balk at using even newly-created flood capacity in a river channel to make room for forests.

Californians need to be satisfied that the promise of an integrated approach to flood and ecosystem management can provide habitat without greater risk of flood damage. A habitat project that fails to achieve its objectives is costly, but not dangerous. In contrast, a flood protection project that fails can mean catastrophe for life and property.

Opposition to Conversion of Farmland to Habitat

Many of the opportunities for ecosystem restoration are on land that is now farmed, especially in the Central Valley and Delta. Although some habitat types, such as seasonal wetlands, can be farmed at other times of year, others, such as riparian forest and most permanent wetlands, cannot. Thus, significant amounts of habitat restoration on arable land, coupled with continued urban growth, could hasten the decline of some forms of agriculture in California. The loss of farmland, especially for habitat uses, is controversial.

Instream Flows

Restoration of adequate instream flows and channel and floodplain form and function is the statewide priority for the California Department of Fish and Game. DFG has legal mandates to determine flows that will assure the viability of fish and wildlife resources, identify the watercourses to evaluate first, initiate flow studies, and develop recommendations to the State Water Resources Control Board (State Water Board) for use in allocating water. In turn, the State Water Board is responsible for allocating water to protect habitat for fish and wildlife. Much work remains to complete studies and develop recommendations. Until then, restoration of adequate instream flows will be hampered by incomplete knowledge of flow needs.

Mercury Contamination

Wetland restoration carries the potential for methyl mercury contamination. Some seasonally and permanently flooded wetlands can convert elemental mercury to methyl mercury. Methyl mercury is highly toxic and can accumulate in natural food chains and in fish that people eat. Many areas targeted for habitat restoration, particularly in and near the Delta, are contaminated with mercury. Hence, wetland restoration in those areas could exacerbate methyl mercury production. The Central Valley Regional Water Quality Control Board is drafting measures to reduce or prevent such contamination, some of which would constrain restoration.

Recommendations to Promote Ecosystem Restoration

1. Devise climate change adaptations that benefit both ecosystems and water and flood management

   The principal predicted effect of climate change on California ecosystems is to further fragment and shrink them. Thus, appropriate corrective actions should serve to expand and reconnect them. In general, measures that can help ecosystems adapt to climate change are those that integrate ecosystem restoration into flood and water projects. This is the surest path to the sustainability of both efforts.

   The following recommendations have been discussed above:
   a. Re-connect rivers to their historic floodplains as part of new flood management approaches.
   b. Increase the use of setback levees and floodwater bypasses.
   c. Expand lowland riparian forest acreage in the form of continuous corridors along watercourses. Set aside habitat in the Delta to compensate for habitat lost to sea level rise.

d. Restore mountain meadows.
e. Enable migratory fish to move past dams and other obstructions into their historic habitat in upper watersheds.

All of these actions could serve as components of a broader and more essential recommendation: to establish large biological reserve areas that connect or reconnect habitat patches. These proposed “landscape reserves” are discussed further in the biodiversity and habitat section of the California Natural Resources Agency’s draft climate adaptation strategy.

2. Promote multidisciplinary approaches to water and flood management

   Conflicting objectives are commonplace in water and flood planning. It is essential to foster broad participation and collaboration among the affected parties to generate a shared vision of water and flood management that incorporates multiple interests. The US Army Corps of Engineers has developed “Shared Vision Planning (SVP)” as a means to involve stakeholders and decision-makers throughout the design and development of technical aspects of flood protection planning. DWR should pursue SVP to improve the transparency and acceptability of technical information developed for the California Water Plan.

3. Expand financial incentives for farmers to grow and manage habitat

   Programs such as the Environmental Quality Incentives Program administered by the USDA, Natural Resources Conservation Service (NRCS), California’s Williamson Act subventions, and DWR’s Flood Corridor grant program are examples of the direction that expansion could take. See the agricultural lands stewardship strategy in this volume for further discussion.

4. Instream flow needs

   Provide a comprehensive and appropriately funded program to identify instream flow needs, perform the necessary studies, and make scientifically defensible recommendations for instream flows to protect fish and wildlife.

   Another way to improve instream flows is contained in California Water Code Section 1707. This section allows any person entitled to the use of water, whether based upon an appropriative, riparian, or other right, to petition the State Water Board to implement a change that preserves or enhances wetlands habitat, fish and wildlife resources, or recreation in or on the water. Usually this is done by foregoing the right to divert the water from a stream. This is considered a reasonable and beneficial use, and ownership of the water right is retained. The petition has to specify the time period, location and scope of the change, which cannot expand the user’s right or injure other legal users.

5. Mercury contamination

Conduct research to reduce human and ecosystem exposure to mercury without preventing other efforts to improve ecosystem health through wetland restoration.

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