Chapter 17

Overcoming Obstacles to Restoring Natural Capital: Large-Scale Restoration on the Sacramento River

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The floodplain forests and wetlands that are the natural capital of the Sacramento River, the largest river in California, have been lost and damaged by deforestation, river canalization, dam building, and water diversion. Restoration of these riparian ecosystems is a crucial goal for improving important ecosystem services, such as water quality, fisheries, and terrestrial wildlife habitats (Postel and Richter 2003). The Sacramento River, a critical breeding and migratory habitat for wildlife, is essential since only 4% of the original riparian forest remains due to hydrological changes and deforestation for agricultural development. However, the amount and pattern of riparian restoration is shaped by competing uses of the floodplain and river, such as water supply, flood control, and agricultural land, and restoration success is further influenced by stakeholder perceptions and socioeconomic dynamics.

In this chapter, we discuss the Sacramento River restoration project as an example of the biological, physical, and social barriers and bridges that can exist when attempting large-scale riparian restoration (Gore and Shields 1995; Wohl et al. 2005). Large-scale river restoration must take into account the complex social and biophysical interactions that occur between different patches across landscapes. For example, stakeholders bring multiple frames of reference to restoration projects, including reasonable objections to restoration and valuing natural capital (Pahl-Wostl 2006). Although restorationists generally view restoration as having only positive effects, many stakeholders view it as having local negative effects. Whether these negative effects are real or perceived, large-scale restoration projects must incorporate these concerns as part of their research and management programs. We discuss potential methods for restoring the Sacramento River, the conflicts that have arisen due to perceived negative impacts, and methods for resolving these conflicts. We also discuss the lessons learned and how they may be applied to other restoration projects facing social conflicts.

Historical Perspective on the Natural Capital of the Sacramento River

The Sacramento River originates in the Klamath Mountains of northern California (figure 17.1) and is bordered by the Coast Ranges on the west and the Sierra Nevada to the east, both of which supply many tributaries. The river descends from the mountains into the upper Sacramento Valley, where it flows across a broad flat floodplain. Historically, during winter storms, the river regularly spilled over into flood basins, causing inundation up to eight kilo-

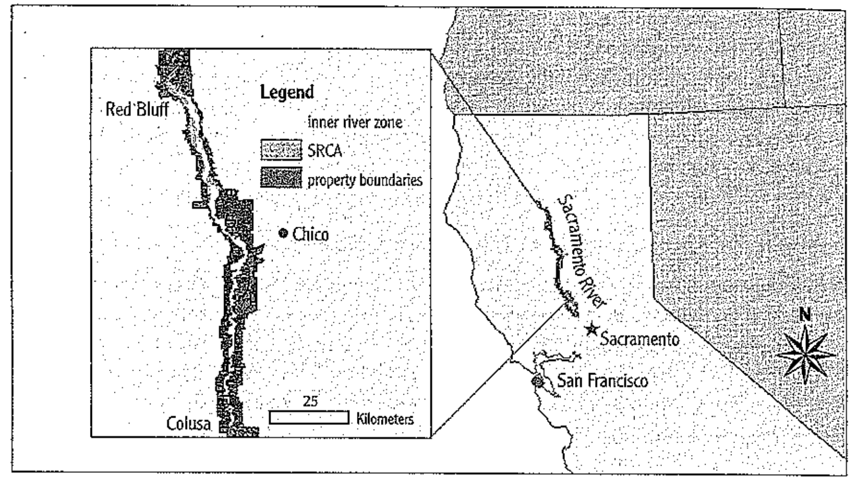

Figure 17.1. Orientation Map for the Sacramento River restoration project. Map shows the location of the Sacramento River restoration project within California and the location of the Sacramento River Conservation Area (SCRA) and adjacent properties surrounding the inner river zone of the Sacramento River.

meters on either side. During major flood events, the upper Sacramento River valley filled with sediment-rich waters that formed natural levees where riparian forest flourished. These natural levees also prevented many of the tributary streams from entering the Sacramento River, and instead distributed the water into extensive wetlands that filtered water and stabilized river flows (Thompson 1961).

Before European settlement, the expanse of riparian forest and the heterogeneity of habitats along the Sacramento River led to a diverse biota. The valley was rich in wildlife, including predators such as grizzly bears, game animals such as antelope and tule elk, large populations of migratory birds, and extensive migrations of anadromous fish. Plant communities included expanses of marshes, upland oak forests, and tangles of cottonwood, willow, oak, and other species in widespread riparian forest habitat (Thompson 1961).

Current Pressures and State of the River

In 1848, gold was discovered in the region, resulting in a rapid population increase and forest destruction (Thompson 1961). By 1866, two-thirds of the land around the Sacramento River was under cultivation for orchards, row crops, and perennial pasture. Riparian forest was further removed to power steamboats and to supply domestic and industrial uses in Sacramento and San Francisco. In 1850, a large flood event caused widespread damage to the many valley towns and agricultural developments located on the floodplain. This and other damaging floods led local communities to construct the first human-made levees, altering the natural hydrologic systems (Kelley 1989). In addition, groundwater pumping, river channelization, dam building, and water diversion were developed for flood control and to meet agricultural and urban demand for water (Kelley 1989). By the late 1970s, over 96% of riparian forests had been removed, with fragments surviving in an agricultural matrix under pressure from human populations (Thompson 1961; Katibah 1984). Even with major alteration of the riparian forest and natural hydrology, the Sacramento River still contains some of the most diverse and extensive riparian habitat in California. Hence, restoration of this important river is essential to conserve remaining species and ecosystem services.

Restoration Objectives, Targets, Plans, and Initiatives

In 1986, recognition of the importance of this riparian habitat to threatened and endangered species and ecosystem services led to the passage of the State Senate Bill 1086. This legislation designated the Sacramento River Conservation Area (SRCA), a 160-km floodplain between Red Bluff and Colusa (figure 17.1), for restoration (CRA 2000). Holistic restoration of large river systems should include the hydrogeomorphic processes causing spatial and temporal habitat heterogeneity through erosion and deposition as the river channel migrates (Gore and Shields 1995). Human alterations to the Sacramento River have changed the frequency, magnitude, timing, and duration of these hydrogeomorphic processes, such as the construction of Shasta Dam in the 1940s, which regulates water flow through the restoration project area. Hydrogeomorphic processes have also been altered by bank revetment and levees. These changes have reduced natural river processes, including meandering, channel and bank erosion and sedimentation, river branching, channel cutoff and oxbow formation, which affect the associated vegetation succession, structure, and wildlife use (Buer et al. 1989). However, completely restoring these processes to their natural states is incompatible with current human settlement patterns and appropriation of water for agricultural and household use (Golet et al. 2006).

Given the limitations for restoring large-scale hydrogeomorphic processes, the Sacramento River project is pursuing the following reach-scale strategies: (1) acquiring land from voluntary sellers, particularly flood-prone areas bordering remnant riparian habitats; (2) revegetating those properties with native trees, shrubs, understory plants, and grasses; and (3) restoring some natural river processes (Golet et al. 2006). To date, using federal, state, and private sources, approximately 2,000 hectares have been planted with riparian species by two main nongovernmental organizations, The Nature Conservancy (TNC) and River Partners. The majority of the planting has been with riparian forest species, although more recently some native grasslands have been restored to reestablish natural heterogeneity and minimize flooding (Efseaff et al. 2003).

Given the large scale of the restoration, the costs are substantial. These include land acquisition (approximately \$2,500–\$10,000/ha) (Hunter et al. 1999) and site preparation, planting, and maintenance (approximately \$10,000/ha) (R. Luster, TNC, California, personal communication). Major funding has come from a state-federal cooperative program (Calfed) aimed at restoring the San Francisco Bay–Delta and Tributaries, as well as other state, federal, and private organizations and individuals, such as the Wildlife Conservation Board, U.S. Fish and Wildlife Service, Ducks Unlimited, and private landowners (Golet et al. 2006). Restoration has also been paid for by bond measures, in which California residents vote on whether to borrow money from the state to pay for restoration. However, most of

these measures have passed in urban counties, where voters often believe that restoration will benefit them through clean drinking water and watershed protection, yet they have received well below the majority vote in the counties where the restoration is being done.

Resistance to the Restoration of Natural Capital

Landscapes are connected not only ecologically but also socioeconomically. While conservationists highlight the economic and ecological benefits of restoration, many landowners in the Sacramento River region perceive net negative impacts of restoration (Golet et al. 2006). These transboundary influences between adjacent landscape elements can lead to tension and conflict. In several surveys conducted in the SCRA, many members of the farming and larger regional community perceived the restoration of natural habitat as locally providing mostly negative effects (Wolf 2002; Singh 2004; Buckley 2004; Jones 2005). These perceptions of negative externalities have led to efforts by the regional community to stop or reduce restoration. For example, in March 2002, the SCRA Board voted to reduce the SRCA from 86,000 to 32,000 hectares at a meeting where more than one hundred landowners spoke out against the SRCA (Martin 2002). Furthermore, the county and city of Colusa, located within the SCRA, voted in 2006 to enforce more stringent protection for private landowners when approving restoration projects (Hacking 2006).

Farmers' concerns associated with natural habitat restoration include the possibilities of increased numbers of vertebrate pests such as squirrels and deer; endangered species use of their land and consequent critical habitat designation; agricultural weeds; and the general loss of farmland and farm culture (Wolf 2002; Singh 2004; Buckley 2004; Jones 2005). Moreover, many of the farmers have lived for generations along the river and feel strong bonds with the land and their neighbors, while respecting the management strategies of their ancestors. There is also general concern that cheap agricultural imports, suburban sprawl, and large-scale corporate farming imperil the farmers' lifestyle. Such threats are more difficult to influence locally than restoration activities, leaving the latter as a more accessible target for local farming communities. The larger regional community has also voiced concerns regarding security, loss of local tax revenue, and flooding.

Concerns about increased flooding are valid in some situations, as reforestation can slow the movement of water during high-flow events due to increased surface roughness, leading to higher flood levels (Sellin and Beesten 2004). However, the type of habitat and spatial positioning of restored areas can affect the possible flooding effects. In contrast, little research exists to support or refute some of the negative perceptions farmers hold about restoration. For example, weed species of concern to farmers are often found in restored or remnant riparian habitat, as well as in road verges and small patches at the edges of farms, where herbicides are not applied. Although weeds are not planted in the restored riparian habitats, they often colonize these areas (Efseaff et al. 2003; Holl and Crone 2004). In fact, there is extensive research on invasive species movement from agriculture to restored habitat (Fox et al. 1997), yet little research has focused on the opposite direction. Additional fears within the wider community are the potential for increased trespassing and security problems associated with greater recreational use of natural habitat (Jones 2005), which may require more police activity, although these issues are largely unquantified.

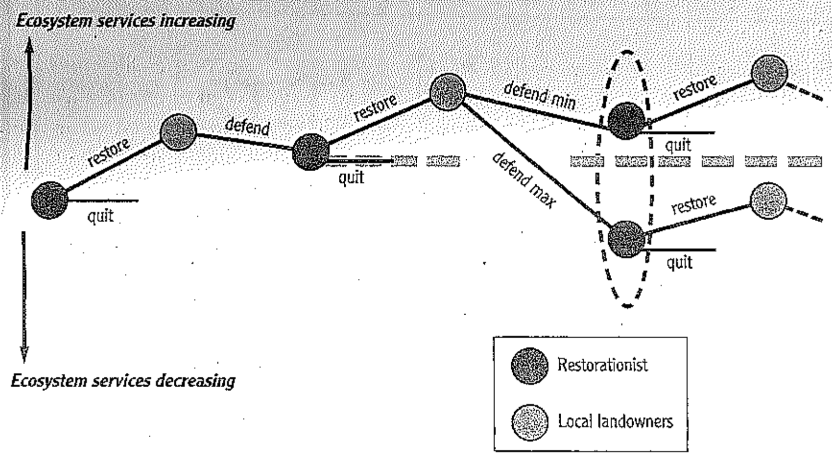

FIGURE 17.2. Restorationists' and local landowners' defensive decisions and their ecological consequences. With decisions by restorationists (black circles) from their indicated decision nodes, local landowners (gray circles) make corresponding decisions to defend against negative impacts. At the second decision node for local landowners, the net effect on ecosystem services can have two different responses (indicated by black dotted oval). Overall ecosystem services could increase if the local landowners have a minimal defensive response. If the local landowners respond with a maximum defensive action, the net effect on ecosystem services could be negative, indicated by the potential for ecosystem services to decrease below the level prior to the last restoration project (indicated by gray dotted line).

(Buckley 2004). Such defensive investments included revetment of riverbanks, removing natural vegetation, fencing, and increasing chemical usage on their property and sometimes on adjacent restoration sites without permission. Defensive investments might also take the form of political activity, such as lobbying, voting, or opposition publicity campaigns, if it is expected to be more effective than on-site activities. Generally, if restoration is perceived to potentially elicit negative social feedbacks, then there might be certain points where restoration elicits responses that offset some or all of the ecological gains (figure 17.2). Identifying these points before they occur is critical to achieving socially desirable outcomes for farmers and restorationists, and spatial positioning, on-site project design, and total landscape-project concentration can all influence the magnitude of response.

Farmers will take defensive actions if they expect that the value of prevented damage to their livelihood and lifestyle is greater than the cost of defense (figure 17.2). The best response for the restorationist is to restore the piece of land if the net ecological gains outweigh the financial and opportunity costs of restoration (figure 17.2). Including social planning and maintenance efforts to remove or reduce negative transboundary effects might increase total restoration costs and reduce on-site ecological gains. However, by preventing negative effects that elicit defensive behavior, total regional ecological-function gains may increase the possibility of reaching the overarching goal (Buckley and Haddad 2006). Directly applying these models would require extensive parameterization and further characterization of the social

dynamics and marginal costs and benefits for landowners and restorationists. However, this approach has the potential as a framework for incorporating social impacts and feedbacks when planning large-scale restoration.

Contribution

To restore natural capital in socioecological systems, such as most large river systems, it is necessary to build bridges among stakeholders early in the process. Restoration is generally viewed and approached by practitioners as having only positive benefits, yet there may be negative local effects that are not addressed when social impacts are considered. This can lead to conflicts among stakeholders in the region that are difficult to resolve after restoration and any potentially damaging effects have occurred. As has been demonstrated on the Sacramento River, negative perceptions by landowners can ultimately reduce and hinder restoration efforts.

Some conflicts over the local effects of restoration projects are inevitable. While the ecological flows (such as nutrient transport, water quality maintenance, and species migration) from restoration of natural capital along the Sacramento River are distributed on large scales (with possibly higher local benefits), the costs of negative externalities are locally concentrated. Local stakeholders also have multiple frames of reference in which they perceive restoration, leading to valid, unknown, or invalid objections. As part of a successful restoration program, managers and policymakers must address these objections through mitigation, research, and communication, ideally prior to implementing restoration. Hence, a socially strategic approach, which focuses on determining and preventing negative effects that could elicit defensive behavior, can lead to local acceptance of activities that improve regional ecosystem services and processes.

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