

Box 18.2. Barriers, Invasion, and Conservation of Native Salmonids in Coldwater Streams

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Habitat loss and fragmentation are threats to persistence of many native fish populations. Invading nonnative species that may restrict or displace native species are also important. These two issues are particularly relevant for native salmonids that are often limited to remnant habitats in cold, headwater streams. On the surface, reversing threats to native fishes would seem to be straightforward: focus all available resources on habitat restoration and control of invaders. However, there are trade-offs that make this a more complex problem. This is well illustrated by the installation or removal of barriers to fish movements because either action may simultaneously mitigate and exacerbate risks to native salmonid populations.

The size, distribution, and connectivity of suitable habitats are common issues in the conservation of native salmonid populations. The reason is that the size of stream habitat networks and connectivity among habitats are important to persistence of local populations. Loss of connectivity can lead to loss of genetic diversity (Wofford et al. 2005; Neville et al. 2006b; Guy et al. 2008), increased vulnerability to catastrophic events, loss of migratory life histories needed to access complementary habitats (Northcote 1997; Rieman and Dunham 2000), and loss of connectivity to other populations that historically facilitated demographic support, rescue, or even reinvasion (Rieman and Dunham 2000; Letcher et al. 2007). Declines in habitat size and connectivity have been caused by habitat degradation (e.g., streamflow diversion, increased water temperature, and decreased water quality) and habitat fragmentation by fish passage barriers (e.g., road culverts, hydroelectric dams, and diversion dams). Reversing habitat degradation can be a relatively complex process involving extensive watershed and streamside protection or restoration that can be expensive, controversial, and slow to take effect. In contrast, many fish passage barriers block access to relatively high-quality headwater habitat, and restoring access to these habitats would seem a simple matter of removing barriers. Most fish passage barriers are quite small, but there are thousands across the landscapes supporting native salmonids (GAO 2001). Restoration of fish passage thus offers an important opportunity to make rapid gains in restoring both size and connectivity of fish habitats and populations.

Nevertheless, even within the apparently simple arena of fish passage restoration involving smaller barriers, there are outstanding issues that require further consideration.

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Box 18.2. Continued.

First, it is clear that existing resources (people, money, time, and materials) are inadequate to restore fish passage in a timely manner for the vast majority of cases (GAO 2001). In this situation, it becomes important to justify the relevance of individual projects. Managers must prioritize limited resources effectively to make sure that projects actually gain the greatest benefits possible. Research on fish population persistence upstream of fish passage barriers (e.g., Morita and Yamamoto 2002) also has shown that the probability of extinction increases as a function of time. A process of triage by which the most urgent projects with the greatest chances of success are prioritized would be required.

A second major consideration is that restoring fish passage might allow invasions of nonnative fishes that could threaten native species and ecosystems. In many parts of the inland West, managers are actively installing passage barriers to protect upstream populations of native fishes from invasions by nonnative fishes. Some existing passage barriers may indeed be protecting upstream habitats from invasions, but in the long term, isolated populations of native fishes face an elevated risk of extinction. Thus, conflicts between management to reduce threats from nonnative fishes versus threats from habitat isolation highlight the real-world uncertainties and complexities in identifying priorities and use of fish passage barriers.

Trade-offs may be relatively clear to biologists with intimate knowledge of a particular system, and their efforts can be focused effectively. Elsewhere, where trade-offs may be more ambiguous or data and experience more limited, the result may be a decision that is influenced more by personal philosophy or public pressure than by knowledge. When differences in these choices cannot be clearly supported and articulated, the decision process can appear inconsistent and arbitrary to the public or administrators who fund these projects. A consistent decision process would include an analysis of the relative risks associated with either action.

Biologists can weigh risks and benefits of installing or removing migration barriers by articulating the biological processes and social values defining the problem. Fausch et al. (2006) suggested that the context for this particular problem can be defined by three key elements: (1) understanding conservation values at risk and recognizing that some (e.g., conservation of genetic purity) may require barriers, but others (e.g., reestablishment of main-stem fisheries supported by tributary spawning) may require barrier removal; (2) understanding how environmental conditions in a particular watershed favor or constrain nonnative fish invasion and displacement of the native species; and (3) understanding the likelihood of local extinction if a native population is isolated, with recognition that time, size, and quality of the isolated habitat, and the species in question can strongly influence that probability. By assembling this kind of information for streams and populations across a region of interest, biologists can begin to prioritize where to work and what to do more effectively. Formal decision models are now available to facilitate this process when the underlying biology is relatively well known (Peterson et al. 2008b); even when it is not, however, acknowledgment of the general gradients important to these trade-offs can help focus limited management resources.