IV. Aquatics

By Michael K. Young

The problem of invasive aquatic species has long been recognized by scientists at the Rocky Mountain Research Station. Fausch and others (2006, 2009) recently overviewed this issue. A point that often distinguishes nonnative aquatic species from nonnatives in other environments is that the presence of some species is frequently prized by managers and the public. For example, many sport fisheries in the Rocky Mountains are based on angling for nonnative brook trout, brown trout, or rainbow trout, which have been implicated in the loss of native cutthroat trout and bull trout (Dunham and others 2002; Rieman and others 2006). In some cases, "native" cutthroat trout are regularly introduced into previously fishless waters where they may displace other aquatic species, such as some native amphibians (Dunham and others 2004). The sometimes conflicting societal desires for protecting native species and providing recreational opportunities presents managers with many challenges, which are intensified by the increasing urbanization of the Rocky Mountains, growing demands for water, and altered precipitation and streamflow patterns driven by climate change. Thus, prioritizing where to conduct native species conservation—based on species habitat requirements, the ecological, evolutionary, and social value of particular populations, and habitat distribution and dynamics—represents a knowledge gap that needs to be addressed, for example with the group of decision models applied to systematic conservation planning (Peterson and others 2008).

Furthermore, much of the research on aquatic invasive species has focused on nonnative salmonid fishes. Little work has been done by RMRS on invasive algae. Given climate change forecasts for reduced late summer stream flows and warming temperatures, future waves of nonnative species invasions are likely to include coolwater and warmwater species of fishes that arrive via connected river networks or human-assisted transport e.g., smallmouth bass throughout the Pacific Northwest (Sharma and others 2009). Moreover, large numbers of other kinds of invasive aquatic organisms—crayfish, mussels, amphibians, macroinvertebrates, and nonindigenous pathogens—are already present or likely to appear. Little work in any of the four core areas has been done with respect to these taxa, although this may become a management and research priority in the near future.

(1) Prevention. The prevention and prediction of invasions of nonnative aquatic species are critical concerns of managers. Rocky Mountain Research Station scientists have contributed to providing information that addresses aspects of prevention and prediction. For example, because rivers and streams are linear networks, strategically placed barriers to fish movements can create upstream refuges for native fish. A critical issue is how the size and characteristics of the upstream network are related to long-term persistence of native fish populations (Peterson and others ongoing), which dictates where barriers to nonnative fish migrations should be placed. Yet perhaps as or more important to persistence of native fish populations is the retention of connectivity between different populations. This connectivity might permit demographic support for marginally productive populations from stronger ones or the re-founding of populations lost after environmental catastrophes. Hence, the management problem is not just where to build a barrier to fish movement, but whether to build one at all. To that end, researchers have constructed a decision model that quantifies the tradeoffs between the invasion of a nonnative species, brook trout, and the retention of migratory pathways for a native species, west slope cutthroat trout (Peterson and others 2008). Constructing similar models for other sets of native and nonnative species, and conducting the field research supporting this work, would assist managers in other parts of the Rocky Mountains.

Less work has been directed at predicting which nonnative aquatic species are likely to appear. This is in part because many nonnative sport fishes have already been widely distributed by management agencies and have access to many waters throughout the Rocky Mountains. Moreover, although stocking of nonnative species in waters containing native species has greatly declined, illegal transfers by anglers have increased in recent decades. Thus the suite of nonnative fishes likely to appear is well known, but whether they will successfully invade new or accessible waters is not. Recent and ongoing research (Rich and others 2003; Rieman and others 2006; Benjamin and others 2007; Wenger and others ongoing; Neville and others

ongoing) is identifying how environmental characteristics (e.g., hydrologic regime, stream valley configuration, water temperature, land management, natural disturbance, and climate change) influence invasion success by brook trout. Similar work needs to be undertaken for other species.

(2) Early Detection and Rapid Response. A focus of aquatic species research in RMRS has been quantifying detectability of fish species during sampling (Peterson and others 2004, 2005; Young and Schmetterling 2004; Rosenberger and Dunham 2005; Schmetterling and Young ongoing; Thurow and others ongoing). The objective of this work was to improve the reliability of electrofishing-based estimates of the presence or abundance of certain species of salmonid fishes, primarily federally threatened bull trout. Tailoring this work to address the presence or abundance of nonnative species such as brook trout, brown trout, or rainbow trout would be relatively straightforward but has yet to be done.

There remain two key problems with respect to early detection of nonnative fish species. First, using electrofishing-based sampling to establish presence tends to be labor-intensive and expensive, making it unlikely that large numbers of waters will be surveyed annually. Thus, early detection of invasions of nonnative fishes is unlikely unless particular sites are already being monitored for other purposes. Second, hybridization of native species with nonnative ones, such as bull trout with brook trout or westslope cutthroat trout with rainbow trout, is a great concern for managers. The loss of genetic integrity of populations of native species may be driven by the movements of hybridized individuals (Hitt and others 2003) that are often difficult to recognize during field sampling. Presently, genetic assessments of these fish are neither timely nor inexpensive enough to permit their use for monitoring the status of invasions of hybridized fish. Hence, a key management need is a cost-effective, broad-scale assessment of fish community composition and genetic status.

(3) Control and Management. Research on the control and management of nonnative aquatic species was mentioned in conjunction with prevention, although relatively little work has directly addressed eradication or suppression of nonnative species. An exception has been the preliminary study on the effectiveness of pheromone-based removals of brook trout (Young and others 2003; Lamansky and others 2009). This research is modeled after insect control practices that rely on pheromone traps or lures. Refinement of this approach for brook trout and its extension to other species, as well as work on mechanical control of other nonnative fishes (Rinne and others ongoing) would fill a large void for managers, who at present have few tools for the effective control of nonnative fishes.

(4) Rehabilitation and Restoration. Rehabilitating or restoring populations of native species following nonnative species removal has not been a focus of research or a widely expressed management need because populations have been reestablished following long-used fish stocking protocols. Nevertheless, research in this area may be required if restoring population characteristics such as genetic diversity or life history complexity become restoration targets. A potentially controversial problem that is largely unstudied involves habitat restoration, much of which is completed under the guise of improving habitat for fish species. Yet it is unknown whether such activities favor native or nonnative species. Similar work on the effects of natural disturbance, e.g., severe fire, debris torrents, and floods, indicated that native fishes responded more favorably following disturbance than did nonnative fishes (Sestrich and others in prep; Rinne and others in prep), suggesting that more stable, "restored" habitats may prove detrimental to native fishes when nonnative fishes are present (Dunham and others 2003; Rinne and others in prep). More comprehensive research on community responses to natural disturbance and human manipulation of freshwater habitats is necessary to satisfy information needs of managers.

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