Barrier dam on the upper West Fork Black River. Such barriers are constructed to isolate downstream non-native fishes from upstream populations of native trout.

Managing Native Trout Past Peak Water

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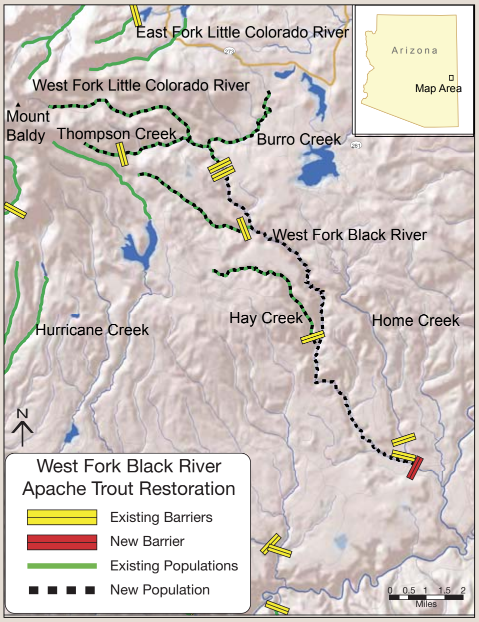
Climate change poses new challenges to managing native trout in the Southwest, where water already is in high demand and will likely become even more scarce as temperatures increase. Overall, the causes for declines of the three native southwestern trout—Apache, Gila, and Rio Grande cutthroat—are similar and mainly due to degradation of stream habitat and negative interactions with introduced trout species. The Gila and Apache trout were listed as endangered under the Endangered Species Act (ESA) 35 years ago, but subsequently have been reclassified to threatened because of recovery efforts by government and tribal agencies and countless anglers and volunteers. However, the status of both species remains precarious. Additionally, the U.S. Fish and Wildlife Service determined in May 2008 that the Rio Grande cutthroat warranted listing pursuant to the ESA.

Recovery plans for Gila and Apache trout require that non-native trout be removed, land-use impacts minimized, and habitat restored. Rock barriers have been constructed in headwater streams to separate downstream non-native species from upstream populations of native trout. The success of native fish re-establishment may depend entirely on barrier integrity, particularly for native trout that hybridize (interbreed) with non-native trout. Thus, biologists depend on solid barrier construction and adequate monitoring to ensure barriers continue to function properly. Equally important to the success of re-established populations is the effective removal of non-native fish that pose serious threats to native fish populations. Biologists rely on chemicals to conduct thorough removal treatments. In combination or separately, fish barriers and piscicides (see sidebar) are tools of the trade that have been used for native fish restoration since the 1950s.

Now, stochastic threats such as drought, wildfire, and post-fire flooding in native trout habitat appear to be on the rise, making these species especially vulnerable because small remaining populations are in areas most likely to be impacted by these climatic effects. Reliance on headwater streams as recovery areas has resulted in the creation of genetically isolated populations in fragmented stream reaches. Historically, interconnected stream systems allowed native trout to migrate and move between headwater streams and larger downstream rivers, and avoid areas disturbed by wildfire or drought. Small stream segments also limit the total number of fish that can be supported in a population, leading to problems with maintaining genetic integrity. The negative impacts of the new restricted habitats are likely to become exacerbated in an era of rapid climate change.

For stream-dwelling trout populations, fishery experts consider that a minimum population of 500 reproducing adults (of equal sex ratio) spread over at least 9.3 kilometers (km) of good-quality stream habitat is needed to ensure long-term persistence of trout populations (Hilderbrand and Kershner, 2000). A recent analysis of Apache trout conducted by Trout Unlimited as part of its Conservation Success Index (*tucsi.spatialdynamics.com*) found that less than one-third of existing populations meet that criteria.



Map of upper Black River showing proposed habitat expansion and reconnection for Apache trout in the West Fork Black River drainage.

Climate Impacts

Climate models for the Southwest predict a continuing increase in drought and flood severity, warmer air and water temperatures, less precipitation, and more evapotranspiration. As noted by Hoerling and Eischeid (2007), the Southwest is past peak water. They estimate that by about 2050, average moisture balance conditions will mimic conditions experienced only rarely at the height of the most severe historic

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droughts. Warming trends will alter seasonal river flows, making them higher during winter and lower in summer. Less snowfall and more rain during winter may result in earlier spring runoff, and drought subsequently may be more intense during summer low flows.

Such climate changes would further endanger native trout in the Southwest. Warmer water temperatures in lower stream reaches and less flow in small tributaries limit available habitat during summer. Apache trout in Home Creek, a small isolated tributary of the Black River of Arizona (see map), illustrate the problems of managing native trout in an era past peak water. Historically, Home Creek provided habitat for Apache trout, but by 2001 drought was starting to dry the stream. Barrier dams constructed in the downstream segment of Home Creek were intended to prevent spread of non-native fishes into Apache trout habitat but also prevented Apache trout from dispersing within the drainage and finding suitable habitat as the stream dried. No Apache trout were found in 2003 surveys of Home Creek, and by the summer of 2007 the stream was completely dry.

Photo: Julie Meka Carter, AGFD

Removing Unwanted Fish

Biologists have few methods to remove unwanted fish. If complete removal is needed, the best method often is chemical treatment; antimycin or rotenone are the most commonly used piscicides. Both interfere with the fish's ability to breathe and are toxic to fish, gill-breathing invertebrates, and to a greater or lesser degree amphibians. Nontargeted species must be removed prior to administering the chemical. If necessary, nontargeted fish can be temporarily held in cages in adjacent streams until the chemicals degrade in two to seven days. The chemical can also be neutralized by adding potassium permanganate to the stream. Fish killed with piscicide may be safely consumed by scavengers.

The presence of non-native fishes further complicates management decisions. In the upper Gila River drainage in New Mexico, recent studies document declining native fish and increasing non-natives during times of lower stream flows (Probst and others, 2008). Impacts of non-native fish predators, such as brown trout and smallmouth bass, appear more pronounced during drought.

Restoring Connectivity

To significantly increase the size of populations and improve their resiliency to drought, fire, and post-fire floods, more stream habitat must be provided by expanding some of the existing recovery populations and creating interconnected "metapopulations." Not only would trout numbers increase as they occupy more habitat, but the larger streams should produce larger individual trout. Increasing the number of large fish is important because larger females produce many more eggs and larger fish are less susceptible to predation from introduced brown trout.

Identifying opportunities for expanding populations is not easy. For Apache trout, few perennial stream networks exist within their historic range that might function as metapopulation sites, mainly because of water impoundments, reservoirs, and conflicts with existing land uses.

State and federal agencies and angler groups are working to restore connectivity within the West Fork of the Black River to create an

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Woody plant encroachment: Large tracts of grasslands and savannas have been converted to woodlands through a process often described as woody plant encroachment. These conversions result from a combination of factors, including overgrazing, reduction in fire frequency, and increases in greenhouse gases. They are likely to significantly affect the water cycle in terms of ecological processes and distribution of water across the landscape. In addition, there is good evidence that a shift from grasses to shrubs diminishes groundwater recharge—although not to a degree important for water supply. Little if any evidence suggests that woody plant encroachment has led to large-scale changes in streamflow, except where it is accompanied by degradation or desertification. Surface runoff and erosion will be significantly higher under degraded than nondegraded conditions. For example, Wilcox and others (2008) demonstrated that floods in west Texas in the earlier part of the last century were much greater than now because rangelands were much more degraded.

Looking Ahead

Understanding and mitigating the effects of transformative landscape change will dominate and transform land and watershed management in the future. The rich and diverse legacy of research into the relationship between vegetation management and water yields will provide a solid foundation for building new strategies to meet these future challenges.

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References

National Academy of Sciences, 2008. Hydrologic Effects of a Changing Forest Landscape. Committee on Hydrologic Impacts of Forest Management, 194 pp, National Academies Press, Washington D.C.

Potts, D.F., 1984. Hydrologic impacts of a large scale mountain pine beetle (Dendroctonus ponderosae Hopkins) epidemic, Water Resour. Bull., 20(3): 373-377.

Rood, S.B., J. Pan, K.M. Gill, and others, 2008. Declining summer flows of Rocky Mountain rivers: Changing seasonal hydrology and probable impacts on floodplain forests, J. Hydrology, 349: 397-410.

Stewart, I., D.R. Cayan, and M.D. Dettinger, 2004, Changes in snowmelt runoff timing in western North America under a "business as usual" climate change scenario, Climatic Change, 62(1-3): 217-232.

Wilcox, B.P., Y. Huang, and J.W. Walker, 2008. Long-term trends in streamflow from semiarid rangelands: Uncovering drivers of change, Global Change Biology, 14(7): 1676-1689.

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Apache trout metapopulation (see map, page 26). The plan requires removal of some existing barriers and construction of a new barrier farther downstream on the West Fork, thereby increasing Apache trout habitat within the streams from 33.4 to 53.1 km. Although some downstream habitat may be warmer during summer, it will also contain deep, shaded pools that offer cooler refuges.

The new barrier will help isolate downstream non-native fishes from Apache trout. Non-native trout likely will have to be removed from the upstream area by chemical treatment. Regular stream monitoring will be needed to determine the relative status of native and non-native species as well as the effectiveness of barriers and control treatments.

State, federal, and tribal agencies typically lack sufficient funding to restore needed interconnected metapopulations such as in the West Fork of Black River. For Apache trout, the National Fish and Wildlife Foundation, Trout Unlimited, and other nongovernmental groups are providing additional support to create a few larger interconnected stream systems that complement existing recovery programs. These efforts may afford the best opportunity for native southwestern trout to survive a future that is past peak water.

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References

Hilderbrand, R.H., and J.L. Kershner, 2000. Conserving inland cutthroat trout in small streams: How much habitat is enough? North Amer. J. of Fisheries Management, 20: 513-520.

Hoerling, M., and J. Eischeid, 2007. Past peak water in the Southwest, Southwest Hydrology, 6(1): 18-19, 35.

Probst, D.L., K.B. Gido, and J.A. Stefferud, 2008. Natural flow regimes, nonnative fishes, and native fish persistence in arid-land river systems, Ecol. Applic., 18(5):1236-1252.