A Study of High Mountain Lake Fish Stocking Effects in the U.S. Sierra Nevada Wilderness

BY KATHLEEN R. MATTHEWS AND ROLAND A. KNAPP

Article coauthor Kathleen R. Matthews.

One common perception is that high mountain lakes in protected areas such as wilderness or national parks are pristine and can be viewed as reserves for native biota. However, recent articles (Duff 1995; Carter 1997) have discussed how stocking non-native fish may have profound impacts on native biota and that the introduction of non-native fish disrupts "naturalness" that should be an integral part of wilderness (Carter 1997). Indeed, in our research we found a profound change in the natural conditions of high mountain lake ecosystems within the John Muir Wilderness in the Sierra Nevada mountain range of California, United States. Moreover, our surveys found a link between the widespread introduction of non-native trout and the decline of a native amphibian, the mountain yellow-legged frog (*Ranamuscosa*). This article summarizes preliminary results from our three-year study of the impacts of non-native trout on native biota in high elevation lakes in the Sierra Nevada, proposes some possible restoration ideas, and discusses some related problems.

A Comparative Study of 2,200 Lakes

All lakes at the upper elevations of the Sierra Nevada were historically fishless, but the majority of large lakes now have one or more species of non-native trout. To improve our understanding of non-native trout impacts on native vertebrate and invertebrate species in Sierra Nevada lakes, we compared the aquatic fauna in lakes in the John Muir Wilderness (JMW) to that found in lakes in Kings Canyon National Park (KCNP). Both sites are located in California and are very similar except regarding fish stocking. Fish stocking historically has been much more intensive in the JMW than in KCNP While this practice continues in the JMW, most fish stocking in KCNP was terminated in the late 1970s. Therefore, comparisons between lakes from these two areas allowed us to separate the effects of non-native trout from other environmental factors (e.g., acid deposition, climatic conditions, pesticide drift) in altering the distribution of native aquatic species.

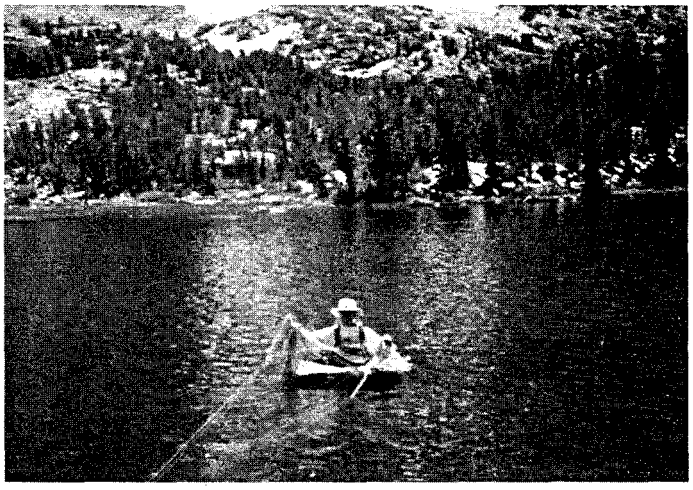
Between 1995 and 1997, research teams from the U.S. Forest Service (USFS) Pacific Southwest Research Station and the University of California Sierra Nevada Aquatic Research Lab surveyed approximately 2,200 lakes (1,079 lakes in the JMW and 1,083 lakes in KCNP). During field surveys, quantitative information on fish, amphibians, invertebrates (zooplankton and benthic macroinvertebrates), and the physical attributes of the lakes and ponds, such'as presence of inlets and outlets, lake depth, and lake size, were collected. This study represents the most extensive sampling of lakes in the Sierra Nevada to date.

Findings

The results of our study indicate that fish distributions have changed dramatically in high elevation lakes throughout the Sierra Nevada. In the areas we surveyed, 316 of 1,079 lakes (29%) in the JMW have introduced trout compared to 207 of 1,083 (19%) in KCNE The percent of lakes with trout increases markedly when only larger lakes are considered, as small lakes and ponds typically have not been stocked with trout. For lakes larger than one hectare (2.5 acres), 80% contain trout in the JMW, but only 40% contain trout in KCNF!

The majority of large lakes (> 1 ha.) in the Sierra Nevada mountain range are regularly stocked by the California Department of Fish and Game based on the assumption that these lakes do not have sufficient natural reproduction to maintain trout populations; however, little study of trout self-sustainability in lakes has been undertaken. We distinguished between lakes with self-sustaining trout populations (those with sufficient natural reproduction to maintain the population even in the absence of stocking) and those with non-self-sustaining trout populations (those with populations maintained solely by stocking because of an absence of natural reproduction) by comparing fish ages with the years in which each lake was stocked. Based on these comparisons for 123 JMW lakes, we estimate that 70% of the lakes currently stocked actually contain self-sustaining trout populations. These populations would persist even if stocking were completely halted. Our estimate that 70% of the currently stocked lakes within the study area are self-sustaining is very similar to the actual percentage of formerly stocked lakes in KCNP that still contain trout. Our surveys of 74 KCNP lakes in which stocking was halted in the late 1970s indicates that 80% still contain trout populations.

We found many more mountain yellow-legged frog populations in KCNP compared to lakes in the JMW Thirty-five percent of the lakes in KCNP (379 of 1,083) contained mountain yellow-legged frogs compared to only five percent of the lakes in the JMW (56 of 1,079). In addition, the total number of frogs observed in KCNP was much higher: A total of 69,638 adult, subadult, and larval mountain yellow-legged frogs were found in KCNP, versus 8,819 adults, subadults, and larvae in the JMW. The mountain yellow-legged frog is particularly sensitive to trout introductions, because it is highly aquatic in all life stages and it has an unusual natural history in which tadpoles overwinter two to three times before metamorphosing into subadult frogs. This overwintering requirement restricts successful breeding to bodies of water that do not dry up in the summer. These are the same bodies of water into which trout most commonly have been introduced.



Netting in a high **mountain** lake. Photo by Kathleen R. Matthews.

Benthic invertebrate and zooplankton samples are currently being processed and the data summarized. Benthic invertebrate data from JMW lakes sampled in 1995 were presented in a 1996 master's thesis by Don Rowan (New Mexico State University). He reported that benthic invertebrate species diversity, mean abundance, and mean size were all lower in trout-contaming lakes, compared to fishless lakes, and that guild composition was greatly altered in trout-containing lakes. The effects of trout on zooplankton appear to be similar.

In conclusion, our preliminary results indicate that most stocked lakes in the JMW have self-sustaining fish populations, and that current levels of fish stocking have had an adverse impact on native biota, especially the mountain yellow-legged frog. Apparently, the lower historical intensity of fish stocking in KCNP and its termination in the late 1970s provided numerous fishless lakes that serve as refuges for mountain yellow-legged frogs. These refuges are nearly absent in the JMW because most of the larger lakes now contain trout. As a result, the mountain yellow-legged frog is now absent from the majority of sites in the JMW where it previously occurred and, if no steps are taken to reverse this decline, it is likely to be listed under the federal Endangered Species Act in the future. Fish and frog distributions in KCNP could serve as a useful model for future restoration strategies in the JMW. Our study indicates that recovery of the mountain yellow-legged frog in the

Mountain yellow-legged frog (***Rana muscosa***). Photo by Kathleen R. Matthews.

High mountain lake in the Sierra Nevada. Photo by Kathleen R. Matthews.

JMW will require that some currently stocked lakes he allowed to revert to a fishless condition. If such lakes are selected carefully, the recovery of the mountain yellow-legged frog could be accomplished with only minimal effect on the recreational fishery. Steps taken now to restore the mountain yellow-legged frog to a subset of formerly occupied habitat could dramatically reduce the likelihood of federally listing this species in the future.

Recommendations

To this end, wc recommend that adaptive management projects he implemented in the JMW to evaluate the effect of reducing trout stocking on resident trout populations and native biota. Specifically, wc have proposed first trying to restore frogs in the basins where they currently are most abundant and where fish distribution can be managed. Within these basins, we propose a halt to fish stocking and removal of fish from lakes where they arc self-sustaining if frogs are present or nearby. Techniques are currently available to remove fish using gillnets (Knapp and Matthews 1998), which avoids any adverse affect of poisons. However, according to current interpretations of The Wilderness Act (TWA) and subsequent agreements, management responsibilities for fish stocking on U.S. Forest Service lands lies with the state agencies. The USFS's role in managing fish stocking in wilderness remains unclear. For example, in the final Environmental Impact Statement (EIS) for the Desolation Wilderness (November 1998) in the northern Sierra Nevada mountain range, fish stocking was not analyzed as an issue and, instead, will be dealt with outside the EIS.

Conclusions

Some have argued that fish stocking is not compatible with the intent of TWA, which defines wilderness as that "which is protected and managed so as to preserve its natural conditions." Regardless of its compatibility, even if fish stocking were completely halted over the entire Sierra Nevada mountain range, fish would still dominate the landscape, because most lakes now have self-sustaining populations. Thus, any restoration projects would only hope to return some small proportion of lakes back to a naturally fishless condition. Moreover, the costs of evaluating the impacts of fish stocking or repairing its damage has not been incorporated into fish stocking programs; so far these have been the financial responsibility of federal agencies. The prospect for restoring lakes to a fishless condition remains uncertain. IJW

KATHLEEN R. MATTHEWS is a research scientist with the USFS Pacific Southwest Research Station in Albany, California. Kathleen can be reached at PSW Research Station, Box 245, Berkeley, California 94701, USA. Telephone: 5 1 O-559-6454. E-mail: kmatthews/psw@fs.fed.us.

ROLAND A. KNAPP is a research biologist at the University of California, Sierra Nevada Aquatic Research Laboratory in Mammoth Lakes, California. E-mail: knapp@lifesci.ucsb.edu.

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