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## When the Trout Arrive, the Amphibian Exodus Begins

BISHOP, Calif., Nov. 27 — The crystal mountain lakes of the Sierra Nevada, set among verdant meadows and snowy granite peaks, have become known throughout the world as a paradise for trout fishing.

But this anglers' heaven is man-made. Like most high-elevation lakes in the West, almost all of those in the Sierra were originally fishless. The trout got their start in hatcheries and were placed by the millions in the lakes by the California Department of Fish and Game.

The trout stocking, scientists are now finding, has been disastrous for some amphibians native to the areas.

A federally financed study released in April showed that the mountain yellow-legged frog has vanished from more than 90 percent of its native range in the high reaches of the Sierra Nevada primarily because it is being devoured by the introduced trout.

The frog's decline is so severe that the United States Fish and Wildlife Service could list it as an endangered species on an emergency basis next year, despite a recently announced moratorium on considering most new listings, said Jason Davis, a Fish and Wildlife Service biologist.

Research in other states has shown that trout stocked by state wildlife agencies have eliminated long-toed salamanders from some mountain lakes in their range, and reduced the numbers of Cascades frogs and spotted frogs at the lakes.

To preserve the amphibians, biologists are recommending that some states reduce the scale of their trout stocking and even remove the fish from some popular fishing lakes.

For the Sierra, federal officials have been developing a recovery plan for the mountain yellow-legged frog that would require eliminating trout from many back country lakes — a plan that would probably anger fishermen and worry local communities whose economies depend on fishing tourism.

Mountain yellow-legged frogs were once among the most common amphibians in the Sierra.

In his 1924 book, "Animal Life in the Yosemite," the naturalist Joseph Grinnell noted an abundance of the frogs, but also that "the advent of fish in a lake sooner or later nearly or quite eliminates the frogs."

In the mid-90's, Dr. Roland Knapp, a fish biologist at the University of California at Santa Barbara, and Dr. Kathleen Matthews, a biologist with the federal Forest Service, began a three-year study of more than 2,000 high Sierra lakes to determine why the frog had vanished from most of its range.

They found that the frogs were seven times as likely to be found in the mountains of Kings Canyon National Park, located in the southern Sierra Nevada and where fish stocking was discontinued entirely in the 1970's, than in the Forest Service's adjacent John Muir Wilderness, stocked intensively with trout by the state since the end of World War II.

The biologists concluded that trout were the main cause of the frog's disappearance because the stocking of fish was the only significant difference between the two pristine preserves.

"There is no question that the decline of the mountain yellow-legged frog is dramatic, and there is no question that trout are playing an important role in the decline and appear to be the primary cause," Dr. Knapp said.

Trout are voracious predators of mountain yellow-legged frogs, devouring tadpoles as well as adults. The frogs are especially vulnerable because they are more aquatic than most amphibians, spending virtually their entire lives, from egg to adult, in the water.

Also, unlike many other frogs that metamorphose from tadpoles to adults in one year, the high-elevation frogs take three to four years to reach adulthood, so they are restricted to deeper bodies of water that do not dry up in summer or freeze solid in winter. Those lakes are the same ones that hold trout.

Environmental groups petitioned the Fish and Wildlife Service to list the frog as endangered this year because it is found nowhere else but the Sierra Nevada and in the San Jacinto, San Bernardino and San Ignacio Mountains of Southern California, where it has already been proposed for listing.

Like the frog in the Sierra, the long-toed salamander has a long maturation period, spending two to three years in the water as larvae vulnerable to trout. A study of lakes in the Frank Church-River of No Return Wilderness in Idaho, conducted by an Idaho State University graduate student, David Pilliod, found that stocked trout were preying heavily on the native salamanders there, reducing their numbers as well as those of spotted frogs.

Another study in the Trinity Alps Wilderness in Northern California is finding that long-toed salamanders as well as Cascades frogs have virtually disappeared from the high-elevation lakes where Eastern brook and rainbow trout have been introduced.

"If there are fish there, there aren't any amphibians or there is just a remnant population, and there is no evidence of breeding," Dr. Hartwell Welsh, a Forest Service research biologist, said of the salamanders. "In places where you do find a lot of breeding, there are no fish. It's a pretty clean-cut result."

Another study in North Cascades National Park in Washington found that long-toed salamanders had either disappeared or were very rare at lakes that held trout.

Although the salamander is not considered an endangered species, its vulnerability to trout has increased concerns across the Pacific Northwest about trout stocking practices.

Dr. Andrew Blaustein, a zoology professor at Oregon State University, added that stocked trout could also transmit a fungus, saprolegnia. "The fungus will kill eggs of amphibians outright and will kill tadpoles and adults," he said. "Fish in hatcheries are just loaded with this stuff."

The studies have focused on alpine and subalpine lakes in the West because most were historically fishless and they are simpler, more fragile ecosystems where the impact of introduced trout tends to be more drastic than at lower-elevation waters.

The scientists believe the disappearance of amphibians has broader effects on ecosystems, particularly at the higher elevations where fewer animals can live. For example, the population of garter snakes, whose diet depends heavily on mountain yellow-legged frogs, has declined in the Sierra wilderness area, Dr. Knapp said.

The best and probably only way to save the frogs is to remove trout from lakes, biologists said. In the Sierra, that would require drastic steps, removing fish from as many as 20 percent to 30 percent of the range's roughly 8,000 lakes.

The federal Fish and Wildlife agency has asked the California Department of Fish and Game to stop stocking fish in the thousands of Sierra lakes within the frog's range that cannot be reached by car.

The California agency has stopped stocking some Sierra lakes and has experimentally removed trout from two lakes. But a final federal recovery plan for the frog is likely to go much further, requiring eliminating all trout from a great many Sierra lakes.

"It's unfortunate that the kinds of management we're trying to do now hadn't started 20 years ago," said Curtis Milliron, a state fish biologist who has supervised the trout removals in the Sierra so far. "That would have changed the course of history and the need for listing."

He added that any plan to remove trout from a large number of Sierra lakes would be highly controversial with some fishermen and local communities.

"As soon as you start talking about removing fisheries on a massive scale, you're going to have a lot of opposition," he said. "I think that there would be quite an uproar opposing that."