



Vince King

Global warming is already afoot in the Sierra Nevada. The monthly minimum air temperature has increased by about 5.4 degrees Fahrenheit over the past 100 years in middle-elevation Sierra Nevada.⁵⁸ At Tahoe City, the percent of precipitation falling as snow has decreased from 52 percent in 1911 to 34 percent in 2006.⁵⁹ And, average snowpack in the Sierra Nevada has decreased by 11 percent since 1950.⁶⁰

shallower and warmer.

These changes in temperature and water flow threaten the fish of the Sierra Nevada. As deep, cold pools become increasingly shallow and warm, most steelhead habitat and potentially all spring-run salmon habitat may disappear.⁴⁹ The downstream reach of brown and rainbow trout on the Tule River could decline severely due to changes in stream flow timing and water temperature.⁵⁰ Salmon and rainbow trout that spawn and rear below dams of foothill reservoirs or at associated hatcheries may decline.⁵¹ Increasing winter flows, flooding, and landslides⁵² will increase erosion and sedimentation, lower water quality, and damage nesting sites. Such increases in peak flow can be especially detrimental to the eggs of brown and brook trout.⁵³ Because many Sierra Nevada aquatic systems are already impaired by dams, water diversions, livestock grazing, mining, forestry practices, and urban development,⁵⁴ fish populations in the region will be less able to recover from the projected effects of global warming.

Less snow in the mountains will also have wide-ranging impacts on fish and wildlife in other regions of the state that depend on snowmelt. The Sierra Nevada and Cascades supply about 40 percent of the surface-water runoff flows to the Central Valley⁵⁵ and help replenish groundwater basins



Sierra Nevada:

DECLINING SNOW PACK IMPACTS FISH DOWNSTREAM

The Sierra Nevada region is the poster child for how changes in temperature can impact water reliability. Temperatures in the region are expected to rise 2 to 2.5 degrees Fahrenheit within 50 years, causing more precipitation to fall as rain rather than snow and the snowpack melt to commence earlier in the season.⁴⁶ By midcentury, snowpack is projected to decrease by 12 to 47 percent from historic levels and water flows into Sierra Nevada

reservoirs could decrease by 25 to 30 percent. If global warming continues unabated, snowpack loss of 70 to 90 percent could become a reality by the end of the century.⁴⁷ Stream flows in the Sierra Nevada region and downstream are likely to reach annual maximums earlier in spring, and decrease sooner in the summer. In fact, some permanent streams may only hold water part of the year⁴⁸ and those streams that remain may be

throughout California. In effect, the snowpack serves as the region's largest natural water reservoir. Global warming will reduce the capacity of this reservoir, presenting challenges to water management strategies that depend on it.

Without new policies in place that accommodate changes to the state's natural hydrology, pressure may build to increase water diversions and exports in the Sierra Nevada and foothills, further affecting the region's habitats. Increased water conservation, watershed planning, mountain meadow restoration, and more comprehensive flood policies can help us better manage this changing hydrology and ensure cool, clean water is available for wildlife.

Coldwater fish thrive in the rivers originating in the Sierra Nevada. Historically, one to three million Chinook salmon (pictured here) spawned each year in the western Sierra, with some ascending up to 6,000 feet in elevation.⁵⁶ Today, recreational fishing in the Sierra Nevada is valued at approximately \$200 million annually.⁵⁷



U.S. Fish and Wildlife Service



Klamath River Basin:

UNCERTAIN AND OVERSTRETCHED WATER SUPPLIES

The Klamath River Basin has been blessed with ample water supplies and prime habitat for salmon, steelhead, trout, and countless waterfowl. With runoff from nearby mountains—including the Coastal Ranges, the Trinity Alps, and the Marble, Salmon, and Russian Mountains—combined with up to 100 inches of annual rainfall in the lower part of the basin, the Klamath has earned a reputation for phenomenal aquatic habitats.⁶¹ Historically sustaining the third largest salmon and steelhead run on the West Coast, the basin and adjacent coast of northern California still support one-third of California's Chinook, most of California's Coho salmon and steelhead, and all of California's coast cutthroat trout.⁶²

Although 80 percent of the Klamath basin's wetlands have been drained to support agriculture, the region remains a major spring and fall stopover spot for Pacific Flyway waterfowl, including tens of thousands of white-fronted, snow, Ross's, and Canada geese, tundra swans, northern pintails, mallards, American wigeon, and other ducks. The area also supports among the most prolific breeding populations of ducks, herons, egrets, terns, avocets, white-faced ibis,

geese, and grebes, as well as the largest population of wintering bald eagles in the lower 48 states.⁶³

Yet, water in the Klamath region is in high demand, and fish and waterfowl often end up paying the price. The region now has chronic low water flows, higher water temperatures, and poor water quality. Dams and water diversions, mining operations, logging practices, livestock grazing, and agricultural channel and berm construction have reduced riparian vegetation and shade, helping to earn the Klamath River "impaired" status under the Clean Water Act because of high temperatures.⁶⁴ Fish in the region have been pushed to the brink: between the 1950s and 1990s, salmon and steelhead populations declined 80 percent.⁶⁵ Coho salmon, an indicator of overall watershed health, were listed as threatened under the federal Endangered Species Act in 1997.⁶⁶

Low summer water flows on the Klamath River and its tributaries will be increasingly common because of global warming. With a 3.8 degrees Fahrenheit warming, snowpack in the Cascades is projected to decrease by 66 percent, greatly reducing the snowmelt feeding the basin in the summer.⁶⁷ As the air temperature



Roberta Pumphrey

"I want people like me, who have enjoyed more than forty years of wild trout fishing in places like the backcountry of Sequoia and Kings Canyon, to be able to pass their love of the Sierra experience onto their grandchildren. But if we allow global warming to alter the natural systems upon which our beautiful trout depend—from stream-flow patterns and spawning habitat to the composition and stability of insect populations—I'm concerned that those opportunities may not exist for tomorrow's anglers."

PETE PUMPHREY

Fishing Guide in Bishop, California and writer for California Fly Fisher Magazine