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Status and Trends of the Grand Canyon Population of Humpback Chub

The Colorado River Basin supports one of the most distinctive fish communities in North America, including the federally endangered humpback chub (Gila cypha). One of only six remaining populations of this fish is found in Grand Canyon, Arizona. U.S. Geological Survey scientists and their cooperators are responsible for monitoring the Grand Canyon population. Analysis of recently collected data indicates that the number of Grand Canyon adult humpback chub—fish 4 years old and older and capable of reproduction—increased approximately 50 percent between 2001 and 2008. When possible model error is considered, the estimated number of adult chub in the Grand Canyon population is between 6,000 and 10,000. The most likely number is estimated at 7,650 individuals.

U.S. Geological Survey scientists estimate that the adult population of humpback chub (*Gila cypha*) in the Grand Canyon increased 50 percent between 2001 and 2008. (Photograph courtesy Arizona Game and Fish Department)

The humpback chub (*Gila cypha*) is a freshwater fish that may live as long as 40 years and is found only in the Colorado River Basin. Habitat alterations, including changes caused by dams and reservoirs and the introduction of a wide variety of nonnative fish, have contributed to population declines that caused the humpback chub to be placed on the Federal list of endangered species in 1967. Only six populations of humpback chub are currently known to exist, five above Lees Ferry, Arizona, and one in Grand Canyon, Arizona. The U.S. Geological Survey's (USGS) Grand Canyon Monitoring and Research Center oversees monitoring and research activities for the Grand Canyon population under the auspices of the Glen Canyon Dam Adaptive Management Program.

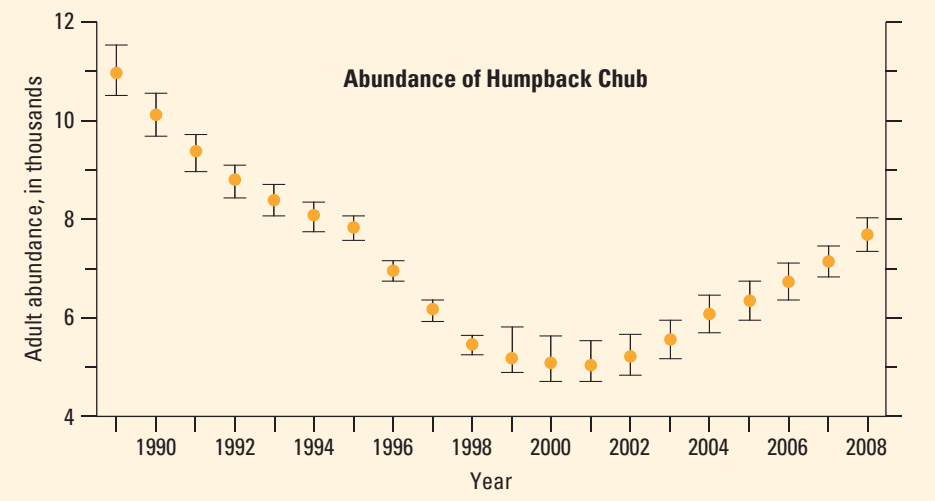
Reaching 20 inches in length, the humpback chub possesses features that distinguish native Colorado River fishes—large adult body size, small depressed skull, large predorsal hump, and small eyes. These features are assumed to be adaptations to life in the historically turbulent and seasonally sediment-laden Colorado River. Today the species is confined to isolated deep canyon stretches of the Colorado River and its tributaries. In Grand Canyon, most humpback chub are found in the Little Colorado River and at its confluence with the Colorado River.

The Grand Canyon population reproduces primarily in the Little Colorado River because mainstem Colorado River temperatures are generally too cold for spawning and juvenile rearing. Humpback chub require a minimum temperature of 16ºC (60.8ºF) to reproduce. Except during drought conditions, the water-intake structures at Glen Canyon Dam are well below the surface of Lake Powell, where the water is not warmed by the sun. Colorado River temperatures in Grand Canyon generally range from 7ºC to 12ºC (44.6ºF–53.6ºF).

Humpback chub have been affected not only by dam-induced changes but also through predation by and competition with nonnative fish. Fish originating in many parts of the world are currently found in the Colorado River, including introduced species of trout, catfish, carp, and bass. Also present in the Colorado River are nonnative fish parasites, such as the Asian tapeworm (*Bothriocephalus acheilognathi*) and anchor worm (*Lernaea cyprinacea*), which infect some humpback chub and may be a threat.

Monitoring the Humpback Chub Population

The USGS uses a method called the Age-Structured Mark-Recapture (ASMR) model, which combines capture data and statistical modeling, to estimate humpback chub



Estimated adult humpback chub abundance (age 4+) from Age-Structured Mark-Recapture (ASMR) model incorporating uncertainty in assignment of age. Error bars represent minimum 95-percent confidence intervals (from Coggins and Walters, 2009) and do not consider uncertainty in growth or mortality rates.

population and recruitment trends. This method provides a relatively strong indication of the population size trend; however, it offers somewhat less confidence for the single population estimate. The data show a steadily declining trend of adult humpback chub from 1989 to 2001 (Coggins and Walters, 2009). From 2001 until 2008, the population reversed, increasing to an estimated 7,650 adult fish in 2008, an increase of approximately 50 percent (Coggins and Walters, 2009).

The ASMR model has been verified as an appropriate approach for estimating trends in humpback chub population size by a series of independent reviewers. Although the current adult population size is estimated at approximately 7,650 individuals, this estimate is very sensitive to assumptions about humpback chub growth and mortality rates. Considering a range of probable values for these parameters, it is likely that there are between 6,000 and 10,000 adult chub in the Grand Canyon population. This level of uncertainty suggests that managers should focus on the temporal trend in humpback chub abundance rather than estimates of absolute abundance.

Causes of the Population Increase

The factors contributing to the estimated increases of adult humpback chub numbers in Grand Canyon are not easy to determine. Between 2000 and 2008, both human-caused and natural events have taken place that may have improved conditions for humpback chub, including experimental water releases from Glen Canyon Dam, removal of nonnative fish, and drought-induced warming of the Colorado River.

Experimental Water Releases

A series of experimental releases from Glen Canyon Dam took place between 2000 and 2008 that may have benefited humpback chub and other native fish. For example, during the summer of 2000, releases from Glen Canyon Dam were constrained during a low steady flow experiment, which caused peak downstream water temperatures in Grand Canyon to exceed 20ºC (68.5ºF). Nearshore water temperatures during the summer of 2000 exceeded the minimum temperature that humpback chub need to reproduce and may have created conditions that allowed fish produced in 1999 to grow more rapidly than in normal, colder temperatures. Additionally, a series of experimental releases from the dam, including three high-flow experiments, may have disadvantaged nonnative fish and improved humpback chub habitat.

Removal of Nonnative Fish

The removal of large numbers of nonnative fish, particularly rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), from the area near the confluence of the Colorado and Little Colorado Rivers may also have benefited the humpback chub population in that area. Not only can trout prey on juvenile humpback chub, but also they rely on the same food sources—aquatic and terrestrial invertebrates, algae, and small fish. Between 2003 and 2006 the rainbow trout population in the Colorado River near the Little Colorado River was reduced by more than 80 percent.

Drought-Induced Warming

Drought conditions are also thought to play a role in the recent rebound in humpback chub numbers. Water temperatures below Glen Canyon Dam increased starting in 2003, as drought caused the level of Lake Powell reservoir to drop, allowing warmer surface water of the reservoir to be released downstream. In 2005, water temperatures in the mainstem Colorado River near the Little Colorado River exceeded 17ºC (60.8ºF), the warmest temperatures recorded there since the reservoir filled in 1980 and approximately the minimum temperature needed by humpback chub to successfully reproduce. Although native fish likely benefit from warmer water releases, there is great concern that warmer water temperatures may also benefit nonnative warmwater fish such as channel catfish (*Ictalurus punctatus*) and other predators.

In the future, USGS, U.S. Fish and Wildlife Service, and Arizona Game and Fish Department scientists will continue to monitor the Grand Canyon population of humpback chub, trying to isolate the conditions responsible for recent improvements in humpback chub population and recruitment trends. Research activities will examine, among other questions, how the March 2008 high-flow experiment affected habitat used by native fish and whether high flows disadvantage nonnative species.

Matthew E. Andersen

Edited by Peter H. Stauffer
Layout by David R. Jones

Reference

Coggins, L.G., Jr., and Walters, C., 2009, Abundance trends and status of the Little Colorado River population of humpback chub—an update considering data from 1989-2008: U.S. Geological Survey Open–File Report 2009–1075, 18 p.

For more information contact:
U.S. Geological Survey
Southwest Biological Science Center
Grand Canyon Monitoring and Research Center
Flagstaff, AZ 86001
928–556–7094 or
mandersen@usgs.gov

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