

L I F E

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A GUIDE TO CALIFORNIA'S  
ENDANGERED NATURAL  
RESOURCES: WILDLIFE

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TO THE CHILDREN, THE NEXT GENERATION OF NATURAL AND CULTURAL HISTORIANS.

ABOUT OUR PAPER ...

Every year, paper mills around the world produce about 240 million tons of paper—most of it made from ground-up trees. In the United States, much of the timber cut each year ends up as paper. In addition, most of the paper destined for printing is bleached white with chlorine compounds, producing extremely toxic organochlorine by-products that are released into the air and water.

Keenly aware of the environmental effects of paper production, we sought a paper for the printing of *Life on the Edge* that would not contribute to excessive timber harvests or the pollution of rivers downstream from paper mills. We wanted a high-quality, chlorine-free paper made with a large percentage of postconsumer waste.

To our dismay, no such paper was available. Suitable grades of recycled paper were not chlorine-free, and chlorine-free papers were not recycled. We did some research to help us solve this dilemma. One thing we discovered was that the recycled label is often not as good as it implies: recycled fibers are relatively short and weak and must be mixed with longer, stronger fibers, such as those from old-growth trees.

Given our limited options, we decided that a chlorine-free paper was preferable to a recycled paper. We settled on MultiArt Silk, made by the Swedish firm Stora Papyrus Nymölla. This paper is bleached with environmentally friendly hydrogen peroxide and oxygen gas. While it contains no recycled fiber, the wood comes from forests managed especially for sustained yield, and no old-growth forest products are used in its manufacture. We hope that in the future the array of choices is less complicated and offers publishers a variety of easily supportable options.



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COVER PHOTO: Computer-enhanced satellite image of coastal California, in the vicinity of Mission Viejo. © EarthSat

## P R E F A C E

In the early 1970s, many species faced extinction, yet we lacked basic knowledge of their biology and the reasons for their decline. After the enactment of endangered species legislation, millions of dollars were invested in species surveys and recovery efforts. Much of the resulting information stayed buried in research reports and symposia proceedings.

Many species teetering on the edge of extinction were pulled back, but conditions promoting endangerment persisted and new species joined the list. People began questioning the effectiveness of endangered species conservation and criticizing its economic impact.

More recently, controversy surrounding the legislation has intensified, and the focus on individual species has come under scrutiny. We saw the need for a guide that sifted the mass of information accumulated over two decades and provided historical and political context, highlighting what is at stake and what is being done.

Our book's distant ancestor, the *Endangered Species Alert Program Manual*, was first published in 1989. This was a handbook for Southern California Edison employees working in or near endangered species habitat. Southern California Edison Company gained wide acclaim for taking action on this important issue. Teachers, resource managers, and others soon were requesting copies of the Manual. This prompted the Manual's project managers, Dan Pearson and Carl Thelander, to bring the same information to a broader audience. The result is *Life on the Edge*.

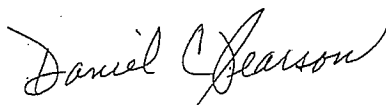
We sought to present the material accurately while making it interesting and comprehensible. It became clear we couldn't accomplish this quickly, and while we no doubt tried the patience of everyone involved, we hope our readers are pleased with the results.

During the coming year, the California Endangered Species Education Program—a K-12 program coordinated by the National Audubon Society—will begin using *Life on the Edge* as a key resource guide. Teachers attending program workshops will be given copies of the book, ensuring that every California child has access to a wealth of information on the state's natural resources.

We are proud to present this first volume on wildlife (a companion volume is planned on endangered plants). *Life on the Edge* is not the product of a single author, but instead was built on the contributions of many. Without them, this book would not have been possible. We thank them all.



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## MOHAVE TUI CHUB

GILA BICOLOR MOHAVENSIS

FEDERAL STATUS: ENDANGERED

STATE STATUS: ENDANGERED

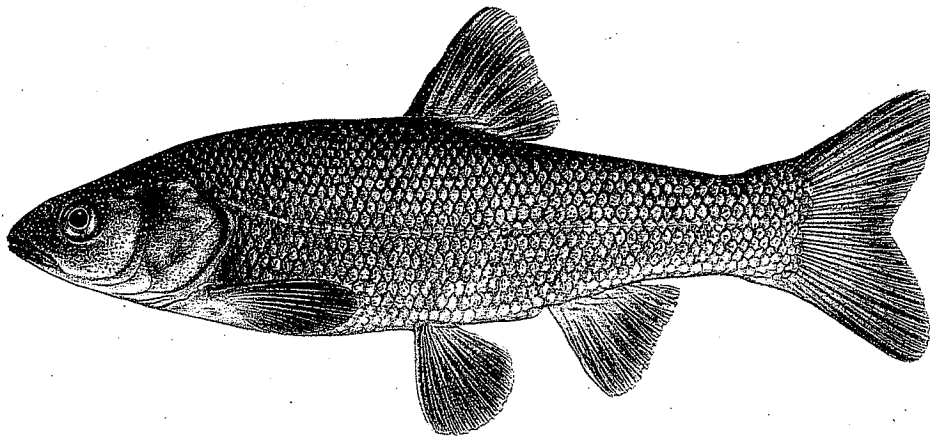
## B I O L O G Y

Tui chubs evolved in the broad, shallow Great Basin lakes present during the Pleistocene. As these lakes dried up at the end of the last ice age (10–20,000 years ago), small populations of tui chubs became isolated in drainages throughout eastern California and adjoining states. The Mohave tui chub is now one of the rarest of these remnant populations.

Extinct within its native Mojave River, the fish survives in a few artificial pools and possibly one natural pool.

Olive brown above and silvery white underneath, the Mohave tui chub glistens with a metallic sheen in bright sunlight. Its chunky body shape, small mouth, and a dip in its lateral line differentiate this fish from other members of the minnow family, Cyprinidae. Adults measure 5–20 cm (2–8 in) in standard length depending on location. The fish eat aquatic insects and their larvae; small, benthic invertebrates; plankton; and, possibly, detritus.

Water conditions fluctuate widely in Mohave tui chub pools during winter and spring flooding and summertime evaporation. Yet because tui chubs evolved in the relatively constant environment provided by the Pleistocene-era lakes, they are not as tolerant of envi-



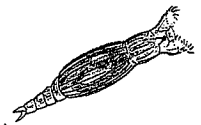
After the Mohave tui chub vanished from its native Mojave River, biologists established refuge populations using fish from a single, small population remaining in a nearby desert spring. One refuge, located at the Desert Research Station on Barstow School District property, offers students the opportunity to study an endangered species in their own backyard.  
Illus. © Joseph R. Tomelleri

ronmental extremes as pupfish and other species adapted to desert waters. To survive, tui chubs must select micro-environments with minimal fluctuations in temperature and salinity. For example, they are unable to withstand water temperatures above 36°C (97°F) and so retreat to deeper waters during the warmest hours. In winter, when water temperatures drop to 12°C (54°F), Mohave tui chubs stop feeding and move down to the pool bottom to await warmer temperatures.

Mohave tui chubs begin to breed in March or April, when water temperatures warm to 18°C (64°F); some females spawn again in the fall. The tiny eggs, less than 2.5 mm (1/8 in) in diameter, stick to the leaves and stems of ditch grass and other aquatic plants. Larval tui chubs hatch within 9 days and begin to feed on tiny crustaceans and rotifers. Schools of fry seek shelter in stands of bulrush, cattail, and other shoreline vegetation, but as the fish mature, they disperse and become solitary.

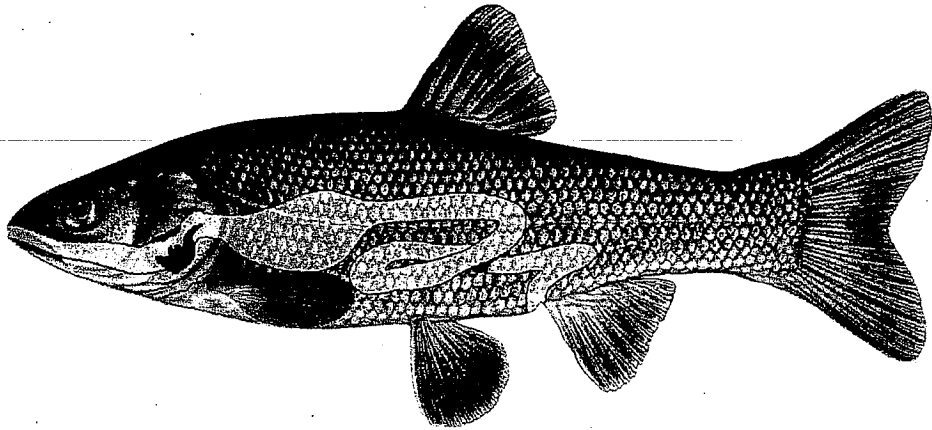
## C O N S E R V A T I O N   A N D   R E C O V E R Y

Until the 1930s, when anglers introduced arroyo chubs (*G. orcutti*) into the Mojave River, the Mohave tui chub was fairly common within its limited native range. The hybridization that resulted between the two chubs was so extensive that the Mohave tui chub disappeared from the Mojave River system. A population of nonhybridized Mohave tui chubs,



**Rotifer**  
*Philodina sp.*  
about 70x lifesize

however, remained in a spring-fed pool on the west side of Soda Dry Lake, south of Baker in San Bernardino County. The population in this spring—historically known as Zzyzx Spring, or Fort Soda, and now part of an area called Soda Springs—eventually served as a source for Mohave tui chub transplants.



In 1970, the Mohave tui chub was added to the federal list of endangered species; the following year the state also listed the fish as endangered. The California Department of Fish

*The Mohave tui chub's mouth may be toothless, but the fish is not without teeth. Like many other fishes, it has pharyngeal teeth, special teeth located in its throat, behind its gills, that grind up food after the fish has swallowed it. Without the added weight of teeth, the mouths of such species become delicately formed, specialized for engulfing certain foods.*

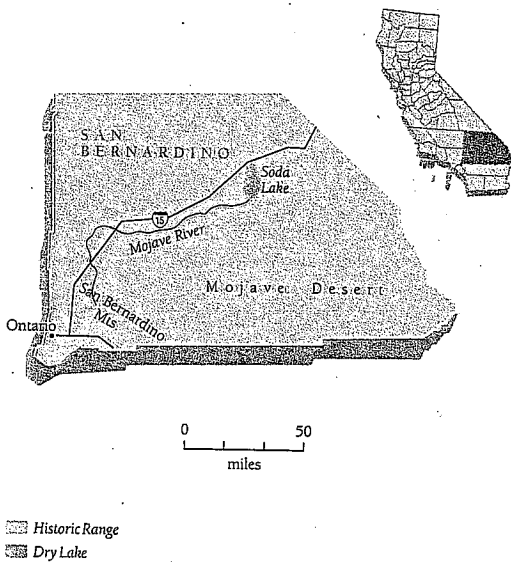
*Background illustration of Mohave tui chub © Joseph R. Tomelleri*

RANGE AND DISTRIBUTION

Native only to the Mojave River, this fish formerly ranged from the river's headwaters in the San Bernardino Mountains to Soda Lake near the southern end of Death Valley, all within San Bernardino County.

The Mohave tui chub is now absent from the Mojave River. An introduced population inhabits two small pools and a spring at Soda Springs, near the western edge of Soda Dry Lake.

More recently transplanted populations of up to several thousand fish live in Lark Seep Lagoon on the China Lake Naval Weapons Center in Kern County; in San Bernardino County fish occupy the Desert Research Station Pond near Hinkley and the Camp Cady Wildlife Area.



and Game (CDFG) has been transplanting the subspecies to new areas since 1971. Several thousand Mohave tui chubs now live in the small Lark Seep Lagoon on the China Lake Naval Weapons Center in Kern County. In San Bernardino County, between 1,500 and 2,000 fish inhabit the Desert Research Station Pond near Hinkley, and several thousand more are found in the CDFG's Camp Cady Wildlife Area. Although only 3 of 14 transplant attempts have succeeded, biologists are encouraged and Mohave tui chub transplanting will continue. The U.S. Fish and

Wildlife Service hopes to establish three more populations of at least 500 fish each, and the CDFG is investigating possible introductions at the Twentynine Palms Marine Corps training center and at Joshua Tree National Monument. Successful transplanting efforts may yet lead to removal of the fish from the endangered species list.

So far, the Mohave tui chub has not been reintroduced to its native Mojave River. Biologists are, however, currently considering a program to first eradicate the arroyo chub from the river and then restock it with Mohave tui chubs. Reintroducing this chub to its historical range, though, could prove challenging: new reservoirs and dams have changed the river's natural flow, and conditions now favor introduced fishes.

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- McClanahan, L. L. et al. 1986.
- Moyle, P. B. 1976.