

## Owens Pupfish (*Cyprinodon radiosus*)

### Legal Status

**State:** Endangered, Fully Protected

**Federal:** Endangered

**Critical Habitat:** N/A

**Recovery Planning:** *Owens*

*Basin Wetland and Aquatic Species Recovery Plan, Inyo and Mono Counties, California* (USFWS 1998)

**Notes:** Species was federally listed endangered on March 11, 1967. It was listed as endangered in California in 1971 (USFWS 2009).

[Species photo to come]

### Taxonomy

The first taxonomic description of Owens pupfish (*Cyprinodon radiosus*) was in 1948 by Miller, but occurrence locations along with relative abundance observations of Owens pupfish were noted as early as 1859 by explorers and scientists (USFWS 2009). Owens pupfish is in the killifish family (Cyprinodontidae) and is one of five pupfish species native to California (BLM 2011). The desert pupfish (*Cyprinodon macularius*), which occurs in the lower Colorado River system, is the closest relative of the Owens pupfish (USFWS 1998). Though Owens pupfish is a member of the *C. nevadensis* complex, a group of four species in two closed basins of the Death Valley System in California and Nevada (Owens River Valley and Ash Meadows–Death Valley), it appears to be more closely related to *C. macularius* than to the Ash Meadows–Death Valley members of the complex (*C. diabolis*, *C. nevadensis*, and *C. salinus*). Apparently, *C. radiosus* and *C. macularius* share both a general morphological similarity and an ancestral mitochondrial deoxyribonucleic acid (DNA) that separates them from the Ash Meadows–Death Valley pupfishes (Echelle and Dowling 1992). Descriptions of the species' physical characteristics can be found in the U.S. Fish and Wildlife Service (USFWS) 5-Year Review (2009).

## Distribution

### General

The Owens pupfish is restricted to the Owens Valley portion of the Owens River in Mono and Inyo counties, California (Figure SP-F3). Based on historical observations, Owens pupfish is believed to have occupied all of the Owens River and possibly the Owens River Delta at Owens Lake. Currently, it occurs at Fish Slough, Mule Springs, Well 368, and Warm Springs (USFWS 2009). Three of the 17 California Natural Diversity Database (CNDDB) occurrences are within the Plan Area, while the remaining occurrences are farther north and east of the Plan Area (CDFG 2012).

### Distribution and Occurrences within the Plan Area

#### *Historical*

Two of the three occurrences in the Plan Area were last documented prior to 1990 (Figure SP-F3). Both of these have possibly been extirpated (CDFG 2012).

#### *Recent*

Only one recent occurrence (i.e., since 1990) of Owens pupfish occurs in the Plan Area. This occurrence is at Well 368, located 0.2 mile west of the Owens River and 2.5 miles south of Mazourka Canyon Road. Last observed in 1999, this occurrence is presumed extant. In 1988, pupfish from Warm Springs were introduced into the ponds at this location, and both adults and juveniles were abundant throughout the North Fork Area in 1999. It is owned by the Los Angeles Department of Water and Power (CDFG 2012).

## Natural History

### Habitat Requirements

Owens pupfish occurs in shallow water habitats in the Owens Valley (CDFG 2012). It will occupy most aquatic habitat where water is relatively warm and food is plentiful (USFWS 2009). However, it

prefers warm, clear, shallow water, free of exotic fishes, and requires areas of soft substrate for spawning (CDFG 2012; USFWS 2009). In addition, Owens pupfish habitat differs from the habitat of other pupfish. Specifically, aquatic habitats associated with the Owens River are typically colder, frequently covered by ice during winter, and lower in conductivity and salinity than habitats occupied by other pupfish species (USFWS 2009).

All life stages may be found in the various microhabitats available with little apparent documented preference. However, adults frequently occupy deeper water than juveniles. Male pupfish are territorial and defend areas of substrate from competing males. Females occupy habitats along the margins of these territories (USFWS 2009). Table 1 lists primary habitat associations and parameters for Owens pupfish.

**Table 1.** Habitat Associations for Owens Pupfish

Land Cover Type	Habitat Designation	Habitat Parameters	Supporting Information
Warm, clear, shallow aquatic habitat	Primary	Soft substrates required for spawning	CDFG 2012; USFWS 2009

**Notes:** Species only occurs in the Owens River.

### Foraging Requirements

Owens pupfish are opportunistic omnivores and consume a variety of plant and animal foods. Their diet changes seasonally and generally includes whatever invertebrates and plants are most abundant at that time (USFWS 1998). However, they primarily feed on aquatic insects and are an effective biological control agent for mosquitos (USFWS 2009; USFWS 1998). They do not prey on other fishes (USFWS 1998).

### Reproduction

Owens pupfish breed from April through October (BLM 2011). Females spawn over soft substrates in spring and summer when water temperatures are near 14°Celsius (C) (57°Fahrenheit [F]) (USFWS 1998). They may spawn up to 200 times per day, laying one

or two eggs at a time (USFWS 2009). Males are very aggressive during the breeding season as they protect their breeding territory (BLM 2011). Incubation lasts for approximately 6 days before hatching in water that ranges in temperature from 75°F to 81°F. On average, 95% of spawned eggs are fertilized. Juvenile pupfish reach sexual maturity in 3 to 4 months and are generally able to spawn before their first winter (USFWS 2009).

In a study examining Owen's pupfish mating systems and sexual selection, it was found that the size of the mother did not strongly influence egg size or fry size. In addition, individual egg size was not correlated with fry size (Mire and Millett 1994).

### **Spatial Activity**

Little information is known regarding this species' spatial activity. However, CDFG (2011) refers to migration between areas. As noted previously in Habitat Requirements, males are territorial and females occupy areas at the margins of territories.

### **Ecological Relationships**

Generally, the lifespan of Owens pupfish is rarely over 1 year. However, they live up to 3 years in refuge habitats (USFWS 2009).

Owens pupfish congregate in small schools (USFWS 2009). Owens pupfish demography has been studied only in intensively managed refuge habitats with little environmental variation. Demographic studies of other pupfishes in the Death Valley system, however, suggest large seasonal variation in population size. Although studies of Owens pupfish in managed refuge habitats indicate little seasonal variation in population size, unmanaged populations may experience more temporal variation in habitats that are more representative of areas historically occupied (USFWS 2009).

Owens pupfish scarcity in the 1930s was attributed to establishment of non-native predatory fish. In addition, water diversions that decreased and altered Owens River flows desiccated shallow pupfish habitats bordering the river (USFWS 1998).

## Population Status and Trends

**Global:** G1, Critically imperiled (NatureServe 2011, conservation status last updated 2007)

**State:** S1, Critically Imperiled (CDFG 2012)

By the 1930s Owens pupfish was scarce throughout most of its historical range. It was believed to be extinct from 1942; until in 1964 when a single population of approximately 200 fish was rediscovered in Fish Slough (USFWS 1998). This was the only known existing population when Owens pupfish was listed as federally endangered in 1967. This population still persists today (USFWS 2009). Since its listing, three additional populations have been established at Warm Springs, Well 368, and Mule Springs, (USFWS 2009) These additional existing populations were established from progeny of the remnant population at Fish Slough (USFWS 1998). All existing populations are small, ranging from 100 to 10,000 individuals. The Owens pupfish still faces a high degree of threat, but it also has a high recovery potential (USFWS 2009).

## Threats and Environmental Stressors

The 1998 Recovery Plan states that Owens pupfish is affected by non-native species and habitat modification for water diversions that altered Owens River flows (USFWS 1998, 2009). Currently, all populations of Owens pupfish are threatened by loss of habitat resulting from cattail (*Typha* spp.) encroachment. Emergent vegetation and accumulated detritus covers and reduces the substrate used by the pupfish for breeding. Emergent vegetation also reduces water depth, elevates water temperature, and potentially produces severe anoxic conditions (USFWS 2009).

Owens pupfish is also seriously threatened by non-native predators. Because populations are highly localized and relatively small, they can be threatened by a single individual predator. At the time of listing in 1967, several non-native fish predators affecting Owens pupfish were identified: largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), brown trout (*Salmo trutta*), and bluegill (*Lepomis macrochirus*). Since its listing, mosquitofish (*Gambusia affinis*), crayfish (*Pastifasticus leniusculus*), and bullfrogs (*Rana*

*catesbeiana*) have been introduced into the pupfish's habitat and also threaten Owens pupfish. Besides eating young and adult Owens pupfish, non-native predators compete with Owens pupfish for food and habitat (USFWS 2009).

Additionally, the Owens pupfish is highly vulnerable to extinction from stochastic (random) demographic, genetic, and catastrophic environmental events because the existing populations are small and isolated. Demographic stochasticity refers to random variability in survival and/or reproduction among individuals that can have a significant impact on population viability when populations are small and short-lived with low fecundity (reproductive output). Genetic stochasticity results from the changes in gene frequencies caused by the loss of genetic variation when a new population is established by a very small number of individuals (i.e., the founder effect). This can result in random gene fixation in which some portion of gene loci are fixed at a selectively unfavorable allele (a different form of a gene) because natural selection is not intense enough to overcome random genetic drift. Inbreeding bottlenecks in which a significant percentage of a population is killed or prevented from breeding may also occur in small, isolated populations. Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other external factors. These three factors may act alone or in combination to reduce the long-term viability of small populations (USFWS 2009).

### **Conservation and Management Activities**

Owens' pupfish reestablishment in the Owens Valley Native Fish Sanctuary has developed as a cooperative undertaking between the City of Los Angeles and the California Department of Fish and Game (CDFG) (Miller and Pister 1971). USFWS and CDFG are making progress toward establishing two new pupfish populations. These populations will be established at the Cartago Springs Wildlife Area (USFWS 2009). Although the four existing Owens pupfish populations do not have approved management plans or implementing agreements between the USFWS and landowners, the new pupfish populations would require management plans that would address threats (USFWS 2009).

Fish screens and the isolation of the artificial refuges for Owens pupfish populations provided some protection from non-native fish predators. In addition, the CDFG actively removes predators as they are observed. Despite these efforts, predators are likely reintroduced into Owens pupfish populations by fishermen intending to stock those sites with bait and sport fish. Cattail encroachment is currently managed at all populations. If not actively managed, cattails will grow back and threaten Owens pupfish breeding sites (USFWS 2009).

## Data Characterization

Few studies have examined the ecology of Owens pupfish. Owens pupfish demography has been studied only in intensively managed refuge habitats that may not be representative of the species' historical, natural demography (USFWS 1998).

## Management and Monitoring Considerations

Habitat protection and management is the key to the recovery of the Owens pupfish (BLM 2011). The 5-Year Review for the species includes the following recommendations for actions over the next 5 years (USFWS 2009):

- 1) Remove emergent vegetation and eradicate non-native predators from Warm Springs and reestablish Owens pupfish in the upper and lower ponds
- 2) Evaluate Round Valley to determine if it is a suitable location for a population of Owens pupfish
- 3) Develop management plans and implementation agreements for all populations
- 4) Establish a new population of Owens pupfish at Cartago Springs Wildlife Area and Blackrock Waterfowl Management Area
- 5) Conduct population surveys and demographic studies, collect additional genetic samples, and complete genetic analysis. Develop breeding programs based on the results of genetic analysis to optimize genetic material in all populations of Owens pupfish.

Furthermore, the American Fisheries Society has published guidelines for introductions of threatened and endangered species that could be

applied to Owens pupfish (Williams et al. 2011). They recommend restricting introductions to sites within the native or historic habitat, sites that are protected, sites where the potential for dispersal has been determined acceptable, sites that fulfill the species' life history requirements, and sites that contain sufficient habitat to support a viable population. In addition, introduction sites should be avoided where endangered or threatened fish could hybridize with other taxa or where other rare or endemic taxa could be adversely affected. The introduction stock should be from an appropriate source, should be examined for taxonomic status and presence of undesirable pathogens, should be of sufficient number and character, should be carefully and quickly transported, should be introduced under favorable conditions, and the translocation procedures should be documented. After translocation, the American Fisheries Society recommends systematic monitoring of introduced populations, which involves restocking if necessary, determining the cause of any failures, and documenting findings and conclusions reached during the post-introduction (Williams et al. 2011).

## Literature Cited

- BLM (Bureau of Land Management). 2011. "Owens Pupfish." U.S. Department of the Interior, Bureau of Land Management, California. Accessed December 2, 2011. [http://www.blm.gov/ca/forms/wildlife/details.php?metode=serial\\_number&search=2803](http://www.blm.gov/ca/forms/wildlife/details.php?metode=serial_number&search=2803).
- CDFG (California Department of Fish and Game). 2012. "*Cyprinodon radiosus*." Element Occurrence Query. California Natural Diversity Database (CNDDB). RareFind, Version 4.0 (Commercial Subscription). Sacramento, California: CDFG, Biogeographic Data Branch. Accessed February 2012. <http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp>.
- Echelle, A.A., and T.E. Dowling. 1992. "Mitochondrial DNA Variation and Evolution of the Death Valley Pupfishes (*Cyprinodon*, *Cyprinodontidae*)." *Evolution* 46(1):193–206.
- Miller, R.R., and E.P. Pister. 1971. "Management of the Owens Pupfish, *Cyprinodon radiosus*, in Mono County, California." *Transactions of the American Fisheries Society* 100(3).



Mire, J.B., and L. Millett. 1994. "Size of Mother Does Not Determine Size of Eggs or Fry in the Owens Pupfish, *Cyprinodon radiosus*." *Copeia* (1)100–107.

NatureServe. 2011. "Owens Pupfish." *NatureServe Explorer: An Online Encyclopedia of Life*. Version 7.1. Arlington, Virginia: NatureServe. Last updated July 2011. Accessed December 5, 2011. <http://www.natureserve.org/explorer>.

USFWS (U.S. Fish and Wildlife Service). 1998. *Owens Basin Wetland and Aquatic Species Recovery Plan, Inyo and Mono Counties, California*. Portland, Oregon: USFWS, Region 1. September 30.

USFWS. 2009. *Owens Pupfish (Cyprinodon radiosus), 5-Year Review: Summary and Evaluation*. Ventura, California: U.S. Fish and Wildlife Service.

Williams, J.E., D.W. Sada, C.D. Williams, J.R. Bennett, J.E. Johnson, P.C. Marsh, D.E. McAllister, E.P. Pister, R.D. Radant, J.N. Rinne, M.D. Stone, L. Ulmer, and D.L. Withers. 2011. "American Fisheries Society Guidelines for Introductions of Threatened and Endangered Fishes." *Fisheries* 13(5).

