

Owens Pupfish
(Cyprinodon radiosus)

**5-Year Review:
Summary and Evaluation**



Photo by Billy Perry, CSUMB

**U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
Ventura, California**

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5-YEAR REVIEW

Owens Pupfish (*Cyprinodon radiosus*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act of 1973 (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The Owens pupfish (*Cyprinodon radiosus*) is a small fish in the killifish family (Cyprinodontidae) that rarely exceeds 6 centimeters (cm) (2.5 inches (in)) in length (U.S. Fish and Wildlife Service 1998). Females are dusky, olive-green in color, with several dark vertical bars aligned in a row along the sides. Males are bright blue, particularly during the spring and summer spawning season. The Owens pupfish is restricted to the Owens Valley portion of the Owens River, Mono and Inyo counties, California.

Historically, Owens pupfish were widespread along the Owens River, occurring in clear waters of springs, sloughs, irrigation ditches, swamps, and flooded pastures from Fish Slough in Mono County south to Lone Pine in Inyo County (see map below) (U.S. Fish and Wildlife Service 1998). Currently, there are only four populations of Owens pupfish. The Fish Slough population consists of three sub-populations. The other three populations are: Mule Springs, Well 368, and Warm Springs.

Methodology Used to Complete This Review:

This review was prepared by the Ventura Fish and Wildlife Office (VFWO), following the Region 8 guidance issued in March 2008. We used information from the recovery plan for the Owens pupfish (U.S. Fish and Wildlife Service 1998), survey information

from experts who have been monitoring various populations of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game (CDFG). The recovery plan for the Owens pupfish and personal communications with experts were our primary sources of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing. There has been no previous 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this species and the opening of a 60-day period to receive information from the public was published in the *Federal Register* on March 5, 2008 (73 FR 11945). The Service received one response to the notice, which we have considered in preparing this 5-year review.

Listing History:

Original Listing

FR Notice: 32 FR 4001

Date of Final Listing Rule: March 11, 1967

Entity Listed: Species (*Cyprinodon radiosus*)

Classification: Endangered

State Listing

The Owens pupfish (*Cyprinodon radiosus*) was listed by the State of California as endangered in 1971. The species is also a Fully Protected Species.

Review History: The general status of the Owens pupfish was reviewed during the preparation of the *Owens Basin Wetland and Aquatic Species Recovery Plan, Inyo and Mono Counties, California* in 1998 (U.S. Fish and Wildlife Service 1998).

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for the Owens pupfish is 3 according to the Service's 2007 Recovery Data Call for the Ventura Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number should be changed to 2, indicating that the pupfish is a species (3 designates a subspecies) that faces a high degree of threat and has a high recovery potential.

Recovery Plan or Outline

Name of Plan or Outline: *Owens Basin Wetland and Aquatic Species Recovery Plan, Inyo and Mono Counties, California.*

Date Issued: September 30, 1998.

Dates of previous revisions: There have been no revisions to this plan.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

We have no relevant information regarding the application of the Distinct Population Segment Policy to the Owens pupfish.

Information on the Species and its Status

Species Biology and Life History

The Owens pupfish was described by Miller (1948) based on a collection from West Spring, Fish Slough, northwest of Bishop, California. The species is a small, deep-bodied, laterally-compressed fish with a total length that rarely exceeds 6 cm (2.5 in). The species is sexually dimorphic; males and females can be distinguished easily from each other by coloration (Miller 1948). Females are dusky, olive-green in color, with several dark vertical bars aligned in a row along the sides. Males are bright blue, particularly during the spring and summer spawning season.

The species is distinguished from other pupfishes by the anterior placement of the dorsal fin, long caudal peduncle (the narrow part of a fish's body to which the caudal or tail fin is attached), absence of spine-like projections on scale circuli (growth rings), and absence

of a terminal black band on the caudal fin. Owens pupfish also have a greater number of dorsal, pelvic, pectoral, and anal fin rays than other pupfish species (Miller 1948).

Owens pupfish congregate in small schools and feed mostly on aquatic insects. Spawning occurs over soft substrates in spring and summer. Mire and Millett (1994) observed that female Owens pupfish may be involved in spawning acts up to 200 times per day laying 1-2 eggs at a time. Eggs incubate for approximately 6 days before hatching in water temperatures ranging from 75°F to 81°F (24°C to 27°C) with an average of 95 percent of spawned eggs fertilized. Juvenile pupfish grow rapidly to sexual maturity in 3 to 4 months (Barlow 1961). They are usually able to spawn before their first winter, and lifespan is rarely greater than 1 year (Soltz and Naiman 1978). However, Owens pupfish live as long as 3 years in refuge habitats (Mire 1993).

Distribution and Abundance

Although the Owens pupfish was not formally described until 1948 (Miller), the distribution and relative abundance of Owens pupfish were noted by early explorers and scientists. Davidson (1859) reported pupfish as common throughout the Owens River, but absent from tributary streams. Fisheries surveys during the early 1900s documented pupfish in habitats throughout the Owens Valley (Kennedy 1916, Snyder 1917). The valley lies along the southwestern boundary of the Great Basin and the northwestern boundary of the Mojave Desert. Surveys concluded that Owens pupfish occupied most valley-floor aquatic habitats from Fish Slough (approximately 19 kilometers (km) 12 miles (mi) north of Bishop) south to Lone Pine (Kennedy 1916, Snyder 1917, Miller 1948), a linear distance of approximately 113 km (70 mi) (see map). Steward (1933) reported that the native Paiute tribe captured large numbers of pupfish with basket-like nets and dried them for use as winter food. Miller and Pister (1971) summarized field studies that showed pupfish were most abundant in shallow sloughs bordering the Owens River, and marshes and springs adjacent to the river. These observations indicate the pupfish occupied all of the Owens River, and possibly the Owens River Delta at Owens Lake. Owens pupfish were believed to be extinct from 1942 (Miller 1969) until 1964 when a single population of approximately 200 individuals was rediscovered in Fish Slough (Miller and Pister 1971). When listed in 1967, the Owens pupfish was still limited to this single population.

In 1998, the recovery plan listed the following populations as occupied by Owens pupfish: Warm Springs (extant population discussed below), BLM Spring (extant population discussed below), White Mountain Research Station (population established in 1988, extirpated by 1995), and Owens Valley Native Fish Sanctuary (population present in 1982, extirpated by 1990). The 1998 recovery plan also recommended that the following locations be considered for Owens pupfish populations: Southern Owens (located west of and adjacent to Owens Lake, from Lubkin Creek to the town of Olancho), Blackrock (located west of the town of Big Pine, and west of the Owens River Channel), and Round Valley (located in the northern Owens Valley and includes lower Rock Creek and lower Pine Creek).

Current distribution of the Owens pupfish is limited to the following four populations (see map):

Fish Slough. This population currently consists of the following three subpopulations:

BLM Spring. This site is managed by the Bureau of Land Management (BLM) and consists of a spring-fed pond that is approximately 0.17 acre (ac) (0.07 hectare (ha)) in area. Owens pupfish were introduced to BLM Spring in 1969. Several largemouth bass (*Micropterus salmoides*) were observed in 1997 and are thought to have consumed the population of Owens pupfish (Malengo 1999). Owens pupfish were absent from 1997 to 2003. The CDFG introduced Owens pupfish to BLM Spring in 2003. In May 2007, a single largemouth bass was found and removed from BLM Spring; no pupfish were observed during the surveys that followed (Parmenter in litt. 2007). By summer 2007, a few pupfish were observed. Currently, the subpopulation is increasing, estimated at between 1,000 and 10,000 individuals and is considered stable (Parmenter in litt. 2008).

BLM Ponds. This site is managed by BLM and consists of two spring-fed ponds totaling approximately 0.01 ac (0.004 ha) in area. Owens pupfish were introduced into BLM Ponds by 1982. Currently this subpopulation is estimated at approximately 100 individuals and is considered stable (Parmenter in litt. 2008).

Marvin's Marsh. This site is managed by the Los Angeles Department of Water and Power (LADWP) and consists of a manmade marsh approximately 0.07 ac (0.03 ha) in area. This subpopulation was first established in 1986 when only a small, unspecified number of Owens pupfish were introduced. Over 2,000 additional pupfish were transferred from Owens Valley Native Fish Sanctuary to Marvin's Marsh in 1988. By 1989, pupfish were present throughout the marsh and numbers were stable. Currently this subpopulation is estimated at approximately 100 to 1,000 individuals and appears to be declining (Parmenter in litt. 2008).

Warm Springs: This site is managed by LADWP and consists of a manmade interconnected upper pond that overflows into a lower pond and an outflow ditch from the lower pond, totaling approximately 0.6 ac (0.2 ha) in area. Owens pupfish were introduced into this site in 1970. By 1989, pupfish were abundant in both ponds (Malengo 1999). Currently Owens pupfish are not observed in either the upper or lower pond. However, a small population of Owens pupfish still occurs in the outflow ditch from the lower pond. This small population is estimated to number less than 100 individuals and is increasing (Parmenter in litt. 2008).

Mule Springs: This site is managed by BLM and consists of manmade interconnected upper and lower ponds. The upper pond was constructed for Owens tui chub (*Gila bicolor snyderi*) and the lower pond for Owens pupfish. The lower pond is approximately 0.01 ac (0.004 ha) in area. Owens pupfish were transplanted to Mule Springs from BLM Spring and Well 368 in 1995 (Malengo 1999). Pupfish were common

during 1997 and 1998 surveys. Currently the lower pond supports a small Owens pupfish population estimated to number 100 to 1000 individuals; the population appears to be stable (Parmenter in litt. 2008).

Well 368: This site is managed by BLM and consists of an overflow channel from a spring-fed, manmade pond. The channel is approximately 0.05 ac (0.02 ha) in area. Pupfish were first introduced to Well 368 in 1986. Shortly thereafter maintenance crews from LADWP inadvertently diverted water away from the channel, causing the complete loss of pupfish habitat. In 1988 pupfish were again introduced to the channel. The CDFG considered the population abundant and stable from 1990 until 2006. Currently this population is estimated to number between 100 and 1,000 individuals and is considered stable (Parmenter in litt. 2008).

Habitat or Ecosystem

Owens Pupfish will occupy most aquatic habitat where water is relatively warm and food is plentiful. Adults frequently occupy deeper water than juveniles, but all life stages may be found in the various microhabitats available in the environment with little preference (Sada and Deacon 1994). Male pupfish are territorial, defending areas of substrate from competing males. Female pupfish occupy habitats along the margins of areas defended by males (Mire 1993). There appear to be several differences between the habitat of the Owens pupfish and that of other pupfish species. Aquatic habitats in and adjacent to the Owens River are generally colder, frequently covered by ice during winter, and lower in conductivity and salinity than habitats of other pupfish species (Cole 1981).

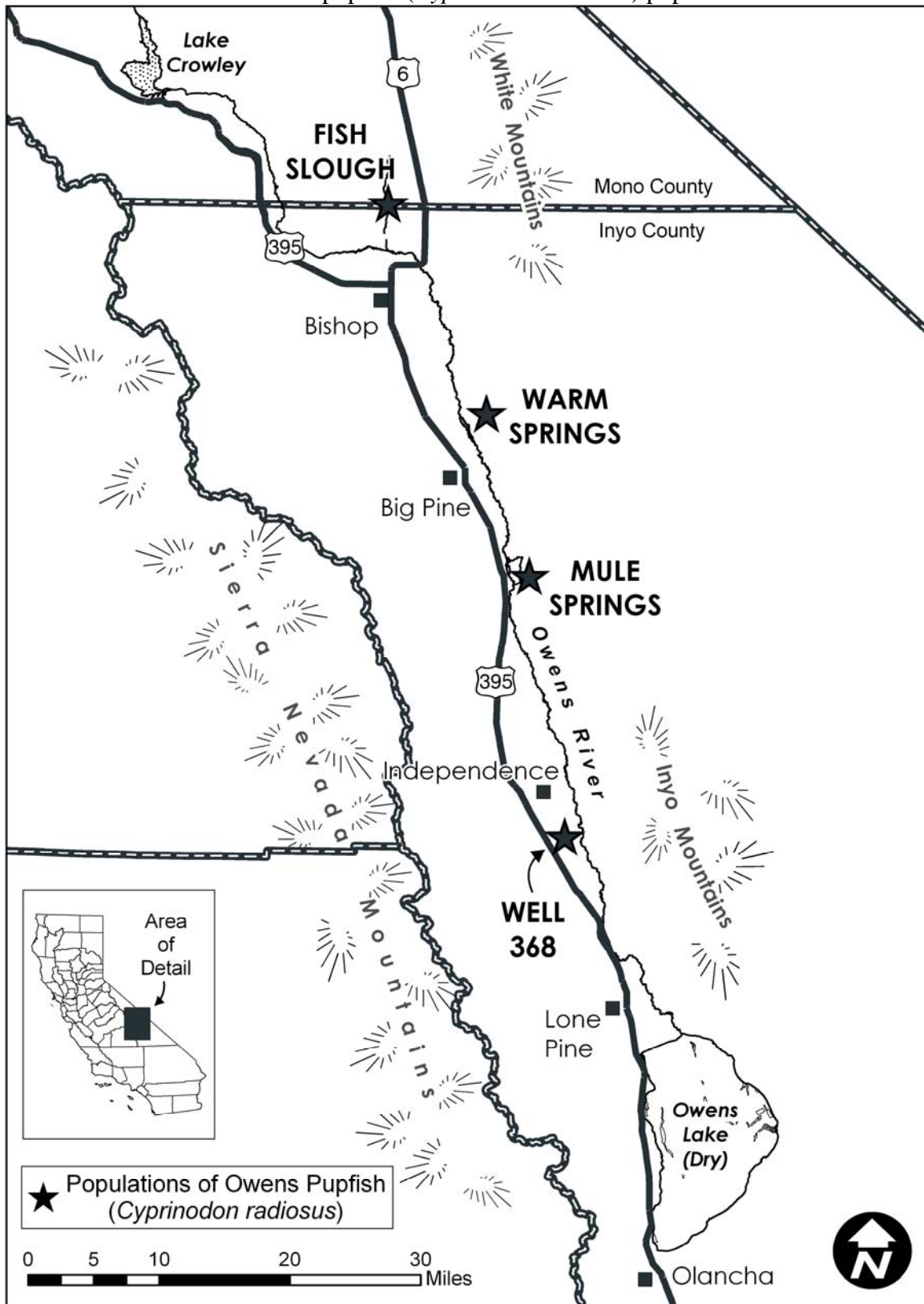
Changes in Taxonomic Classification or Nomenclature

No changes in taxonomic classification or nomenclature are proposed at this time.

Genetics

In 1964, the Owens pupfish was extant in only 1 site. The significant reduction in Owens pupfish distribution and number may well have created a genetic bottleneck which in combination with the subsequent rescue and management practices may have inadvertently reduced the genetic diversity of current Owens pupfish populations. The CDFG applied for funding pursuant to section 6 of the Endangered Species Act to study how genetic diversity has been affected. The primary objectives of the project are to compare the contemporary genetic structure and diversity of all four existing Owens pupfish populations with each other and with historic samples, and prepare a genetic management and monitoring plan for the species. Funds were awarded in 2006; however, results from the project are not yet available.

Current Owens pupfish (*Cyprinodon radiosus*) populations.



Species-specific Research and/or Grant-supported Activities

In 1997, the CDFG secured section 6 funding to conduct habitat restoration activities at the three Fish Slough pupfish subpopulations sites. The restoration projects included vegetation removal (to increase aquatic habitat and breeding areas), fencing (to exclude cattle from pupfish habitat), water control structure maintenance, and control of non-native fishes.

Five-Factor Analysis

Section 4 of the Act established a rulemaking procedure that requires a five-factor analysis for determining whether to list a species as endangered or threatened. However, the Service listed the Owens pupfish as endangered on March 11, 1967 (32 FR 4001) under the Endangered Species Preservation Act of 1966. This precursor to the current Act did not require a five-factor analysis; consequently a five-factor analysis was not conducted for the Owens pupfish. In 1989, the American Fisheries Society (AFS) published its list of endangered, threatened, or species of concern fishes of North America (Williams et al. 1989). The AFS reported the Owens pupfish as endangered and identified two categories of threats: present or threatened destruction, modification, or curtailment of habitat or range, and other natural or manmade factors affecting its continued existence (hybridization, introduction of non-native or transplanted species, predation, or competition). The 1998 recovery plan identifies the following threats, establishment of non-native predatory fish and water diversions that decreased and altered Owens River flows. The following analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Historically, the Owens pupfish was found throughout the Owens River, but was absent from tributary streams. In the early 1900s, the Los Angeles Department of Water and Power constructed an aqueduct to carry water from the Owens River to Los Angeles (Reisner 1993). A second aqueduct was completed in 1970 which diverted more water from the Owens Valley. Both surface and ground water were diverted to the aqueducts. Over time water diversion projects eliminated almost all the habitat of the Owens pupfish; by 1942 the Owens pupfish was considered extinct (Miller 1969). Owens pupfish were rediscovered in 1964. The CDFG has established 6 populations since 1969; however, currently only four populations of Owens pupfish exist.

Presently, all four populations of Owens pupfish are threatened by loss of habitat due to cattail encroachment. CDFG personnel regularly control cattail encroachment at all Owens pupfish population sites, to maintain open water. Without this control, the open waterways become clogged with emergent vegetation and accumulate detritus. Detritus covers and thereby eliminates substrate used by the Owens pupfish for breeding, spawning, and courtship behaviors. Emergent vegetation encroachment also reduces water depth, elevates water temperature, and can result in severe anoxic conditions.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial, recreational, scientific, or educational purposes was not considered a threat at the time of listing, and there is no information to suggest that it has become a threat.

FACTOR C: Disease or Predation

Disease: Disease was not known to be a threat to Owens pupfish at the time of listing in 1967, and there is no information to suggest that it has become a threat.

Predation: Non-native predators are a serious threat to the Owens pupfish. At the time of listing in 1967, predation by non-native fish (e.g., largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), brown trout (*Salmo trutta*), and bluegill (*Lepomis macrochirus*)) threatened the species. Since listing, mosquito fish (*Gambusia affinis*), crayfish (*Pastifasticus leniusculus*), and bullfrogs (*Rana catesbeiana*) have been introduced into the pupfish's habitat and are recognized also as threats to the Owens pupfish. Non-native predators eat young and adult Owens pupfish; they also compete with Owens pupfish for food and habitat. Owens pupfish populations are vulnerable and may be threatened by a single individual predator.

Non-native predators are currently present in much of the habitat pupfish historically occupied. Therefore, establishing new populations of Owens pupfish will require reintroductions to occur in locations where non-native predators can be managed. Management plans for each population will include conditions for non-native predator management.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not identified as a threat to the Owens pupfish at the time of listing. The 1998 Recovery Plan did not identify inadequacy of existing regulatory mechanisms as a threat to the species, nor did it identify recovery tasks that would mitigate this factor. We found no information in the scientific literature that indicates this factor is a threat to the Owens pupfish.

The Act is the primary Federal law providing protection for this species. Since its listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 C.F.R. § 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project. Incidental take refers to

taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 C.F.R. § 402.02). In cases where some incidental take is unavoidable, the Service works with the agency to include additional conservation measures to minimize negative impacts. For projects without a Federal nexus that may negatively impact listed species, the Service may issue incidental take permits pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved habitat conservation plan (HCP) that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional HCPs in some areas now provide an additional layer of regulatory protection for covered species, and these HCPs are coordinated with the related NCCP-State program.

The Owens pupfish was listed as endangered under the California Endangered Species Act (CESA) in 1971. Under CESA, the Owens pupfish cannot be "taken" under CESA without first obtaining a permit. "Take" is defined in section 86 of the California Fish and Game Code as to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." If the take is incidental, CDFG requires that the permit applicant fully mitigate for it. If the take is intentional or purposeful (e.g., for research purposes), the researcher must first obtain a Memorandum of Understanding (MOU) with the CDFG.

The CDFG classified the Owens pupfish as a fully protected species. A fully protected species may not be taken or possessed at any time and no licenses or permits may be issued for their take except for collecting for necessary scientific research. Hence, incidental take and purposeful take are not authorized for a fully protected species except for collecting for necessary scientific research and relocation of bird species for the protection of livestock.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

In 1989 the AFS identified other natural or manmade factors as threats to the Owens pupfish (Williams et al. 1989). The recovery plan also recognizes that other natural or manmade factors threaten the Owens pupfish (U.S. Fish and Wildlife Service 1998).

The creation and maintenance of small, often intensively managed, populations have prevented extinction of Owens pupfish. Only four populations of Owens pupfish exist, and they are completely isolated from each other. Species consisting of small populations, such as the Owens pupfish, are recognized as being vulnerable to extinction as a result of stochastic (i.e., random) threats (Shaffer 1981). Such threats that may be important to the Owens pupfish are demographic, genetic, and environmental stochasticity and catastrophic events (Shaffer 1981).

Demographic stochasticity refers to random variability in survival and/or reproduction among individuals within a population (Shaffer 1981). Random variability in survival or reproduction can have a significant impact on population viability for populations that are small, have low fecundity, and are short lived. In small populations reduced reproduction

or die-offs of a certain age-class will have a significant effect on the whole population. Individuals vary naturally in their ability to produce viable offspring; for example, a particular male may be sterile or a female may produce fewer eggs than average. Although of only minor consequence to large populations, this randomly-occurring variation in individuals becomes an important issue for small populations.

Currently Owens pupfish populations are small, between 100 and 10,000 individuals and therefore random events that may cause high mortality or decrease reproduction will have a significant effect on the viability of a population. Furthermore, because Owens pupfish live for approximately one year (Miller 1948), a single bad year in reproduction coupled with or followed by high mortality could threaten the population with extinction. Furthermore, because the number of populations is small (four) and each is vulnerable to this threat, the risk of extinction is exacerbated.

Genetic stochasticity results from the changes in gene frequencies caused by the founder effect, random fixation, or inbreeding bottlenecks (Shaffer 1981). Founder effect is the loss of genetic variation when a new population is established by a very small number of individuals. Random fixation refers to when some portion of gene loci are fixed at a selectively unfavorable allele (a different form of a gene) because the intensity of selection is insufficient to overcome random genetic drift. Random genetic drift (the occurrence of random changes in the gene frequencies of small isolated populations) happens when alleles are transmitted from one generation to the next, because only a fraction of all possible zygotes become breeding adults. A bottleneck is an evolutionary event in which a significant percentage of a population is killed or prevented from breeding.

In small populations, such as the Owens pupfish, these factors may reduce the amount of genetic diversity retained within populations and may increase the chance that deleterious recessive genes may be expressed. Loss of diversity could limit the species' ability to adapt to environmental changes, and deleterious recessive genes could reduce the viability and reproductive success of individuals. Isolation of the four remaining populations preventing any natural genetic exchange will lead to a decrease in genetic diversity. Lack of genetic diversity impairs the species' ability to adapt to changes in its environment and contributes to inbreeding depression (i.e., loss of reproductive fitness and vigor). Changes in gene frequency are likely to have occurred and are believed to be a problem for the Owens pupfish (Parmenter in litt. 2006). Further analysis may show populations of Owens pupfish are experiencing genetic drift and a loss of genetic diversity (Parmenter in litt. 2006).

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 factors external to the population (Shaffer 1981). Drought or predation in combination with a low population year could result in extinction. Catastrophes are an extreme form of environmental stochasticity. Although they generally occur infrequently, catastrophes, such as severe floods or prolonged drought, can have disastrous effects on small populations and can directly result in extinction. Climate change over the next century

may increase the occurrence of prolonged drought. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time.

All three of these factors may also act in combination. One possible scenario of how these factors in combination could increase the risk of extinction for the Owens pupfish would be the loss of one or two populations during a drought period at the same time a predator is introduced to one of the remaining populations. Although one or two of the populations may survive and be used for reintroductions, the resulting loss of genetic diversity would likely further increase the risk of extinction.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the status of the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was approved may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

The recovery criteria and tasks for the Owens pupfish are listed in the Service's recovery plan (U.S. Fish and Wildlife Service 1998). Although the five factors are not mentioned specifically, the recovery plan addresses factors A, C, and E. Listing factors B and D are not considered to be threats to the species.

The recovery plan includes the following criteria specifically for Owens pupfish:

Owens pupfish will be considered for downlisting to threatened status when the following goals have been achieved:

- (1) Reproducing populations of Owens pupfish occupy all potential habitat in three populations [referred to as Conservation Areas in the plan] in which threats are controlled for 5 consecutive years. Priority order for establishing populations is as follows: Fish Slough, Warm Springs, and Round Valley.

This criterion addresses Factor A.

Populations: When the recovery plan was being prepared, Owens pupfish occurred at BLM Spring (Fish Slough), White Mountain Research Station, Owens Valley Native Fish Sanctuary, and Warm Springs. However, surveys of the White Mountain Research Station and Owens Valley Native Fish Sanctuary in 1998 found that the pupfish was extirpated from those locations. Presently pupfish occur only at Fish Slough, Warm Springs, Mule Springs, and Well 368. No introductions have occurred at Round Valley; its suitability as a recovery site needs to be re-evaluated. Plans are underway to establish new Owens pupfish populations at Cartago Springs Wildlife Area, which is located about 5 km (3 mi) south of Olancho and Blackrock Waterfowl Management Area (Blackrock Conservation Area), which is a privately-owned duck club about 76 km (47 mi) north of Olancho. Land has been acquired at Cartago Springs (Southern Owens Conservation Area) by CDFG. The Service and CDFG are working with the Blackrock landowner for the introduction. Since the approval of the recovery plan in 1998, two populations of Owens pupfish have been established, and two populations have been lost. Reproducing populations of Owens pupfish have not occupied all potential habitat in three populations for 5 consecutive years simultaneously in three populations. Therefore, this part of criterion 1 has not been achieved.

Threats: Currently, all populations of Owens pupfish are threatened by non-native fish species predation. Fish screens and the isolated nature of Owens pupfish populations have provided some protection from non-native fish predators. The CDFG remove predators as they observe them. However, predators are likely reintroduced into Owens pupfish populations, in an effort by local fishermen to stock those sites with bait and sport fish. Cattail encroachment is currently managed at all populations. However, cattails will grow back and fill in water surface area if not managed. Threats have not been effectively controlled for 5 consecutive years simultaneously in three populations. Therefore, this part of criterion 1 has not been achieved.

Habitat Occupancy: The recovery plan was published in 1998. Since that time no three Owens pupfish populations have occupied all potential habitat at the same time, for 5 consecutive years. Non-native predators exclude Owens pupfish from occupying all potential habitat in each location. Therefore, this part of criterion 1 has not been achieved.

- (2) The area [i.e., potential habitat] occupied by Owens pupfish within each of these [three] populations [i.e., Fish Slough, Round Valley, and Warm Springs] should approximate the amount shown in Table 1.

Table 1. Locations and habitat totals to reach downlisting or delisting as stated in the 1998 Recovery Plan for the Owens pupfish.

Population [Conservation Area]	Water Surface Area Acres (hectares)	Linear Habitat Miles (kilometers)
Fish Slough	8 (3.2)	7 (11.2)
Round Valley	6 (2.4)	5 (8)
Warm Springs	5.5 (2)	2 (3)
Blackrock	500 (200)	5 (8)
Southern Owens	0.6 (1.6)	2 (3)

This criterion addresses Factor A.

Owens pupfish have not been introduced at Round Valley, Blackrock, or Southern Owens River locations. The current Owens pupfish population at Warm Springs consists of approximately 100 individuals and does not occupy the required 5.5 acres (ac) (2 hectares (ha)) of water surface area (the minimum water surface area requirement for downlisting or delisting as stated in the 1998 Recovery Plan). The current Owens pupfish sub-populations at Fish Slough could total as many as 11,000 individuals. However, the sub-populations collectively do not occupy 8 ac (3.2 ha) of water surface area. The current Owens pupfish population at Mule Springs consists of approximately 100 to 1,000 individuals, but does not occupy a minimum of 5.5 ac (2 ha) of water surface area. The current Owens pupfish population at Well 368 consists of approximately 100 to 1000 individuals, but does not occupy 5.5 ac (2 ha) of water surface area. Therefore, criterion 1 has not been achieved.

- (3) Each [existing] population of Owens pupfish must have an approved management plan and implementing agreement between the landowner and the U.S. Fish and Wildlife Service.

This criterion addresses Factors C and E.

Management Plans: The four existing Owens pupfish populations do not have approved management plans or implementing agreements between the U.S. Fish and Wildlife Service and the landowners. All future introductions would also require management plans. This criterion has not been achieved.

- (4) Successful establishment of these populations will occur when demography follows an annual pattern in which adult fish numbers dominate spring and autumn populations, and juvenile fish numbers dominate early summer

populations, and when the biomass of Owens pupfish exceeds the biomass of deleterious non-native fish.

This criterion addresses Factor C and E.

Surveys of population demographics have not been implemented for any population. However, the surveys that have been conducted indicate that biomass of Owens pupfish does not exceed the biomass of deleterious non-native fish at any population (Parmenter in litt. 2008) Therefore, criterion 4 has not been achieved.

Owens pupfish can be considered for delisting when all of the following goals have been achieved:

- (1) Populations of Owens pupfish are established as part of self-sustaining native fish assemblages throughout all aquatic habitats in four populations for a period of 7 consecutive years during which threats are controlled. Priority order for establishing populations is as follows: Fish Slough, Warm Springs, Round Valley, and Blackrock Conservation Area.

This criterion addresses Factor A

Criterion 1 for downlisting has not been achieved yet (see downlisting above).

- (2) The area occupied by Owens pupfish within each [four] population should approximate the amount shown in Table 1 above.

This criterion addresses Factor A.

Criterion 2 for downlisting has not been achieved yet (see downlisting above).

- (3) Each [existing] population must have an approved management plan and implementing agreement between landowner and the U.S. Fish and Wildlife Service.

This criterion addresses Factor C and E.

Criterion 3 for downlisting has not been achieved yet (see downlisting above.)

- (4) Successful establishment of these populations will occur when demography follows an annual pattern in which adult fish numbers dominate spring and autumn populations, and juvenile fish numbers dominate early summer populations, and when the biomass of Owens pupfish exceeds the biomass of deleterious non-native fish.

This criterion addresses Factor C and E.

Criterion 4 for downlisting has not been achieved yet (see downlisting above).

IV. SYNTHESIS

As a result mainly of habitat loss from water diversion, the Owens pupfish was at one time considered extinct (U.S. Fish and Wildlife Service 1998). In 1964, a small population of Owens pupfish was discovered in Fish Slough, which was still the only existing population when the pupfish was listed as endangered in 1967. Since listing, three additional populations have been established (Warm Springs, Well 368, and Mule Springs). Presently, there are four populations of pupfish, Fish Slough, Warm Springs, Well 368, and Mule Springs. Only the Fish Slough population has persisted since listing. Progress is being made toward establishing two new pupfish populations. Management plans are being developed for each of the potential Owens pupfish populations. The plans will include requirements to manage threats.

Current major threats to the Owens pupfish include habitat encroachment by aquatic vegetation, predation by non-native species, and stochastic factors. These threats are occurring at all four of the existing pupfish populations and at all locations identified in the recovery plan for future introductions. Future introductions are not likely to be successful unless these threats are eliminated or reduced from those areas. Based on these ongoing threats and the small number and isolation of existing populations, we recommend that the endangered status of the Owens pupfish remain unchanged.

V. RESULTS

Recommended Listing Action:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist (indicate reason for delisting according to 50 CFR 424.11):
 - ☐ *Extinction*
 - ☐ *Recovery*
 - ☐ *Original data for classification in error*
- ☒ No Change

New Recovery Priority Number and Brief Rationale: The recovery priority number should be changed to 2 (a recovery priority number of 3 designates a subspecies). The Owens pupfish is a species that faces a high degree of threat and has a high recovery potential.

Listing and Reclassification Priority Number and Brief Rationale: No change needed

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

- 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.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW**

Owens Pupfish (*Cyprinodon radiosus*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

☐ Downlist to Threatened

☐ Uplist to Endangered

☐ Delist

☒ No change needed

Appropriate Listing/Reclassification Priority Number: N/A

Review Conducted By: Brian Croft

FIELD OFFICE APPROVAL:

Field Supervisor, U.S. Fish and Wildlife Service

Approve Diane K. Hoke Date 1/14/09

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, U.S. Fish and Wildlife Service

Approve Michelle Date 2-4-09