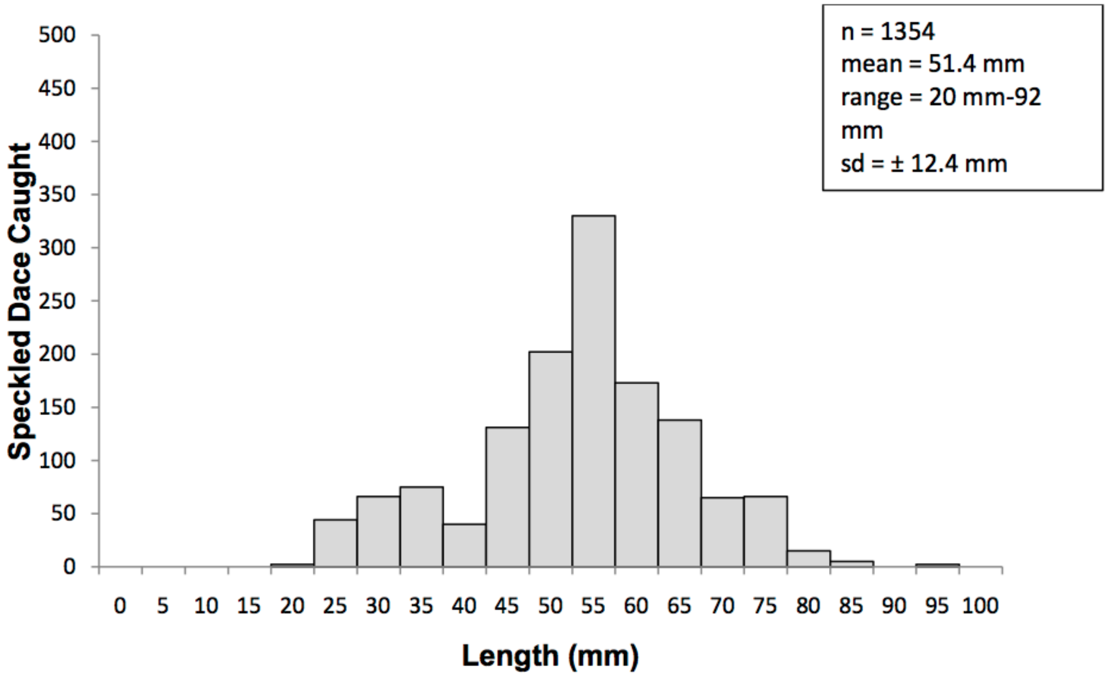
## AMARGOSA CANYON SPECKLED DACE
## *Rhinichthys osculus* ssp.

**Status: Critical Concern.** Amargosa Canyon speckled dace are highly vulnerable to extinction in the next 50 years because they are restricted to a single desert stream system which is under threat of dewatering and invasion by non-native plants, fishes, crustaceans and amphibians.

**Description:** Speckled dace are small cyprinids, usually measuring less than 8 cm SL at maturity but occasionally reaching 11 cm SL (Moyle 2002). Although physically variable, they are characterized by a wide caudal peduncle, small scales (47-89 along lateral line), and pointed snout with a small subterminal mouth. At maturity the dorsal fin usually has 8 rays and originates well behind the origin of the pelvic fins (Moyle 2002). The anal fin has 6-8 rays. Pharyngeal teeth (1,4-4,1 or 2,4-4,2) are significantly curved with a minor grinding surface. The maxilla usually has a small barbel at each end. The snout is connected to the upper lip (premaxilla) by a small bridge of skin (frenum). As their common name indicates, most fish larger than 3 cm have distinctive dark speckles on the upper and sides of the body, although some fish from highly turbid waters may lack speckles. Dark blotches present on the side can merge, creating what looks like a dark lateral band. A stripe on the head, below the eye, extends to the snout, and there is black a spot on the caudal peduncle. The rest of the body is dusky yellow to olive, with the belly being a paler color. Breeding adults of both sexes have fins tipped by orange or red, while males also have red snouts and lips, as well as tubercles on the head and pectoral fins.

Amargosa Canyon speckled dace are visually similar to other *Rhinichthys osculus* subspecies. However, dace from Amargosa Canyon are characterized by a comparatively smaller head depth, shorter snout-to-nostril length, longer anal-to-caudal length, more pectoral fin rays, and fewer vertebrae than other forms. Speckled dace captured during a summer, 2010 survey of Amargosa Canyon ranged from 20 to 92 mm in fork length with a mean of 51 mm (Scoppettone et al. 2011, Fig. 1).

**Figure 1.** Length frequency of speckled dace (*Rhinichthys osculus* spp.) caught during the summer, 2010 survey of the Amargosa River Canyon, California. Figure from Scoppettone et al. 2011.




**Taxonomic Relationships:** The speckled dace has long been considered the most widely distributed freshwater fish species in the western United States and isolated populations can be found in many small streams and springs. However, its taxonomy is poorly understood and highly confusing because the species is naturally so variable. Originally, small morphological differences among speckled dace populations isolated in different watersheds (especially in the endorheic valleys of the Great Basin) led ichthyologists to describe 12 separate species (Jordan and Evermann 1896). Later, because of the plastic morphology of the species, all speckled dace were collapsed into a single species, *Rhinichthys osculus* (Hubbs et al. 1974). Recently, however, genetic analysis has supported a return to the some of the original taxonomy. A number of forms are now recognized as separate taxa, not only because of their distinctive morphology, different habitats, and isolation from other dace populations, but also because they can be shown to be genetically distinct. Four such forms are now recognized in the Death Valley system: the Owens speckled dace, the Long Valley speckled dace, the Amargosa Canyon speckled dace, and the Ash Meadows speckled dace (Nevada).

Gilbert (1893) described *Rhinichthys nevadensis* from Ash Meadows, Nevada, but the subspecific name *R. o. nevadensis* was later also applied to speckled dace in the Amargosa River canyon and Owens Basin (La Rivers 1962, Moyle 2002). However, in the early 1980s, research revealed that these three populations are morphometrically distinct (Williams et al. 1982). Amargosa Canyon dace have a comparatively smaller head depth, shorter snout-to-nostril length, longer anal-to-caudal length, more pectoral fin rays, and fewer vertebrae than the other forms. As a consequence, Williams et al. (1982) and Deacon and Williams (1984) recommended that the populations from these three areas be treated as undescribed subspecies. In addition, the dace population in Long

Valley, in the northern Owens Basin, has been found to be morphologically distinct (Sada 1989, Sada et al. 1995) and genetically monophyletic (Oakey et al. 2004).

Each of these taxa are treated as separate subspecies in this report. It may also be valid to consider all of the above forms as comprising one taxon, *R. o. nevadensis,* while recognizing that each population represents a unique component of the overall population, on its own evolutionary trajectory. If so, it is important to realize that each DPS is in greater danger of extinction than is the entire group collectively. In such a case, the Owens, Amargosa Canyon and Ash meadows speckled daces would represent distinct population segments within the subspecies *R. o. nevadensis,* while the Long Valley speckled dace would still be recognized as an undescribed subspecies.

Although the Ash Meadows speckled dace was listed as a federally endangered species in 1984, the Owens and Amargosa Canyon populations remain unprotected, partially because they have never been formally described. Regardless of taxonomy, all populations in the Amargosa and Owens River drainages are in need of protection with individualized management plans to prevent declines in their status.

**Life History:** Amargosa Canyon speckled dace are active throughout the year, including the winter months. As a consequence, because growth is continuous throughout the year, they are difficult to age by scale analysis. However, length-frequency analysis of dace from other localities suggests that dace generally live for 5-6 years (Moyle 2002). In Amargosa Canyon, the most frequent size class in May was 52-54 mm TL but, in July, smaller fish averaging 31-33 mm were more common (Williams et al. 1982). However, in May there were many small fish (<30 mm TL), suggesting that peak spawning occurs in early spring (March) and that spawning activity is reduced or absent in late spring and summer. Speckled dace reproduce in their second year (Constantz 1981), so the 52-54 mm TL size class (common in May) are probably first-year fish (Williams et al. 1982).

Few data have been collected on the life history of Amargosa Canyon speckled dace. This description, therefore, is based on data from other *R. osculus* populations. Speckled dace are usually found in loose groups in appropriate habitats, although they avoid large shoals except while breeding. They can be active both day and night, although Moyle (unpubl. data) found that Lahontan speckled dace were more nocturnal in their habits when subjected to heavy bird predation in streams. Their activity is also mediated by stream temperatures; they apparently stay active all year if stream temperatures remain above 4°C, which would be typical of the Amargosa River (Moyle 2002).

Their subterminal mouth, pharyngeal tooth structure, and short intestine are characteristic of small invertebrate feeders. Not surprisingly, diet varies according with prey availability and speckled dace, in general, prey opportunistically on the most abundant small invertebrates in their habitat, which may change seasonally. Speckled dace generally forage on small benthic invertebrates, especially taxa common in riffles, including hydropsychid caddisflies, baetid mayflies, and chironomid and simuliid midges, but will also feed on filamentous algae (Li and Moyle 1976, Baltz et al. 1982, Hiss 1984, Moyle et al. 1991). Preference of forage items may also be influenced by the presence of other fishes that share similar habitats (e.g., pupfish).

Length frequency analyses have determined age and growth patterns. By the end of their first summer, dace grow to 20-30 mm SL (Moyle 2002), growing an average of

10-15 mm/yr in each subsequent year. Females tend to grow faster than males. However, growth rates can decrease under extreme environmental conditions, high population densities, and/or limited food (Sada 1990). Slight changes in growth rates are also positively correlated with changes in temperature, as seen in the Colorado River (Robinson and Childs 2001). Life expectancy is approximately 3 years, where maximum sizes do not exceed 80 mm FL; however, dace may reach 110 mm FL and live up to six years (Moyle 2002). Dace reach maturity by their second summer, with females producing 190-800 eggs, depending on size and location (Moyle 2002). Females release eggs underneath rocks or near the gravel surface while males release sperm (John 1963). Eggs settle into interstices and adhere to substrates. At temperatures of 18-19°C, eggs hatch in 6 days, but larvae remain in the gravel for another 7-8 days (John 1963). Fry in streams congregate in warm, shallow areas, often in channels with rocks and emergent vegetation.

When extreme conditions such as floods, droughts, or winter freezing eliminate local populations, speckled dace from nearby areas can readily recolonize or repopulate available habitats if accessible (Sada 1990, Pearsons et al. 1992, Gido et al. 1997). Following a devastating flood, densities of speckled dace in the Colorado River, Arizona, returned to pre-flood levels after eight months, recolonizing from upstream and stream margin areas (Valdez et al. 2001). Such recolonization may be of particular importance in the Amargosa River where large but infrequent flood events are a defining characteristic of the desert hydrograph.

**Habitat Requirements:** Unlike other speckled dace, which usually prefer moving water, Amargosa Canyon dace prefers pool-like habitat with deep (0.45-0.75 m), slow (<0.01 $m^3$ $sec^{-1}$) water. Williams and others (1982) found speckled dace to be rare within the Amargosa River Canyon but abundant in Willow Creek and Willow Creek Reservoir (Williams et al. 1982). In contrast, a recent survey found both speckled dace and pupfish in robust numbers in the Amargosa Canyon but found dace to be rare in Willow Creek (Scoppettone et al. 2011). Summer water temperatures ranged little (23.4-24.8°C) in Amargosa River Canyon during the 2011 survey, while dissolved oxygen ranged from 6.2 to 8.6 mg/L, conductivity ranged from 2,044 to 5,318 µS/cm, and pH ranged from 7.9 to 8.3. Water temperatures were generally warmer in the river than in Willow Creek where they ranged from 25.2 to 28.7 °C (Scoppettone et al. 2011).

Williams et al. (1982) reported the following physical characteristics for Willow Creek, a small, clear stream with low flow (1 cfs) and fine sand/silt substrates: pH of 7.7, dissolved oxygen of 5-6 mg $l^{-1}$, total dissolved solids of 700 ppm, and water temperatures of 21-28° C. The reservoir was turbid, with a substrate of easily roiled fines. The periphery of the reservoir has dense stands of salt-cedar and cattails (Williams et al. 1982). Scoppettone et al. (2011) made the following daytime measurements in Willow Creek: dissolved oxygen 7.1–12.1 mg/L, conductivity 1,027–1,082 µS/cm, and pH 7.6–8.4. The high dissolved oxygen (12.1 mg/L) was probably due to the lower station having shallow water (<4 cm deep), with little flow and exposure to the sun, all of which are conditions promoting higher photosynthesis.

Riparian vegetation does not appear to drive distribution, because no significant difference in abundance and density of speckled dace was observed between open water and highly vegetated reaches of Amargosa Canyon (Scoppettone et al. 2011).

**Distribution:** This population is confined to the Amargosa River in Amargosa Canyon and its tributaries, especially Willow Creek and Willow Creek Reservoir (Williams et al. 1982, Scoppettone et al. 2011). In the summer of 2010, it was found to be abundant throughout Amargosa Canyon, except in the lowest reaches which are subject to drying (stranded dead pupfish were observed in desiccated pools at the time of the survey). It is possible that speckled dace scarcity in this lower reach of Amargosa Canyon was due to stranding avoidance behavior (Scoppettone et al. 2011). Historically, Amargosa dace were found in a warm spring just north of Tecopa (Miller 1938) but that population is no longer present. Overall, its range may have been reduced by water diversion which may reduce surface flow in Amargosa Canyon.

**Trends in Abundance:** During a 1981 survey of the Amargosa Canyon that included Willow Creek, speckled dace comprised 1% and introduced western mosquitofish (*Gambusia affinis)* 40% of the fish collected (Williams et al. 1982). In the most recent survey, speckled dace were relatively abundant, representing 40% of the total catch, while mosquitofish only represented 8%, with the remaining 52% being pupfish. These latest results suggest that speckled dace populations in Amargosa Canyon fluctuate, possibly in response to flow patterns in Amargosa Canyon and interactions with introduced mosquitofish. It is likely that flood events favor native speckled dace by flushing mosquitofish from the system.

**Nature and Degree of Threats:** The major threat to Amargosa Canyon speckled dace is the potential dewatering of its unique habitats, the Amargosa River and tributaries, combined with interactions with invasive species (Table 1).

*Agriculture, rural residential development, urbanization.* These three categories are lumped because, together, they result in water withdrawals from sources which feed the Amargosa River, both far and near. The Amargosa Aquifer supplies the springs of Ash Meadows, Nevada and the Amargosa River, to which they are tributary (Riggs and Deacon 2002). It receives much of its recharge flow from areas on the northern and northeastern slopes of the nearby Spring Mountains but, along with springs on the eastern side of Death Valley, is partially dependent on regional groundwater movement through large, ancient aquifers that extend into western Utah and central Nevada (Dettinger and Cayan 1995, Deacon et al. 2007). In order to supply the city of Las Vegas, the Southern Nevada Water Authority (SNWA) proposed to mine large quantities of this water from several different valleys which lie within the Ash Meadows groundwater basin (Breen 2004, Southern Nevada Water Authority 2004, Vogel 2004). Farming operations and human settlements in the Amargosa region are withdrawing increasing amounts of water from the aquifer, producing noticeable declines in the water level of closely-monitored Devils Hole, Nevada (habitat of the endangered Devils Hole pupfish, *Cyprinodon diabolis*) (Riggs and Deacon 2004, Bedinger and Harrill 2006).

If Amargosa region water withdrawals continue to increase and if the SNWA proceeds with its planned withdrawals, it is highly likely that Amargosa River flows will be greatly reduced or even disappear entirely during dry years. Already, diversions of springs and outflows on private land in the Tecopa area have reduced flows in the river and local pupfish populations as well. Corresponding with increasing human population growth around Tecopa and the upper Amargosa Valley, potential threats to aquatic habitats in the Amargosa River from water use and flood protection also increase.

Although most land in Amargosa Canyon is owned or administered by The Nature Conservancy or the Bureau of Land Management, important habitat for the dace includes a large tract of privately owned land, China Ranch, which contains the headwaters of Willow Creek. Diversion of water from the creek or other alterations affecting water quality may be affecting dace populations.

*Grazing.* Although grazing is not a major land use in the region, cattle have a tendency to aggregate around water sources, particularly in arid landscapes, so their impact on aquatic habitat can be disproportionate to their actual numbers. Water is also diverted directly from the stream for cattle and pumped to grow alfalfa for feed.

*Recreation.* The deserts of California support high recreational use, driven by the millions of people living in the nearby major urban areas of southern California. Off-highway vehicular use (motorcycles, quads, sand rails, dune buggies, etc.) is a growing form of recreation, creating impacts to sensitive desert and aquatic habitats. These activities are difficult to regulate and, although regulations are in place that ban the use of off-road vehicles in sensitive areas, riparian and streambed habitat degradation from illegal vehicle use still occurs. The rapidly increasing popularity of off road motorized vehicle recreation represents a growing threat to the Amargosa River and its watershed.

*Alien species.* Although historic data are lacking, it is assumed that native fishes were likely found in greater abundance in the Amargosa River prior to the invasion of saltcedar (*Tamarisk*), crayfish, and mosquitofish, all of which have been found to negatively impact native fish populations (Scoppettone et al. 2011). Crayfish compete with and prey upon native fishes (Light 2005) and mosquitofish likely aggressively compete with speckled dace for food (Caiola and Sostoa 2005), as well as being a known predator of fish larvae and eggs (Meffe 1985, Mills et al. 2004). Similar to many other desert aquatic habitats in the American Southwest, Saltcedar is proliferating and altering habitats in Amargosa Canyon (Scoppettone et al. 2011). Historically, stochastic events such as fire and flood periodically cleared large areas of riparian vegetation, keeping stream channels open and dynamic (Benda et al. 2003, Kozlowski et al. 2010). Today, these same processes serve as agents for the spread of saltcedar (Wiesenborn 1996), threatening to form a saltcedar monoculture throughout the floodplain (Scoppettone et al. 2011). Because saltcedar has a substantially greater water demand than native vegetation, increases in saltcedar density in the riparian zone result in a corresponding increase in water lost to transpiration (Duncan and McDaniel 1998).

| | Rating | Explanation |
|---|---|---|
| Major dams | n/a | |
| Agriculture | High | Water withdrawals, both locally and in and around the Pahrump Valley, threaten flows in Amargosa River |
| Grazing | Medium | Livestock grazing in this arid region may disproportionately impact aquatic habitats |
| Rural residential | Medium | Residential water use contributes to reduced stream flows |
| Urbanization | High | Water demands from Las Vegas threaten aquifers which feed the Amargosa River |
| Instream mining | n/a | |
| Mining | Low | No known effects but present throughout region |
| Transportation | Low | Roads present; possible sources of increased sediment input |
| Logging | n/a | |
| Fire | Low | Fire can intermittently affect riparian habitats |
| Estuary alteration | n/a | |
| Recreation | Medium | Recreational use in the region is fairly high, including off-road vehicle use |
| Harvest | n/a | |
| Hatcheries | n/a | |
| Alien species | High | Competition/predation from mosquitofish, crayfish and bullfrogs could play a major role in species decline, while saltcedar can substantially alter aquatic habitats |

**Table 1.** Major anthropogenic factors limiting, or potentially limiting, viability of populations of Amargosa Canyon speckled dace in California. Factors were rated on a five-level ordinal scale where a factor rated "critical" could push a species to extinction in 3 generations or 10 years, whichever is less; a factor rated "high" could push the species to extinction in 10 generations or 50 years whichever is less; a factor rated "medium" is unlikely to drive a species to extinction by itself but contributes to increased extinction risk; a factor rated "low" may reduce populations but extinction is unlikely as a result. A factor rated "n/a" has no known negative impact. Certainty of these judgments is moderate. See methods section for descriptions of the factors and explanation of the rating protocol.

**Effects of Climate Change:** The predicted impacts of climate change pose a direct threat to the continued existence of Amargosa Canyon speckled dace. The Amargosa River canyon exists in an exceptionally arid region and is fed by isolated desert springs and subsurface aquifer flow; this is a precarious ecosystem, vulnerable to geologic and anthropogenic disruption. Fed by rain and snow melt at high elevation in the desert mountain ranges, desert aquifers in the Death Valley region will likely receive less recharge as the region warms (Riggs and Deacon 2004). This decline in regional water supply will be compounded by growing human demand for water both locally and in southern Nevada, which will only increase as the climate gets hotter and more arid. Moyle et al. (2013) rated the Amargosa Canyon speckled dace as critically vulnerable to climate change effects.

**Status Determination Score = 1.9 – Critical Concern** (see Methods section Table 2). The Amargosa Canyon speckled dace is a Bureau of Land management Sensitive Species, is listed as Critically Imperiled by Natureserve (Natureserve.com) and Endangered by the American Fisheries Society (Jelks et al. 2008). These dace are highly vulnerable to extinction in the next 50 years, because they are restricted to a single desert stream system which is under threat of dewatering and invasion by non-native plants, fishes, crustaceans and amphibians (Table 1).

| Metric | Score | Justification |
|---|---|---|
| Area occupied | 1 | Endemic to Amargosa Canyon |
| Estimated adult abundance | 3 | Highly fluctuating; probably low in dry years |
| Intervention dependence | 3 | Depends on protection of stream corridor and limited water removal |
| Tolerance | 2 | Exists near edge of thermal tolerances |
| Genetic risk | 2 | Single population |
| Climate change | 1 | Water withdrawals likely to increase and flows decrease |
| Anthropogenic threats | 1 | See Table 1 |
| Average | 1.9 | 13/7 |
| Certainty (1-4) | 2 | Recent comprehensive survey of Amargosa Canyon |

**Table 2.** Metrics for determining the status of Amargosa Canyon speckled dace, where 1 is a major negative factor contributing to status, 5 is a factor with no or positive effects on status, and 2-4 are intermediate values. See methods section for further explanation.

**Management Recommendations:** The Amargosa Canyon speckled dace needs immediate attention in order to prevent its decline and possible extinction.

1. Efforts should be made to ensure natural flow of water in Willow Creek and the Amargosa River, including occasional flood flows that reduce populations of alien fishes and saltcedar. Fortunately, most of the canyon area is now owned by the Nature Conservancy or administered by the Bureau of Land Management. Amargosa Canyon is part of a BLM Area of Critical Environmental Concern and is closed to off-road vehicle use. Fences and barriers need to be properly maintained, however, because vehicle trespass has been a common problem in the past. Increased law enforcement presence in the area would likely reduce illegal off-road vehicle use impacts.
2. An evaluation should be conducted in Willow Creek to determine if complete eradication of alien species from speckled dace habitat is possible. If not feasible, invasion-proof refuges for the species (and Amargosa pupfish) should be created within the drainage.
3. Minimum base flow requirements in Willow Creek through China Ranch should be established.

4. Efforts should be made to locate the spring where Amargosa dace were documented in 1937 (Miller 1938) to determine if this spring, or another nearby spring, could again support a dace population. Frequent surveys of Amargosa Canyon are necessary to monitor habitat conditions and the presence of alien fishes, crayfish, bull frogs and saltcedar.
5. Water removal from the aquifer(s) that apparently feeds the river is a pressing threat that needs further study. The U.S. Supreme Court decision that protected the Devils Hole pupfish from water withdrawals (United States v. Cappaert 1977) may have offset some impacts, but its utility on a larger, regional, basis is uncertain. Hydrological studies should be performed to evaluate relationships between Amargosa River flow and regional aquifers and to aid in the development of models to predict how various levels of pumping in different geographic areas might affect surface flow.

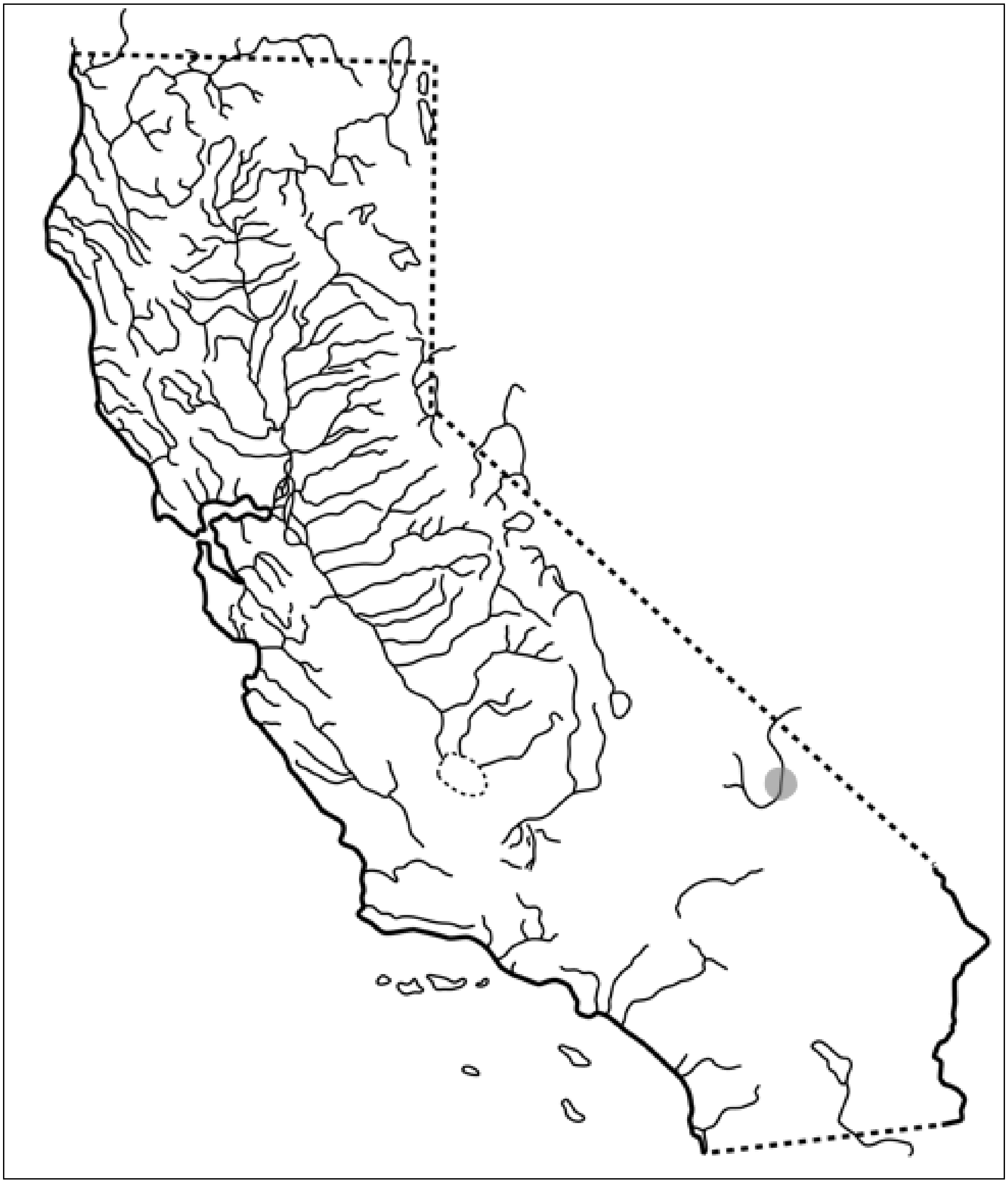


**Figure 2.** Distribution of Amargosa Canyon speckled dace, *Rhinichthys osculus* ssp., in the Amargosa Canyon area of the Amargosa River, California.