UPPER KLAMATH MARBLED SCULPIN
***Cottus klamathensis klamathensis* Daniels and Moyle**

Status: Critical Concern. No immediate extinction risk exists for upper Klamath marbled sculpin in Oregon but it is at risk of localized extirpation in California because of its limited distribution in a single, highly modified, watershed.

Description: All subspecies of marbled sculpin (*Cottus klamathensis)* have large, dorsally flattened heads with two chin pores; large, fan-like pectoral fins with four elements; and small pelvic fins that are positioned ventrally between the pectorals (Moyle 2002). Marbled sculpin are distinguished from other *Cottus* species by having 7-8 dorsal fin spines, joined dorsal fins, an incomplete lateral line with 15-28 pores, and relatively smooth skin (Daniels and Moyle 1984), although a few prickles can sometimes be felt below the lateral line. They also lack palatine teeth and have only one preopercular spine (Moyle 1976). Fin ray counts are: 18-22 in the second dorsal fin, 13-15 in the anal fin, 14-16 in the pectoral fin, and 11-12 (principal rays) in the caudal fin (Moyle 2002). All other sculpin species in California possess a split dorsal fin and more than 7 dorsal spines. Marbled sculpin are generally green-hued with a dark circular spot at the posterior end of the dorsal fin and alternating dark and light spots on the pectoral fin rays. Fish from the Klamath River are generally lighter and more marbled than those from the Pit River (Moyle 2002). Other marbled sculpin characteristics include: a wide interorbital region, a wide head and blunt snout, a maxillary rarely extending beyond the anterior half of the eye, and unjoined preoperculo-mandibular canals, but these characteristics are shared with one or more other species (Daniels and Moyle 1984). Upper Klamath marbled sculpin are identified by 15-22 lateral line pores, indicating a shorter lateral line than lower Klamath marbled sculpin (Gilbert 1897, Daniels and Moyle 1984). Other marbled sculpin subspecies have 22 or more pores along the lateral line.

Taxonomic Relationships: *Cottus klamathensis* was first described by Gilbert (1898) from the Klamath River system, including Upper Klamath Lake. Rutter (1908) then described *Cottus macrops* from the Fall River, a large tributary to the Pit River, and noted that it closely resembled *C. klamathensis*. Robins and Miller (1957), upon review of specimens and then recent collections, concluded that the two species were not sufficiently different to warrant separate species designations and considered *C. macrops* synomymous with *C. klamathensis*. Daniels and Moyle (1984), however, on the basis of meristic and mensural differences in fish from the Pit and Klamath river systems, concluded that *C. klamathensis* could be divided into three subspecies: (1) *C. k. klamathensis* (upper Klamath marbled sculpin), the nominate subspecies found in rivers upstream of Klamath Falls and in the headwaters of the Lost River; (2) *C. k. polyporus* (lower Klamath marbled sculpin), found in the lower Klamath River downstream of Klamath Falls and in some of its larger tributaries, and possibly in the Trinity River system; and (3) *C. k. macrops* (bigeye marbled sculpin), found in the Pit River system downstream from the confluence of the Fall River to Pit 7 Reservoir and in three tributaries: Hat Creek (downstream of the Rising River system), Burney Creek (downstream of Burney Falls), and the Fall River system (with the exception of Bear Creek). Baumsteiger et al. (2012), using molecular techniques, confirmed that the three subspecies do represent three separate lineages.

Life History: Upper Klamath marbled sculpin life history remains largely unknown but is likely similar to that of bigeye marbled sculpin in the Pit River, based on similarity of habitats. Bigeye marbled sculpin grow quickly, attaining 35% of their maximum length in their first year and live about five years (Daniels 1987). Growth occurs from spring to early autumn. Average sizes are 39 mm at the age of 1 year, 55 mm at 2 years, 62 mm at 3 years, 70 mm at 4 years, and 79 mm at 5 years. Although fish over 80 mm are rare, one specimen was recorded at 111 mm. Marbled sculpin attain sexual maturity after 2 years during the winter (Moyle 2002). Spawning occurs from late February to March. Fecundity of upper Klamath marbled sculpin is fairly high for sculpin, with 8-9 cm DL females producing about 1,200 eggs each (Markle et al. 1996). Adhesive eggs are deposited in clusters in nests under flat rocks. Eggs from different females may be present in the same nest. Nests are usually guarded by males (Daniels 1987). Embryos number from 826-2,200 per nest. Larvae measure 6-8 mm upon hatching, are benthic, and likely rear close to their nests (Moyle 2002).

Habitat Requirements: Upper Klamath marbled sculpin occur in a wide variety of habitats, from Upper Klamath Lake to headwater streams. Bond et al. (1988) found that they were most likely to be collected in water with summer temperatures of 15-20°C, in coarse substrates (cobble and gravel), where water velocities ranged from slow to swift; most streams had widths greater than 20 m. Bond et al. (1988) characterized marbled sculpin as a slow water species. Markle et al. (1996) noted that, while found at temperatures of 8-24°C, they appear to prefer temperatures of 10-15°C. In Upper Klamath Lake, they occur on soft bottom substrates and come off the bottom to feed at night (Markle et al. 1996).

Distribution: The upper Klamath marbled sculpin is apparently common in the upper Klamath Basin in Oregon but, in California, has been found recently only in Willow and Boles creeks, Modoc County, California (Markle et al. 1996). Based on what is known about its habitats elsewhere, it may have once occurred in much of the Lost River, before water quality and habitats became degraded.

Trends in Abundance: Most fish surveys of the Lost River basin have been focused on endangered suckers (Catostomidae), so sculpins may be underrepresented in existing data sets. Nevertheless, some records exist. V. King (CDFW, unpublished memo to E. Bailey, October 18, 1972) found a few marbled sculpin in pools below Clear Lake Reservoir dam. Sonnevil (1972) found marbled sculpin to be "common" in Willow Creek and "present" in Boles Creek. Koch et al. (1975) collected only seven sculpins, all from Willow Creek, by electrofishing. Shively et al. (1999) sampled the entire watershed in Oregon, using a variety of techniques, and collected only 11 marbled sculpins out of over 5,000 fish collected. A majority of the fish were alien species that had invaded since the 1970s. This spotty evidence suggests that Upper Klamath marbled sculpins have become rare in the Lost River watershed. In California, they may persist only in upper Boles and Willow creeks.

	Rating	Explanation
Major dams	High	Major dams have altered flows and changed habitats throughout the species range
Agriculture	High	The mainstem Lost River contains mainly agricultural return water of poor quality
Grazing	High	Cattle grazing is the major land use in the Willow and Boles creek watersheds
Rural residential	Low	Few residences in range
Urbanization	n/a	
Instream mining	n/a	
Mining	n/a	
Transportation	Low	Roads line most streams and are potential sources of sediment input and possible habitat fragmentation (e.g., culverts)
Logging	Medium	Limited historic and present logging probably contributes to degraded aquatic habitats in CA portion of range
Fire	n/a	
Estuary alteration	n/a	
Recreation	n/a	
Harvest	n/a	
Hatcheries	n/a	
Alien species	Medium	Alien fishes occur throughout range and presumably prey on sculpin, as they do other native fishes

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of upper Klamath marbled sculpin 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 unlikely as a result; and a factor rated "no" has no known negative impact to the taxon under consideration. Certainty of these judgments is low. See methods section for descriptions of the factors and explanation of the rating protocol.

Nature and Degree of Threats: Upper Klamath marbled sculpin in California are apparently now restricted to highly modified and degraded habitats in limited portions of the Lost River drainage in California (Table 1).

Major dams. Lost River flows and habitats have been altered by multiple dams in California and Oregon. The principal dam in California creates Clear Lake Reservoir, capturing water from the Willow-Boles Creek drainage. Dam releases have greatly reduced natural flows in the Lost River, creating generally poor water quality and increased temperatures (Snively et al. 1999).

Grazing. Grazing is the dominant land use around Willow and Boles creeks, the principal habitats of upper Klamath marbled sculpin in California. In riparian areas, grazing can degrade aquatic habitats by removing riparian vegetation and associated stream shading, reducing depth, increasing sediment and nutrient input, and increasing stream temperatures so habitats

become less suited for sculpins (Moyle 2002).

Logging. Logging occurs in Modoc National Forest but impacts on streams are undocumented. In general, logging practices degrade aquatic habitats by increasing sediment delivery to streams and removing riparian vegetation (Moyle 2002). Culverts along logging roads can prevent longitudinal movement, potentially isolating populations.

Alien species. The Lost River is dominated by alien species, including various centrarchids, brown bullhead (*Ameiurus nebulosus*), and fathead minnow (*Pimephales promelas*). While predation and competition are of concern, the presence of these species is more indicative of poor water quality (Shively et al 1999). Sacramento perch (*Archoplites interruptus*) are now one of the most common fish in Willow Creek and they may be predators on, or competitors with, marbled sculpin (Moyle 2002).

Effects of Climate Change: The most noticeable and widespread predicted impacts of climate change on aquatic habitats in California will be increased water temperatures and changes to the frequency and timing of drought and flooding events. Water temperature increases may reduce the individual fitness of fishes by decreasing growth, decreasing reproductive potential, and increasing susceptibility to disease (Moyle and Cech 2004). While specific impacts to upper Klamath marbled sculpin remain unknown, climate change increases the likelihood that Willow and Boles creeks will become less suitable as sculpin habitat, including large sections of stream drying completely during extended drought periods. Upper Klamath marbled sculpin occur in an already arid portion of the state, with instream flows highly dependent on both snowmelt (headwater tributaries) and dams and diversions and associated releases (mainstem rivers). Reduction in snowpack, or precipitation in general, coupled with modified dam operations associated with reduced reservoir recharge, will likely negatively impact marbled sculpin and other native fishes. These changes will also likely favor alien species and potentially allow for expansion of their distribution. Moyle et al. (2013) scored upper Klamath marbled sculpin as being “highly vulnerable” to extinction from the combination of climate change effects and other stressors.

Status Determination Score = 1.7 - Critical Concern (see Methods section, Table 2)**.** NatureServe ranks marbled sculpin as apparently Secure (S4), although no specific status is noted for the upper Klamath subspecies. The rationale for this status determination (see Table 2) relates to the fact that little is known about upper Klamath marbled sculpin distribution and abundance in California. The limited empirical data suggest that their populations may be critically low.

Metric	Score	Justification
Area occupied	1	Restricted to the Lost River drainage; mainly occurs in Boles and Willow creeks
Estimated adult abundance	2	Unknown; habitat limited and records few
Intervention dependence	2	Limited headwater habitats need to be managed to benefit sculpins if they are to persist in CA
Tolerance	3	Upper Klamath marbled sculpin appear to withstand some environmental fluctuation
Genetic risk	2	No information on genetic structure but populations are small and isolated from one another
Climate change	1	Increased likelihood of warmer water temperatures, reduced flows, and potential drying of large portions of existing habitat
Anthropogenic threats	1	See Table 1
Average	1.7	12/7
Certainty (1-4)	1	Little information specific to upper Klamath marbled sculpin is available

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

Management Recommendations: Willow and Boles creeks should be managed as refuges for upper Klamath marbled sculpin (and other native fishes), with protected water sources and stream banks protected from grazing. A survey of all native fishes of the entire Lost River watershed in California and Oregon should be undertaken, expanding upon existing efforts to assess sucker and trout populations. A comprehensive survey, repeated at some level of frequency in order to establish trend information, would clarify the status of upper Klamath marbled sculpin and allow for improved management of their populations and habitats.

Figure 1. Distribution of upper Klamath marbled sculpin, *Cottus klamathensis klamathensis***,** in Willow and Boles creeks, tributaries to the Lost River, Modoc County, California.