MOUNTAIN WHITEFISH
Prosopium williamsoni (Girard)

Status: Moderate Concern. Mountain whitefish are locally abundant, where present, but their overall abundance and distribution are reduced from historic levels. However, population estimates are generally lacking throughout their range, as are comprehensive distribution surveys, so their overall status remains uncertain.

Description: Mountain whitefish are silvery, large-scaled (74-90 on lateral line) salmonids, with a conspicuous adipose fin, a small ventral mouth, a short dorsal fin (12–13 rays), a more or less cylindrical body and a forked tail. Gill rakers are short (19–26 on the first gill arch), with small teeth. They have 11-13 anal fin rays, 10-12 pelvic fin rays (with a conspicuous axillary process at the base), and 14-18 pectoral fin rays. The body is silvery and olive green to dusky on the back, and scales on the back are often outlined in dark pigment. Breeding males develop distinct tubercles on the head and sides. Juveniles are pencil-thin and silvery with 7–11 dark, oval parr marks.

Taxonomic Relationships: Mountain whitefish are sometimes placed in a separate family, the Coregonidae (Moyle 2002), from other salmonids and are regarded as one species throughout their extraordinarily wide range. However, a thorough genetic analysis may reveal a number of distinct population segments within this range. The Lahontan population in California and Nevada is the one most isolated from other populations and may eventually be recognized as a distinct taxon.

Life History: Mountain whitefish are usually observed in loose shoals of 5–20 fish, close to the bottom. As their subterminal mouths and body shape suggest, they are bottom-oriented predators on aquatic insects (Moyle 2002). Small juveniles feed on small chironomid midge, blackfly, and mayfly larvae but their diet becomes more diverse with size. Adults feed on mayfly, caddisfly, and stonefly larvae during summer (Ellison 1980). In Lake Tahoe, they consume snails, a variety of insect larvae, crayfish, and amphipods (Miller 1951). Most feeding takes place at dusk or after dark. However, they will feed during the day on drifting invertebrates, including terrestrial insects (Moyle 2002).

According to Moyle (2002), "Growth is highly variable, depending on habitat, food availability, and temperature. Growth of fish from a small alpine lake (Upper Twin, Mono County) was… 11 cm SL at the end of year 1, 13.5 cm at year 2, 15 cm at year 3, 17 cm at year 4, and 20 cm at year 5. Fish from rivers at lower elevations seem to be 25–30 percent larger at any given age after the first year. Young reared in tributaries to Lake Tahoe were largest in the Truckee River (8.6 cm FL at 10 months) and smallest (7.3–7.8 cm) in small tributaries (Miller 1951). Large individuals (25–50 cm SL) are probably 5–10 years old." The largest whitefish in California come from lakes; one measuring 51 cm FL and weighing 2.9 kg came from Lake Tahoe. In Fallen Leaf Lake, the population sampled by gill nets was on average 31 cm FL, with the largest fish being 44 cm long (Al-Chokhachy et al. 2009). Rogers et al. (1996) have developed a standard length-weight relationship for mountain whitefish, based on data from 36 populations throughout their range.

"Spawning takes place in October through early December at water temperatures of 1–11°C (usually 2–6°C)…. Spawning is preceded in streams by upstream or downstream movements to suitable spawning areas, possibly as the result of homing to historical spawning grounds. Movement is often associated with a fairly rapid drop in water temperature. From lakes, whitefish migrate into tributaries to spawn, but some lake spawning may take place in shallow waters as well… Whitefish do not dig redds but scatter eggs over gravel and rocks, where they sink into interstices. The eggs are not adhesive. Little is known about spawning behavior, but they may spawn at dusk or at night, in groups of more than 20 fish. They become mature in their second through fourth year, although the exact timing depends on sex and size. Each female produces an average of 5,000 eggs, but fecundity varies with size, from 770 to over 24,000. The embryos hatch in 6–10 weeks (or longer, depending on temperatures) in early spring. Newly hatched fish are carried downstream into shallow (5–20 cm) backwaters, where they spend their first few weeks. As fry grow larger, they gradually move into deeper and faster water, usually in areas with rock or boulder bottoms. Fry from lake populations move into the lake fairly soon after hatching and seek out deep cover, such as beds of aquatic plants." (Moyle 2002).

Habitat Requirements: Mountain whitefish in California inhabit clear, cold streams and rivers at elevations of 1,400–2,300 m. While they are known to occur in a few natural lakes (e.g. Tahoe), there are few records from reservoirs. In streams, they are generally associated with large pools (<1 m deep) or deep runs. In lakes, they typically live close to the bottom in fairly deep water (Al-Chokhachy et al. 2009), although they will move into shallows during spawning season. Spawning takes place in riffles where depths are greater than 75 cm and substrates are coarse gravel, cobble and rocks less than 50 cm in diameter.

Environmental tolerances of mountain whitefish in California are poorly understood but they are largely found in waters with summer temperatures <21°C. More northern populations have been reported to have temperature preferences of 10-18°C, depending on season (Ihnat and Bulkley 1984). Spawning has been recorded at temperatures of 0-9°C but 2-5°C is typical, which corresponds with optimal temperatures for development of embryos (Northcote and Ennis 1994). Mebane et al. (2003) noted that mountain whitefish were somewhat more tolerant of adverse water quality (high temperature, low dissolved oxygen) than other salmonids and, therefore, likely more resilient in response to environmental change.

Distribution: Mountain whitefish, as the taxon is broadly recognized, are found in western North America, from California to Alaska. They are distributed throughout the Columbia River watershed (including Wyoming, Montana, Oregon, Washington, Idaho, British Columbia, and Alberta), the upper reaches of the Missouri and Colorado rivers, the Bonneville drainage, and the Mackenzie and Hudson Bay drainages in the Arctic. In California and Nevada, they are present in the lower Truckee, Carson, and Walker river drainages on the east side of the Sierra Nevada, in both states, and in the Humboldt River drainage in Nevada. Their range includes both natural lakes (e.g., Tahoe, Fallen Leaf) and streams. Curiously, they are absent from the Susan River and from Eagle Lake, Lassen Co.

Trends in Abundance: According to Moyle (2002), "Mountain whitefish are still common in their limited California range, but their populations are fragmented. There is no question that they are less abundant than they were in the 19th century, when they were harvested in large numbers by Native Americans and then commercially harvested in Lake Tahoe. There are still runs in tributaries to Lake Tahoe, but they are relatively small and poorly documented.

Whitefish were apparently already reduced in numbers by the 1950s. They still appear to be fairly common in low-gradient reaches of the Truckee, East Fork Carson, East and West Walker, and Little Walker rivers. Small populations are also still found in the Little Truckee River, Independence Lake and some small streams, such as Wolf and Markleeville creeks, tributaries to the East Fork Carson River. Their populations in Sierra Nevada rivers and tributaries have been fragmented by dams and reservoirs and whitefish are generally scarce in reservoirs." Severe decline in abundance of whitefish in Sagehen and Prosser creeks, and their eventual disappearance, followed construction of reservoirs that covered their lower reaches (Erman 1973, Moyle, unpublished data). However, a population in nearby Independence Lake (a natural lake) did not show an obvious decline in the period from 1997- 2005 (Rissler et al. 2006). These observations all suggest that mountain whitefish are less abundant and less widely distributed in California than they once were, although they continue to be common enough in the Truckee, Carson, and Walker rivers so that they can support recreational fisheries. However, there is some indication from diving surveys of dramatic decline in the mountain whitefish population in the Truckee River over the past 20 years (R. Cutter, pers. comm. 2013). At present, California allows 5 whitefish per day to be taken by anglers and Nevada allows 10 whitefish per day. According to the Nevada Department of Wildlife, mountain whitefish are "much less abundant today" than they were historically (http://dcnr.nv.gov/documents/documents/nevadas-fishes-2/).

Overall, indications are that whitefish populations have declined significantly in last 10-20 years. However, existing electrofishing data within their range should be analyzed for presence/absence and trends in abundance in order to better understand their status and inform conservation and management strategies.

Nature and Degree of Threats: Mountain whitefish are little studied in California so factors affecting their abundance and distribution are poorly documented (Table 1). The keys to understanding their possible decline, however, are habitat-related: (1) they live primarily in the larger streams of the northeastern Sierra Nevada and associated lakes, (2) they do not seem to fare well in reservoirs, and (3) they require high water quality and generally low water temperatures for persistence. In general, they live in the waters most likely to be impacted by human activities, especially by expanding development (e.g., rapid expansion in areas surrounding Truckee), dams and diversions, and by highways and railroads.

Major dams. As noted, whitefish inhabit the larger stream of the eastern Sierra Nevada, many of which have been dammed or impounded for agricultural or municipal water delivery. Dams may block movements of whitefish to favored spawning and feeding grounds and create unfavorable conditions both above reservoirs and below them, especially poor water quality. For example, when Farad Dam (Nevada) on the Truckee River was blown out by high flows in 1997-98, the river below it recovered rapidly, with higher flows creating more complex habitat and cooler summer temperatures that favored whitefish and trout. Erman (1986) noted that mountain whitefish abundance dropped in Sagehen Creek following the flooding of its lower reaches by Stampede Reservoir. However, it is possible that flow releases to support trout fisheries below dams also improve conditions for mountain whitefish in certain areas.

Agriculture. Pasture and alfalfa fields line streams occupied by mountain whitefish, especially in the lower reaches of the West and East Walker rivers in California, as well as in Nevada. Attendant diversions and warm, often polluted, return water may impact whitefish populations, which generally require cold, high quality water. Diversions may also reduce stream flows and corresponding water quality required by whitefish.

Grazing and logging. The watersheds in which mountain whitefish occur in California were extensively logged and grazed in the past and continue to be actively managed for such use, although at a much lower and carefully controlled level than occurred historically. Nonetheless, continued timber harvest operations and open range and allotment grazing may contribute to increased sedimentation and water temperatures, as well as riparian and stream habitat degradation.

Urbanization. The Truckee River and tributaries to Lake Tahoe have been altered in many ways by urban and suburban sprawl, along with associated road and highway networks; however, the effects and potential impacts of such developments on whitefish are not quantified.

Harvest. Over-exploitation in the past presumably depleted whitefish numbers although this threat is now largely gone, in part because few anglers target them despite their high degree of edibility.

Alien species. Whitefish coexist in many areas with alien brown, brook, and rainbow trout and it is possible that these trouts may limit whitefish populations by preying on their fry, which have been recorded as an item in brook trout diets. In recent years, smallmouth bass have spread into some parts of the Truckee River system which may present a new predation threat.

	Rating	Explanation
Major dams	Medium	Prefer larger rivers that are most affected by dams; reservoirs provide poor habitat
Agriculture	Medium	Diversions remove water from streams; return water contributes to increased temperatures and pollutant input
Grazing	Low	Most watersheds extensively grazed; impacts to mountain whitefish unknown
Rural residential	Medium	Rural development increasing rapidly in portions of range (e.g., Truckee, Tahoe Basin)
Urbanization	Low	Increasing development of Lake Tahoe, Truckee and Reno regions may reduce habitat quality and quantity
Instream mining	Low	Effects of placer and other mining historically substantial; now greatly reduced
Mining	Low	Effluent from mines may affect local populations (e.g., Leviathan Mine in EF Carson drainage)
Transportation	Medium	Most streams affected by riparian roads, railroads, or both (e.g., Truckee River)
Logging	Low	Most watersheds extensively logged; impacts much greater in the past
Fire	Low	Fires common in watersheds; effects unknown
Estuary alteration	n/a	
Recreation	Low	Heavy use of many streams (e.g., recreational fisheries, boating, ski resorts in headwaters); impacts to whitefish unknown
Harvest	Low	Limited harvest; generally by-catch in trout fisheries
Hatcheries	n/a	
Alien species	Low	Some potential for predation by bass and alien trout to affect populations

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of mountain whitefish 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: Climate change is predicted to increase variability in stream flows, increase water temperatures by 2-4°C and increase human demand for water. The combined impact of these changes is likely to reduce suitable habitat for whitefish, especially summer rearing habitat, and may cause further population declines. Extended drought or flash flooding associated with predicted increased frequency of 'rain-on-snow' events in this portion of the Sierra Nevada may also negatively affect whitefish populations. Moyle et al. (2013) rated mountain whitefish as "highly vulnerable" to extinction in California in the next 100 years as the result of climate change severely altering their already limited habitats, assuming no major changes in water management in the large rivers (Truckee, Carson, Walker and their tributaries) that constitute the core of their habitat in California.

Status Determination Score = 3.9 – Moderate Concern (see Methods section Table 2). Mountain whitefish are locally abundant in many areas, although their overall abundance and distribution are probably reduced from the past. Because so little is known about their abundance, distribution and population trends, the conservative approach is to treat mountain whitefish as a declining species, unless evidence indicates otherwise, in spite of the fairly high score in Table 2.

Metric	Score	Justification
Area occupied	4	Present in three watersheds
Estimated adult abundance	4	Numbers appear to be fairly large in rivers where whitefish are still present
Intervention dependence	5	Populations persist; however, abundance and distribution data are needed; many habitats have been degraded and fragmented
Tolerance	4	Whitefish are more physiologically tolerant than most salmonids, live at least 5 years and are iteroparous; however, they require high water quality and low temperatures
Genetic risk	4	Genetics have not been studied but most populations are isolated from one another
Climate change	2	Whitefish are likely to be negatively affected by decreased flows, warmer temperatures and increased diversions
Anthropogenic threats	4	See Table 1
Average	3.9	27/7
Certainty (1-4)	2	Most reports are anecdotal although there is some grey literature

Table 2. Metrics for determining the status of mountain whitefish in California, 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: It is clear that mountain whitefish in California would benefit from a thorough study of their biology including systematics, genetics, distribution, abundance, environmental tolerances, and habitat requirements of all life stages. Existing fisheries surveys in eastern Sierra Nevada streams where mountain whitefish occur are generally focused on trout species (both native – e.g., Lahontan cutthroat and non-native – e.g., rainbow, brown, brook) and the popular recreational fisheries they support. While mountain whitefish are often captured during these surveys (Deinstadt et al. 2004), few efforts have been made, thus far, to assess distribution or population trends. A shift in fisheries management toward native species restoration and recovery is occurring within their range but is currently focused on Lahontan cutthroat trout, which are a listed species (threatened) under the federal Endangered Species Act of 1973. Inclusion of mountain whitefish in survey data analyses, reporting, and management or restoration plans would increase their profile as likely the most abundant native salmonid in the eastern Sierra Nevada. Because of their low tolerance for high water temperatures and poor water quality, they also are a good indicator of 'health' of the Carson, Walker, and Truckee rivers, as well as of Lake Tahoe and other natural lakes. As such, perhaps the best recommendation to benefit mountain whitefish populations is to advocate that they become an integral part of ongoing management and restoration efforts currently focused on other salmonids. Specific recommendations include: (1) basic research on their biology and distribution, (2) monitoring of existing populations at least once every 5 years, (3) habitat restoration in degraded (simplified) stream reaches, and (4) maintenance of flows in regulated rivers at high enough levels so that temperatures remain below 21° C and high water quality is maintained throughout the year.

Figure 1. Distribution of mountain whitefish, *Prosopium williamsoni* (Girard), in California.