RUSSIAN RIVER TULE PERCH
Hysterocarpus traskii pomo (Hopkirk)

Status: Moderate Concern. Populations of Russian River tule perch are large but remain of concern because the subspecies is endemic to one highly altered river system.

Description: Tule perch are small (up to 150 mm SL), deep-bodied fish that are green, bluish or purple dorsally, and white to yellow ventrally. Three color variants are described, based on their lateral barring patterns: wide-barred, narrow-barred, and bars absent. The narrow-barred color variant predominates (99%) in the Russian River population, with few broad-barred (1%) fish (Hopkirk 1973). The unbarred variant is absent. Bars on Russian River fish may be bright yellow (Chase et al. 2005). Adults have a pronounced hump (nuchal concavity) immediately anterior to the dorsal fin. The dorsal fin has 15-19 spines and 9-15 rays; the anal fin, 3 spines and 20-26 rays; the pectoral fins, 17-19 rays. There are 34-43 scales along the lateral line (Moyle 2002). Body proportions and gill-raker morphology of Russian River tule perch differ from the other two subspecies in California (Hopkirk 1973, Moyle and Baltz 1981).

Taxonomic Relationships: The tule perch is the only freshwater species in the marine family Embiotocidae. Russian River tule perch, *Hysterocarpus traskii pomo,* were described by Hopkirk (1973) as one of three subspecies. Morphometric analyses by Baltz and Moyle (1981) showed that *H. t. pomo* is different from *H. t. lagunae* (from the Clear Lake drainage basin) and from *H. t. traskii* (from the main Sacramento-San Joaquin drainage). The three subspecies also show genetic divergence (Baltz and Loudenslager 1984), as well as striking differences in life-history patterns (Baltz and Moyle 1982).

Life History: Tule perch are the only viviparous (live-bearing) native freshwater fish in the state. Like other members of the predominantly marine family Embiotocidae, females produce young that are surprisingly large considering the size of the mother. As a result, females have reduced swimming abilities while pregnant.

Russian River tule perch are adapted to a flow regime that varies widely by both season and year (Baltz and Moyle 1982). Because flows in the Russian River are driven by the heavy winter rains and dry summers of California's Mediterranean climate, flows are high in winter but, for six months or more (June- October), there is little rainfall and the river drops to minimum flows. Currently, the Sonoma County Water Agency (SCWA) maintains minimum summer flows at 125 cfs by releasing water from Sonoma Reservoir into Dry Creek (a tributary to the Russian River) and from Lake Mendocino on the East Fork of the Russian River, which is augmented by Eel River water via the Potter Valley Project (PVP). Before the PVP was implemented in 1923, portions of the lower Russian River likely became intermittent in the late-summer/early-fall of dry years and flow would become subsurface between large pools. Because rainfall in this region shows extreme variation from year to year, peak flows are unpredictable both in extent and timing. Following heavy storms, stream flow may peak rapidly and the river often floods.

This highly variable flow pattern resulted in the evolution of a life history quite different from that of other tule perch populations, one which reflects low survival rates of fish in most years (Baltz and Moyle 1982). High winter flows presumably flushed fish, particularly pregnant females, into poor habitats. During periods of drought, small, shallow pools and other habitats would become stagnant or too warm to support tule perch. Although deep, cool water refugia would have existed in larger pools, limited suitable summer habitat likely restricted population size, especially of adults.

The reproductive strategy of Russian River tule perch is an adaptation to this unpredictable environment (Baltz and Moyle 1982). They are relatively short-lived (typically <2 years, maximum 3-4 years), compared with the two other subspecies. The viviparous females produce more young per brood and reproduce at smaller sizes than those of other subspecies. Mating occurs from July through September and sperm is stored within the female until January, when fertilization takes place. During the mating season, males may hold and defend territories, usually under overhanging branches and among plants close to shore. Courtship and mating can, however, occur away from territories (Moyle 2002). Young are born during May-June, when food is abundant in most years (Moyle 2002). The young are released into areas with complex cover and remain associated with such cover for their first summer, often in daytime aggregations of dozens of individuals.

Except when breeding, tule perch are gregarious and adults forage and swim in small groups while smaller fish congregate in larger groups. The terminal mouth of Russian River tule perch, with its protrusible upper jaw and coarse gill rakers, is adapted for feeding on a wide variety of benthic and plant-dwelling aquatic invertebrates (Baltz and Moyle 1981). The number and length of gill rakers of this subspecies are intermediate to the two other subspecies. The lake-dwelling *H. t. lagunae* has a greater number of longer gill rakers and feeds on zooplankton, while *H. t. traskii* feeds largely on benthic invertebrates (Baltz and Moyle 1981).

Habitat Requirements: This subspecies requires clear, flowing water (Cech et al. 1990) and abundant cover, such as beds of aquatic macrophytes, submerged tree branches, overhanging plants, and large boulders. Large cover is essential for near-term females and young, serving as refuge from predators and velocity associated with high flow events. Although Russian River tule perch sometimes feed in riffles or in flowing water at the heads of pools, they congregate in deep (>1 m) pools during summer and will use rip-rap and fallen trees in deep water for cover. They are usually absent from reaches with poor water quality.

With the exception of Clear Lake, tule perch are rarely found in water where temperatures exceed 25˚C for extended periods of time; they generally prefer temperatures below 22˚C (Knight 1985). Indicative of the surfperch family's physiology, tule perch have high salinity tolerance. Sacramento tule perch thrive in salinities that fluctuate annually from 0 to 19 ppt and have been found at salinities as high as 30 ppt. Presumably, Russian River tule perch have similar tolerances because they are consistently found in small numbers in the Russian River estuary where salinity levels fluctuate from 0 to as high as 32 ppt (Cook 2006). However, tule perch in the estuary seem to inhabit plumes of relatively fresh water at the mouths of tributaries, often remaining near the surface.

Distribution: This subspecies is confined to the Russian River and its tributaries in Sonoma and Mendocino counties, California (Hopkirk 1973). Recent sampling from 1991-2009 (Figure 1) has documented tule perch in the main stem Russian from Ukiah (Mendocino County) downstream to the river mouth near Jenner (Sonoma County), as well as in the lower reaches of tributaries (Fawcet 2003, Cook 2003, Chase et al. 2005, Cook 2006, Cook et al. 2010). Historical records (Figure 2) exist from the North Fork above the present day location of Lake Mendocino; however, recent surveys have failed to document tule perch in the North Fork above or below the lake (Cook et al. 2010).

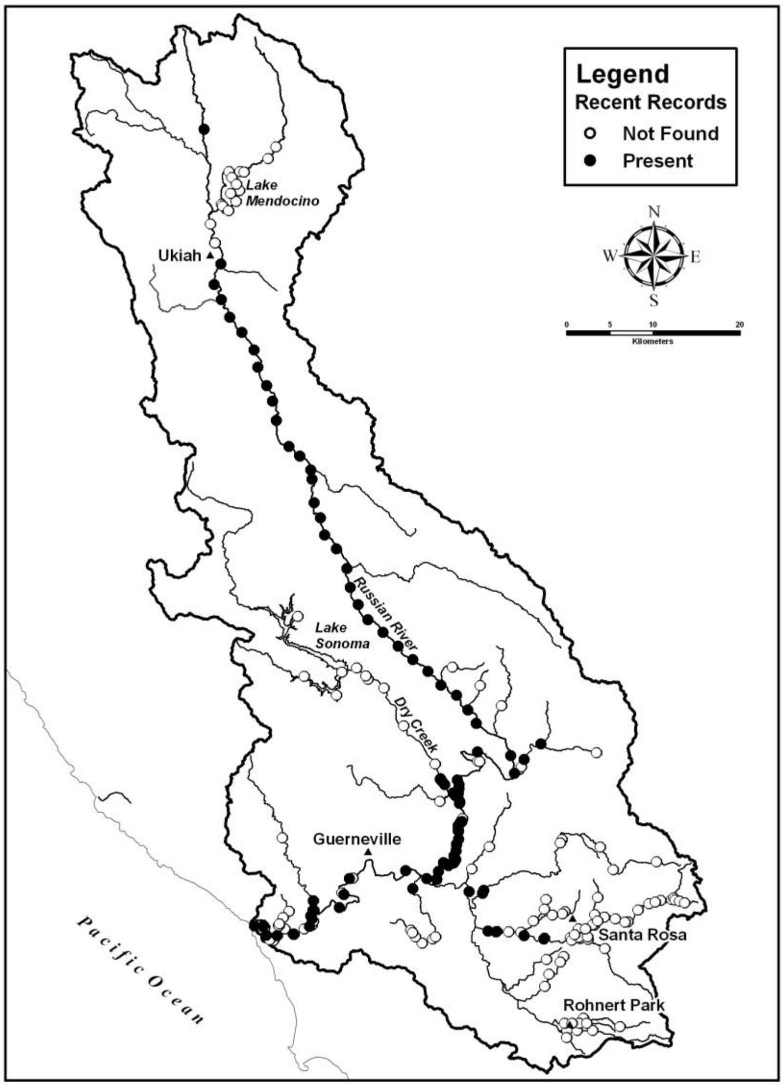

Figure 1. Recent distribution of Russian River tule perch based on records from 1991-2009. Figure from Cook et al. (2010).

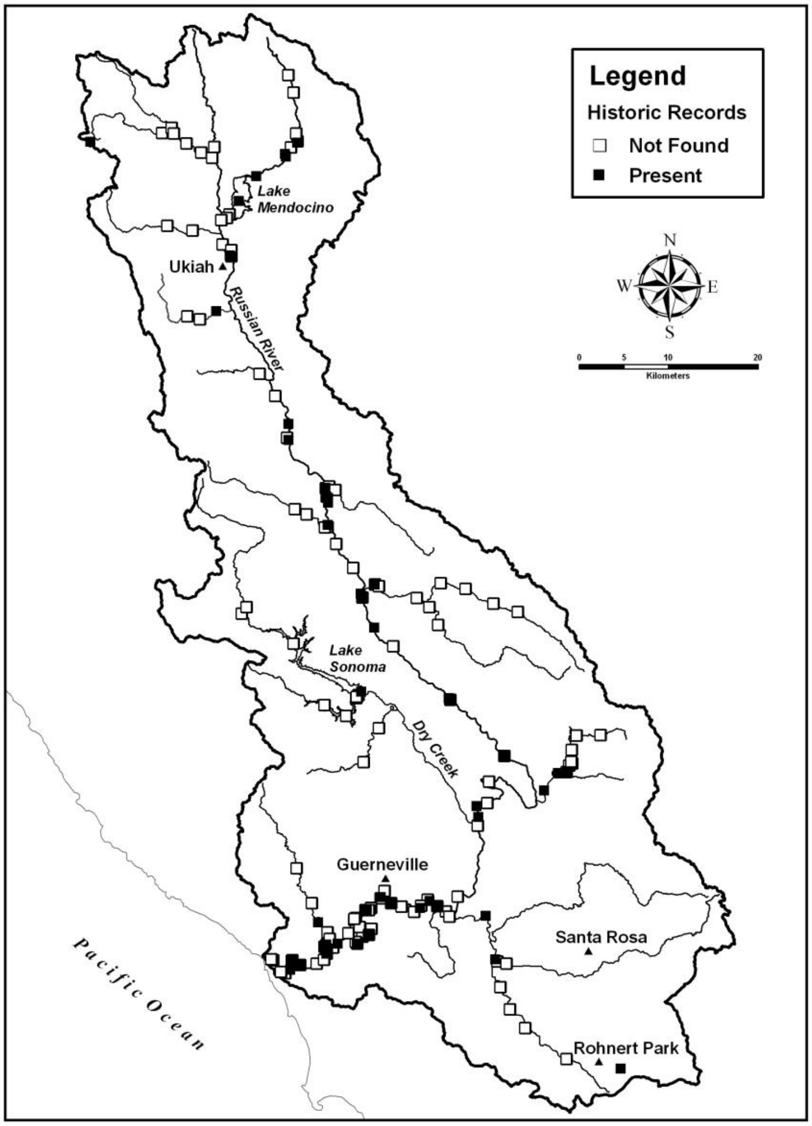

Figure 2. Historic distribution of Russian River tule perch based on records from 1897-1990. Records within the footprint of Lake Sonoma and Lake Mendocino are prior to reservoir construction. References include: Hopkirk (1973), Pintler and Johnson (1958), and unpublished data from the Sonoma County Water Agency. Figure from Cook et al. (2010).

Trends in Abundance: Extensive sampling of the Russian River by SCWA from 2000-2004 revealed that tule perch were widely distributed in the river and fairly abundant. In a 2003 snorkel survey of the upper Russian River from Coyote Dam (Mendocino Reservoir) to the confluence of Dry Creek below Healdsburg, 5,657 tule perch were counted. Tule perch accounted for between 3% and 9% of fish observed in each surveyed reach (Cook 2003). A total of 37 segments were sampled, which equaled approximately 18% of the upper Russian River. Tule perch appear to be even more common in the middle river, between Healdsburg and Forestville, where they made up 17% (329 tule perch of 1902 fish) of the catch in electro-fishing sampling conducted by SCWA in 2004 (Chase et al. 2005). From 2003-2005, tule perch were caught in beach seine-net surveys of the Russian River estuary. Fish densities appeared to be highest near the mouth of perennial Austin Creek, where salinities remained near 0 ppt. Downstream, tule perch abundance decreased as salinity increased (Cook 2005, 2006). Because of vertical stratification of fresh and saline waters in the estuary, exact salinities at the locations of capture could not be determined.

In the mid-1950s, as part of a project aimed at "steelhead trout habitat improvement," the California Department of Fish and Wildlife (CDFW) performed chemical (rotenone) treatments of the Russian River and larger tributaries, in an effort to reduce presumed competition between native nongame fishes and steelhead and salmon. During this effort, tule perch represented 3% of the fish eradicated in the stretch between Ukiah and Healdsburg and 3.5% from Healdsburg downstream to Duncans Mills (Johnson 1958). In 1979, Hopkirk found that tule perch accounted for only 1% of his catch in a beach seine survey (Hopkirk and Northen 1980). A seine survey of 15 sites between Hopland and Jenner conducted in 1984 found tule perch accounted for 1.5% of the total catch (Cox 1984). Another seine survey in 1988 also found that tule perch were uncommon compared to other fishes in the river (A. Phelps, unpublished M. S. thesis).

It is likely that sampling bias accounts for much of the discrepancy between historic and modern relative abundance estimates. Tule perch favor habitat around heavy structure and vegetation, precisely the habitats most difficult to sample with a seine. Because most historic surveys were conducted with seines, it seems likely that tule perch were under-represented in catch reports until surveys by SCWA, beginning in 2000, utilized more efficient snorkeling and electrofishing methods.

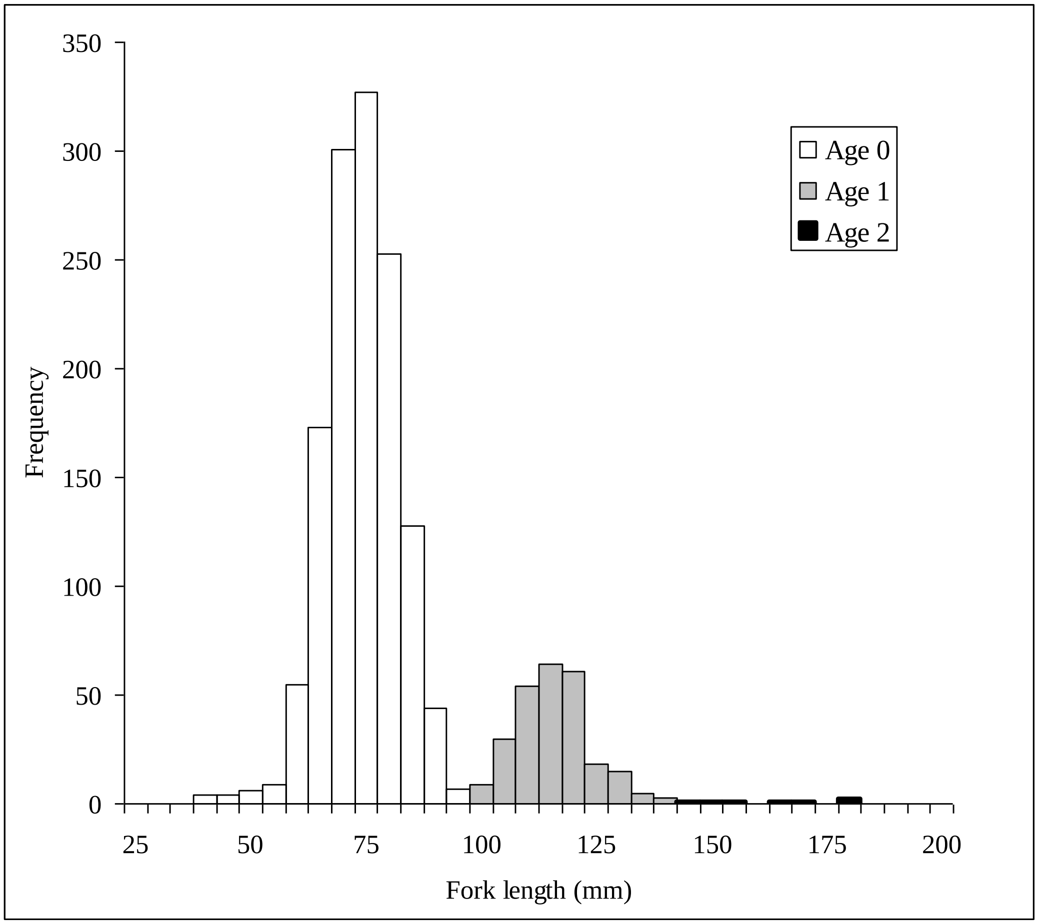

Figure 3. Length frequency histogram for tule perch in Wohler Reservoir, Russian River basin. Fish were collected annually in August by boat electrofishing from 1999-2004 and 2006 (Chase et al. 2005; Chase unpublished data). Fish captures included 1,435 (age 0; young-of-year), 286 (age 1), and 7 (age 2). Figure from Cook et al. (2010).

Nature and Degree of Threats: The limited distribution and short life span of Russian River tule perch makes their populations vulnerable to a number of factors that could reduce their numbers (Table 1). The most important threats to their persistence are: (1) regulation and alteration of stream flows, (2) pollution, (3) changes in water quality, (4) alterations to habitats, (5) gravel mining, and (6) alien species. These threats are not listed in order of severity and should be viewed as cumulative and synergistic impacts that, in combination, can threaten tule perch populations and other native fishes of the Russian River system.

Flows. Since the construction of Coyote Dam on the East Fork of the Russian River (1959) and Warm Springs Dam on Dry Creek (1983), flows in much of the watershed have become more predictable, with a decrease in frequency and duration of high flow events and an increase in summer base flows. The increased summer flows are partly the result of water being diverted into the Russian River from the Eel River, through the PVP, which began in 1923. While data are lacking, it is likely that tule perch populations have benefited from reduced flow variability due to increased survival of pregnant females and juveniles. However, the long-term effects of this highly controlled flow regime are uncertain given that: (1) the PVP may be shut down or operations modified at some time in the future, (2) summer flows may be reduced under new management guidelines aimed at improving juvenile salmonid rearing habitat, and (3) stabilized flows may increase populations of alien fishes.

Pollution. Tule perch are a remarkably resilient species, given that they survived large-scale chemical treatments of the Russian River in 1952 –1954, 1958 and 1963 by CDFW, which were aimed at reducing abundance of all non-game fishes in the river. While chemical treatments of this nature, scope and magnitude are unlikely to occur again, other events such as pesticide and oil spills from accidents on Highway 101 (which parallels long sections of the river) or more chronic and pervasive inputs from agricultural return waters (especially from viticulture) may pose ongoing threats. Pollution from waste water may be a specific threat to tule perch because females can pass heavy metals (e.g., mercury) and pesticides they accumulate directly to their young.

Water quality. Dam regulation and associated summer flow increases have improved water quality for tule perch by decreasing temperatures in some areas and diluting pollutants. However, this benefit is likely to diminish as diversions increase to meet growing agricultural and municipal water demands, including pumping of ground water. Human development of the Russian River watershed and landscape conversion to agriculture (especially viticulture) is rapidly increasing and water quality in the river may decline as a consequence, without strict controls on both water removal and effluent in water returns.

Habitat modification. The Russian River and its tributaries are increasingly confined by levees and bank stabilization projects designed to reduce the natural tendency of streams to meander and cut into agricultural fields, roads and towns. Much of the river is lined with a highway or road on at least one bank, increasing the tendency to stabilize banks wherever possible. Rip-rap, summer dams and other structures may actually create favorable habitat for tule perch in the short-run; however, longer-term simplification of habitats (e.g., decreasing pool size and depth, removal of trees that fall into the river for flood control and safety, instream gravel mining) will ultimately reduce the amount of suitable tule perch habitat.

Instream mining. Deep gravel mining pits that are separated from the river channel by narrow levees can be captured by the river during flood events. Such “pit capture” has the potential to significantly alter the hydrologic function of the entire middle reach of the Russian River and poses a threat to tule perch habitat. Flooded mining pits often harbor populations of alien species that, under flood conditions, can escape from mining pit habitats into adjacent rivers or streams. Removal of surface gravel from bars (skimming) may also reduce habitat complexity and change flow patterns.

Mining. Legacy effects of mercury and other hardrock mining still exist but appear to be currently minor. The presence and ongoing input of residual mercury in Russian River aquatic food webs may disproportionally affect tule perch, since females can pass bioaccumulated mercury to their young. Increased demand for crushed rock for use as aggregate has enlarged rock quarries, amplifying sedimentation risks from these sources.

Alien species. Although tule perch, in general, seem to coexist with alien species better than most other native fishes, introduced predators already present such as smallmouth bass (*Micropterus dolomieui*) may limit tule perch distribution, especially if flow and habitat changes increasingly favor smallmouth and other alien species, including striped bass (*Morone saxatilis*) or other black bass species (*Micropterus spp.)*.

	Rating	Explanation
Major dams	Low	Decreased flow variability and increased summer flows likely benefit tule perch; long-term negative impacts possible
Agriculture	Medium	Water withdrawals and polluted return water impair water quality; bank protection reduces cover
Grazing	Low	Still occurs in many areas but more extensive and greater threat in the past
Rural residential	Medium	Increasing water withdrawal by residential users from tributaries and groundwater aquifers decrease surface water quality and quantity
Urbanization	Medium	Urban water use affects quality and quantity of stream flows; urban development generally simplifies aquatic habitats, reduces habitat quality and quantity, and contributes to pollutant input
Instream mining	Low	Gravel mining can simplify habitats and increase turbidity, as can instream bar-skimming operations; fairly localized impacts
Mining	Low	Mainly legacy effects from past mining; possible source(s) of mercury input
Transportation	Low	Much of the river and tributaries are bordered by roads, leading to habitat simplification and increased sediment and/or pollutant input
Logging	Low	Legacy effects may still exist but logging in the Russian River basin is much reduced from the past
Fire	Low	Fire may increase sedimentation of river and reduce riparian vegetation
Estuary alteration	Low	Limited use of estuary by tule perch
Recreation	Low	Recreational use of the river is heavy; associated reduction of habitat complexity through removal of tree hazards, etc.
Harvest	n/a	
Hatcheries	n/a	
Alien species	Medium	Alien predators appear to have minimal impact at present; potentially a greater threat in future with changes in flows and water quality that may favor alien species

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of Russian River tule perch. 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 unique life history, environmental tolerances, and population resilience of Russian River tule perch would appear to make them relatively resistant to the effects of climate change, which are predicted to increase flow variability and water temperatures. The most severe impacts would likely occur during extended drought periods, when there would be long periods of low river flows, coupled with impaired water quality and high water temperatures. Under these conditions, aquatic habitats in the Russian River drainage will become increasingly unsuitable for tule perch, especially if human water demand continues to increase and ground water storage capacity is reduced through landscape conversion to agriculture (i.e., viticulture) or development. Moyle et al. (2013) rated the Russian River tule perch as "highly vulnerable" to extinction as the result of climate change, as flows will likely decrease due to increased human water demand and water temperatures are predicted to increase.

Status Determination Score = 3.7 – Moderate Concern (see Methods section Table 2). Russian River tule perch do not face immediate threat of extinction (Table 2) but this subspecies is confined to a single, highly altered, watershed. The Russian River watershed is undergoing rapid change through development of vineyards and urban areas, while flows in the river are artificially controlled by water projects. Although tule perch are very resilient, they are also short-lived so extended periods of artificially enhanced drought could cause severe declines. The abundance and distribution of this subspecies is a good indicator of habitat and water quality in the mainstem Russian River and their populations should be closely monitored as a metric of overall watershed health.

Metric	Score	Justification
Area occupied	1	Limited to Russian River and major tributaries
Estimated adult abundance	5	Populations large
Intervention dependence	5	Little tule perch-specific management needed
Tolerance	4	Fairly tolerant of conditions in the Russian River although susceptible to warm temperatures or turbid conditions
Genetic risk	5	No genetic risks known
Climate change	2	Reduced stream flows may restrict available habitats; likely worsened by rapidly increasing water demand in region
Anthropogenic threats	4	See Table 1
Average	3.7	26/7
Certainty (1-4)	3	Good recent surveys

Table 2. Metrics for determining the status Russian River tule perch, 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 Russian River should be managed to maintain its assemblage of native fishes by maintaining high water quality, diverse habitats, and suitable flow releases from dams. A flow regime should be implemented that assures the river will not go dry or become intermittent in reaches important to tule perch and other native fishes. Because tule perch are a good indicator species for river health, a regular fisheries monitoring program of the Russian River, which includes monitoring of all native fishes, should be continued to determine their population status, distribution, and trends. The fish monitoring program of SCWA is a good model and should be continued.

Figure 4. Distribution of Russian River tule perch, *Hysterocarpus traskii pomo* (Hopkirk), in California.