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DISTRIBUTION AND ECOLOGY OF THE RUSSIAN RIVER TULE PERCH

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The Russian River is a coastal stream located north of the San Francisco Bay drainage, California, and has a fish fauna derived from the Sacramento River system. Although the Russian River tule perch (*Hysterocarpus traski pomo*) is the only endemic fish in the watershed, this taxon has received limited study. Historic and recent records indicate that Russian River tule perch are widespread in the Russian River. Tule perch were found in 94% of the 156-km-long river mainstem, and the lower valley reaches of 9 large tributaries. No tule perch were found in 2 large reservoirs located on tributaries, although they occurred in free-flowing waters prior to the construction of these reservoirs. Dive surveys in the upper Russian River found tule perch abundance as high as 2,424 fish/km and they comprised 2.9% to 9.5% of the fish observed. In other mainstem sections, tule perch were approximately 12.5% of the fish observed. Our life history findings were similar to other studies where females give birth in May, young double or triple in length the first summer, and few adults are greater than 1 year of age. We found tule perch use mostly complex wood debris habitats associated with riparian forest, and also utilize boulders and widgeon weed for cover when present.

Key words: California, fish, freshwater, *Hysterocarpus traski pomo*, life history, Russian River, tule perch, viviparous

INTRODUCTION

The Russian River is a coastal stream located north of the San Francisco Bay drainage, California. There are approximately 32 freshwater fish species in the Russian River, and about half of these species are natives derived from the Sacramento River fish fauna (Snyder 1908, Pintler and Johnson 1958, Hopkirk 1973, Chase et al. 2005app [Appendix I]). Freshwater obligate species presumably colonized the Russian River during periods of hydrologic connection between the Russian River and the Sacramento River basin. Moyle (2002) presented two scenarios describing likely routes for transfer of freshwater species to the Russian River Basin. First, a series of volcanic events and landslides rerouted Cold Creek, a tributary to Clear Lake, into the upper Russian River. Clear Lake is connected to the more inland Sacramento River via Cache Creek, although high gradient sections now restrict fish passage to the lake. The second route was through stream capture between the Petaluma

River and Copeland Creek, connecting San Pablo Bay with the lower Russian River. The subsequent isolation of basins from the Sacramento River resulted in a high level of speciation and endemism in Clear Lake and a single endemic subspecies in the Russian River, the Russian River tule perch (*Hysterocarpus traski pomo*) (Hopkirk 1973, Baltz and Moyle 1981).

The tule perch (*H. traski*) is the only freshwater member of the surfperch family (Embiotocidae). Three subspecies are recognized in 3 central California drainages, including Clear Lake basin (*H. t. lagunae*), the Sacramento-San Joaquin drainage system (*H. t. traski*); and the Russian River basin (*H. t. pomo*) (Hopkirk 1973, Baltz and Moyle 1981). This species is unique in that it is the only viviparous freshwater fish native to California (Baltz and Moyle 1981). Tule perch inhabit lowland waterways with complex submerged cover and prefer water temperatures below 22º C (Moyle 2002). Although this species is a freshwater resident, it can tolerate salinities approaching pure seawater (Moyle 2002). The lifespan of Russian River tule perch is short with few living longer than 2 years, while other subspecies may live as long as 8 years (Baltz and Moyle 1982, Moyle 2002). Russian River tule perch are sexually mature the first year of life, and females give birth in spring to relatively large numbers of young compared to other subspecies (Baltz and Moyle 1982).

Although not formally protected by government regulations, the Russian River tule perch is a California Department of Fish and Game (CDFG) Species of Special Concern (Moyle et al. 1995). Reasons for this designation include limited distribution, short lifespan, and low abundance. Management recommendations include conducting thorough surveys to determine the status and range of this taxon in the river drainage.

Accurate descriptions of the historic and current trends in abundance and distribution are fundamental components of species management. The objectives of our study of the Russian River tule perch were to compare historic and recent distribution patterns and relative abundances, provide additional life history information, and describe habitat use patterns in the Russian River and its tributaries.

STUDY AREA

The Russian River watershed drains an area of 3,846 km^2 in Mendocino and Sonoma counties, and enters the Pacific Ocean 112 km north of San Francisco, California (Figure 1). The watershed consists of a series of narrow valleys surrounded by 2 mountain ranges: the Mendocino Highlands to the west and the Mayacama Mountains to the east. The tidally-influenced Russian River estuary extends upstream from the ocean 11 river kilometers (rkm) to the Duncans Mills area. The headwater East and West Forks of the river are located near Ukiah at 156 rkm. Substantial areas of the Russian River and many of the tributaries have been altered through historic and recent activities including agriculture, urban development, construction of dams, channelization for flood control, gravel mining, and timber harvest (Chocholak 1992app). Although this river has been modified, a patchy to near contiguous riparian forest covers the riverbanks.

The natural hydrograph of the Russian River that once included extremes in both high winter and low summer flows (including periods where some sections of the river were likely intermittent) has been modified. The historic summer flow in the Russian River was probably 0.6 to 0.9 m^3/s and now is a minimum of 3.5 to 5.2 m^3/s (National Marine Fisheries Service 2008app). In 1908, Eel River water was diverted into the headwaters of the East Fork Russian River. Later termed the Potter Valley Project, this diversion began year-round

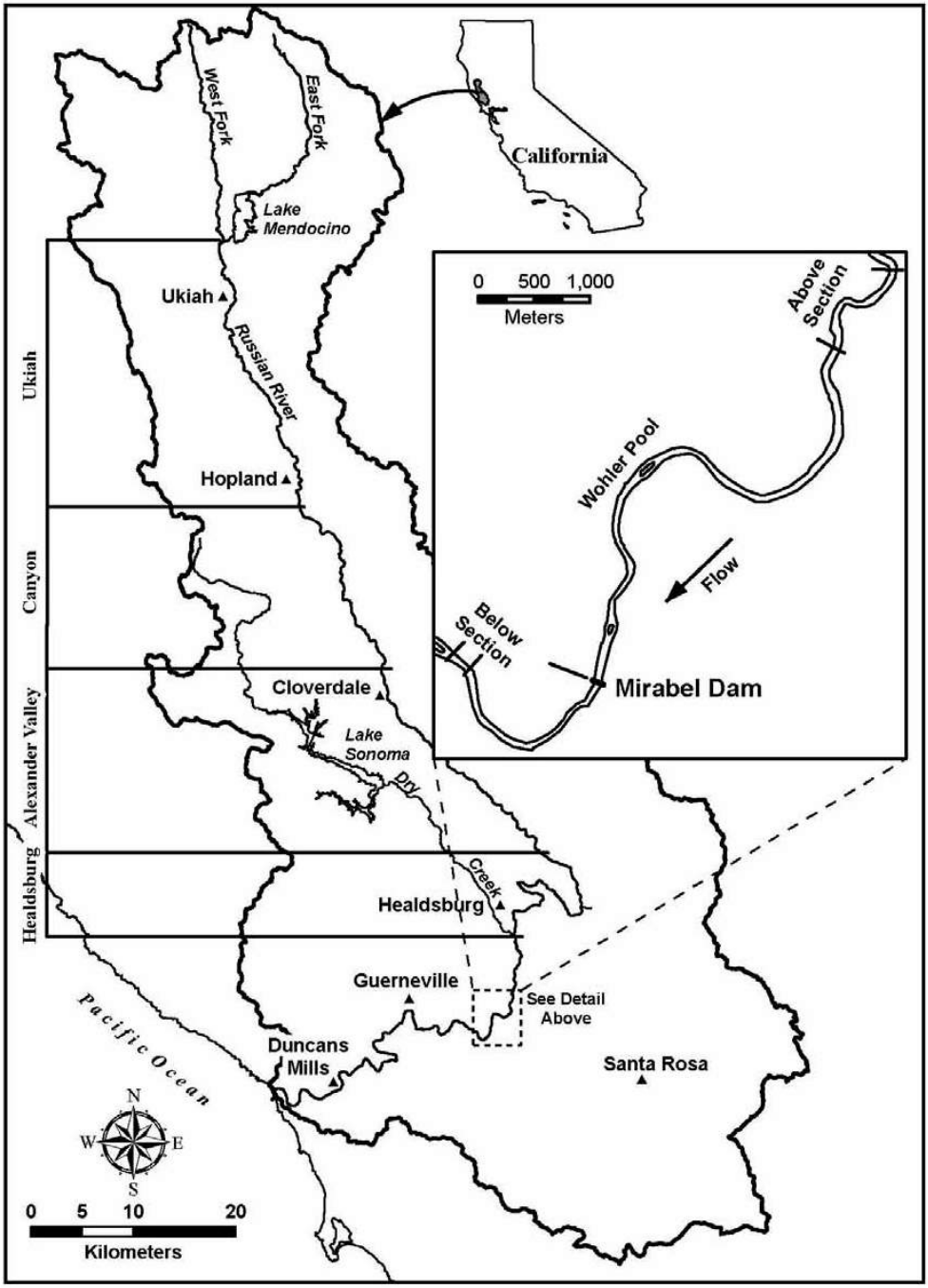

Figure 1. Location of the Russian River watershed and focused study areas. Dry Creek confluence, at 50rkm upstream of the Pacific Ocean, defines the upper and lower Russian River reaches. Dive surveys were conducted in 4 subreaches of the upper river. Boat electrofishing was conducted in and around the Wohler Pool, as shown on the inset. Beach seining was conducted in the estuary from the Pacific Ocean to near Duncans Mills.

operation in 1922. Two large reservoirs are located on tributaries of the Russian River and were constructed mainly for flood control and water supply (Figure 1). Coyote Valley Dam, forming Lake Mendocino, was constructed in 1959 on the lower East Fork 158 rkm upstream of the ocean. Dry Creek is the second largest tributary to the Russian River and is located at 50 rkm from the ocean. Warm Springs Dam (Lake Sonoma) was constructed in 1982 on upper Dry Creek 22 rkm upstream of its confluence with the Russian River. Although the entire mainstem Russian River is a warm water system and summer temperatures commonly exceed 20 C (Resource Management Associates 2007app, Cook 2003app), below the two reservoirs summer hypolimnetic water releases can be 6 to 11 C cooler than the Russian River downstream (Winzler and Kelly 1978, Prolysts and Beak Consulting 1984 [as cited in Entrix 2004app]). Despite the existence of the two reservoirs, most winter flow in the Russian River watershed is unimpeded and high flood events are common. The largest effect on river flows has been the augmentation of summer base flows.

The Sonoma County Water Agency operates the seasonal Mirabel Dam, a water- and air-filled rubber bladder, that when inflated creates a 5.1-rkm-long reservoir on the Russian River mainstem termed the Wohler Pool (Figure 1). The dam is approximately 4.0 m high and contains 2 Denil-style fishways to facilitate fish passage. The dam is typically inflated from mid-spring through late-fall annually. During periods of non-operation, the dam is deflated and lies flush with the streambed.

METHODS

Document Review

We conducted searches for historic and recent fisheries documents at the Smithsonian National Museum of Natural History, California Academy of Sciences archives in San Francisco (CAS), Sonoma State University vertebrate collection, University of California at Davis Museum of Wildlife and Fish Biology, CDFG regional headquarters in Yountville, California Natural Diversity Database managed by CDFG, and the Sonoma County Water Agency archives. Sources included voucher specimens, CDFG memoranda, environmental reports, and field notes. We also interviewed local biologists.

The most quantitative historic data came from a chemical control program of non-game fish in the Russian River and tributaries implemented by CDFG during the 1950s through the early 1960s. The purpose of this program was to enhance the steelhead (*Oncorhynchus mykiss*) sport fishery by eradicating "rough" fish (Johnson 1957app, Pintler and Johnson 1958, Hansen 1965app). Rough fish were non-game species that were thought to prey on or compete for food resources with steelhead. This control program documented many accounts of tule perch in the Russian River basin during pre-chemical treatment through post-treatment monitoring.

Focused Field Studies

In addition to literature searches described above, the authors and other Sonoma County Water Agency biologists collected extensive fish data in the Russian River basin beginning in 1999 as part of a fisheries enhancement program implemented by the Sonoma County Water Agency. These data were collected using several sampling techniques including downstream migrant traps, backpack and boat electrofishing, beach seining,

underwater visual encounter (dive) surveys, and underwater camera monitoring. Through these studies we collected quantitative information on native and non-native species in the Russian River. For this study we used the Dry Creek confluence as the division between the upper and lower Russian River. Details of the methods used in these studies are summarized below.

Fish Distribution in the Upper Russian River

We conducted standardized dive surveys to quantify the relative abundance of fish in the upper mainstem of the Russian River. The study area extended 106 km along the river from the confluence with Dry Creek (50 rkm) near Healdsburg to the East and West Forks (156 rkm) of the Russian River near Ukiah. The river was divided into 4 subreaches based on gradient and surrounding topography, including Ukiah Valley, Canyon, Alexander Valley, and Healdsburg (Figure 1). A total of 37 randomly selected river segments with a length of 0.5 rkm each were sampled, totaling approximately 17.5% of the upper Russian River reach (Cook 2003app). Surveys were conducted from July 31 to September 19, 2002, at a time of year when flows were relatively low and temperatures were highest. Three divers would swim upstream in designated lanes and record fish observed. Habitat characteristics were recorded and photographs taken at all survey sites. In addition, we conducted ad hoc dive surveys in the lower Russian River to characterize the fish composition.

Fish Distribution in a Seasonally Impounded River

We conducted boat electrofishing surveys to determine the relative abundance of fish inhabiting free-flowing and summer impounded sections of the Russian River (Chase et al. 2005app). We sampled the entire 5.1-km-long Wohler Pool, which is formed along the Russian River when the Mirabel Dam is inflated, and river sections above and below the reservoir (Figure 1). We collected fish with a 5-m-long electrofishing boat. Electrofishing was conducted at night during August from 1999 through 2004 and 2006. Captured fish were measured to fork length and then released. Fish abundance was measured in each section as catch-per-unit-effort (CPUE). We defined CPUE for this study as the number of fish captured per time that the electrofishing unit was in operation. In addition, we conducted backpack electrofishing sampling in several tributaries.

Downstream Migrant Fish Traps

We operated rotary screw traps immediately below Mirabel Dam from 2000 to 2008 to capture downstream moving fish. Although the traps were sited to capture migrating salmonids, tule perch were also encountered. Depending on river flows in a given year, screw trap operation began in March or April and continued through June or early July with daily monitoring (Chase et al. 2005app). Captured fish were identified to species, measured, and released. In addition, we operated a downstream migrant fyke trap during spring 2009 located in freshwater near the upper Russian River estuary and Duncans Mills. Fyke trap monitoring and fish processing were the same as the above-mentioned rotary screw trap.

Beach Seining

We conducted beach seine surveys at 8 stations in the Russian River estuary from the river mouth at the Pacific Ocean to Duncans Mills at rkm 9.5 (Cook 2006app, D. Cook unpublished data). We sampled from May to September once or twice per month from 2003 to 2009. A 50-m by 3.5-m seine, with 1-cm-mesh, was deployed with a boat and then hauled on to the beach. Fish where identified to species, measured, and released. Water temperature and salinity data were also collected at 0.5 m intervals in the water column during each seining survey.

RESULTS

Distribution

We located a total of 172 site records of Russian River tule perch consisting of 62 historic records dating from 1897 to 1990, and 110 recent records from 1991 to 2009 (Figure 2, Figure 3). There were also 167 historic and 150 recent site records where tule perch were not detected. Based on these records, tule perch occur throughout 94% of the Russian River mainstem. There is a near contiguous record of tule perch from the Russian River estuary at the Willow Creek confluence (4 rkm) to Ukiah located upstream at 150 rkm. There are preserved tule perch specimens from 1972 collected at the Willow Creek mouth (Kramer and Moskowitz 1972app) and we captured tule perch at this site by beach seine annually from 2004 to 2009. We detected a few tule perch further downstream during beach seining surveys; however, we believe these detections are from fish swept downstream during late-spring flooding or, possibly, they were juvenile shiner surfperch (*Cymatogaster aggregata*) that were mistakenly identified as tule perch.

We found records of tule perch in 9 tributaries to the Russian River (Figure 2, Figure 3). Tule perch appear to be restricted to low gradient valley reaches of larger creeks within about 20 rkm of the confluence with the Russian River. We found no occurrence of tule perch in foothill or headwater reaches of creeks. The distribution of tule perch in tributaries appears to be similar for both historic and recent records (Figure 2, Figure 3). In the upper watershed tule perch occur in the lower reaches of both the East and West Forks of the Russian River, although there are only historic records for the East Fork.

Although the lower reaches of Dry Creek were historically intermittent during the summer, suggesting marginal habitat conditions, there are historic accounts of tule perch from this tributary. Based on visual observations in 1952, Pintler and Johnson (1958) stated that “tule perch were well distributed in small numbers” along Dry Creek, but no exact location of sample sites were given. Specimens from Dry Creek consist of collections at the pre-Warm Springs dam site from 1958 (CAS 1958app), and several collections apparently from further downstream (Arnold 1965app, Anderson and Burdick 1967app, Arnold 1967app, Arnold 1969app, Arnold 1971app, Reyes 1983app).

The current distribution of tule perch in Dry Creek appears to be restricted to the lower reach of the creek (Figure 3). Several recent boat electrofishing surveys of Lake Sonoma located no tule perch (Cox 1992aapp, Cox 2007app). Recent Dry Creek fish surveys conducted between Warm Springs Dam and the Russian River confluence found tule perch in the lower reach of Dry Creek from the river confluence upstream 3.3 rkm (Cox 1992bapp, Cox et al. 1994app, Northen 1996app, D. Manning unpublished data).

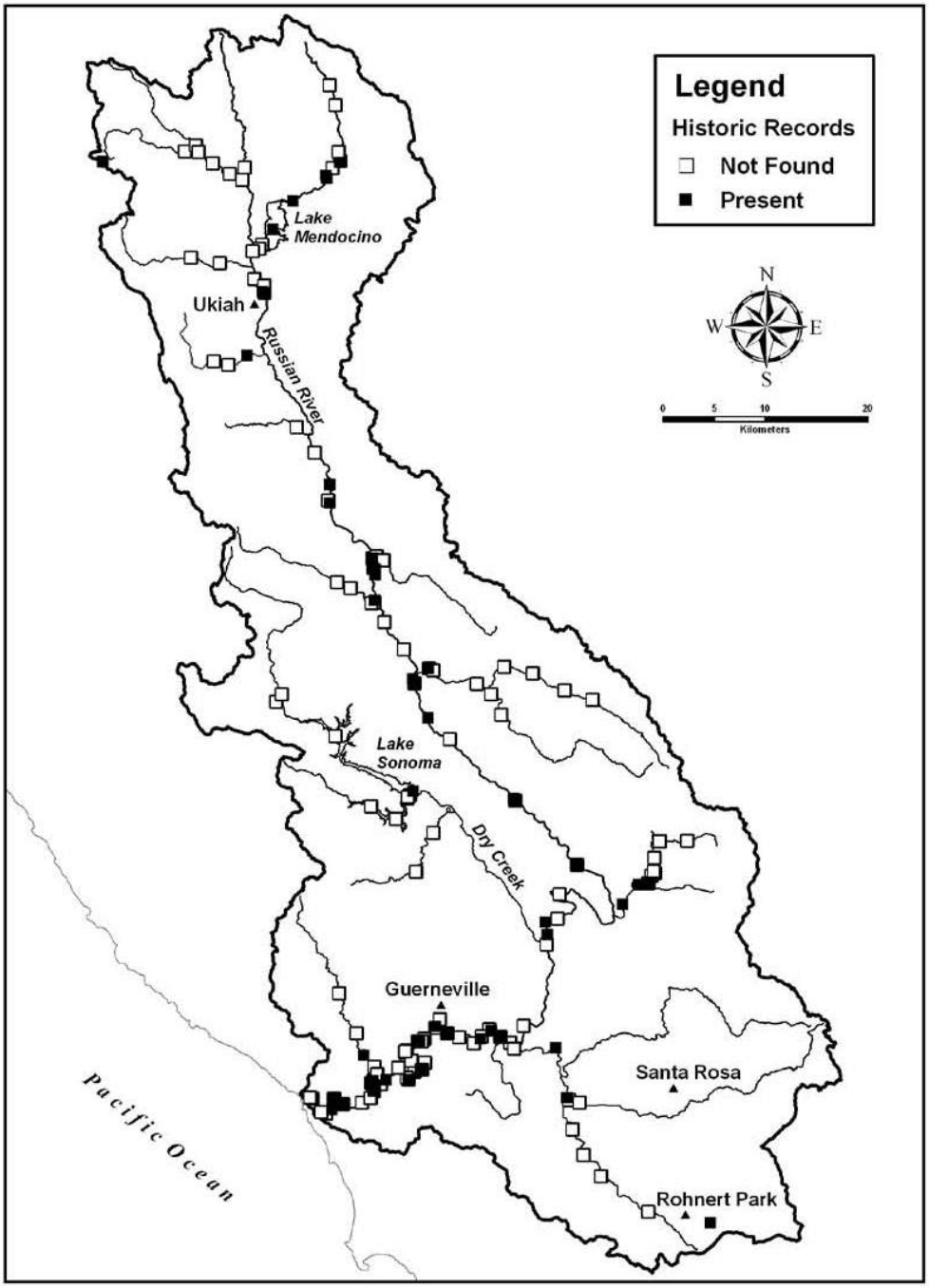

Figure 2. Historic distribution of Russian River tule perch based on records from 1897 to 1990. Reference materials used to prepare this figure are Hopkirk (1973), Pintler and Johnson (1958), and Appendix I documents. Records within the footprint of Lake Sonoma and Lake Mendocino are prior to reservoir construction.

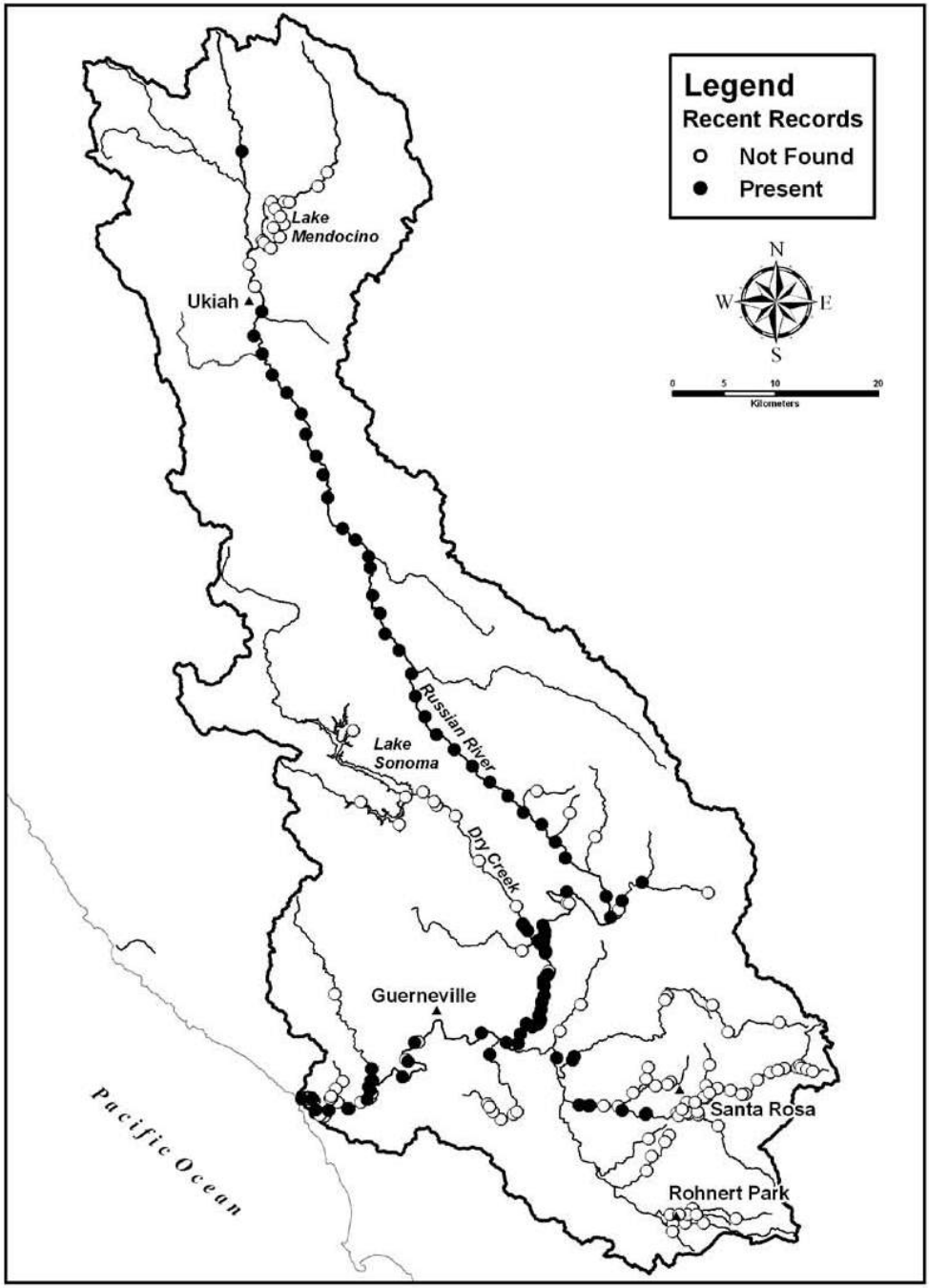

Figure 3. Recent distribution of Russian River tule perch based on records from 1991 to 2009. Reference materials used to prepare this figure are the author's data, and Appendix I documents.

There are 3 historic records of tule perch in the lower East Fork prior to the construction of Coyote Valley Dam and Lake Mendocino in 1959 (Figure 2). One museum record (CAS 1957app), which predates the dam construction, is located in the current footprint of Lake Mendocino. Two other historic records of tule perch from 1953 (Johnson 1954capp) are located a few rkm upstream of the current lake footprint. Also, Pintler and Johnson (1958) noted that tule perch in the East Fork "below the lower end of Potter Valley" were "fairly abundant everywhere." We detected no tule perch during boat electrofishing surveys in Lake Mendocino in 2005 and 2007. During spring 2009, we conducted dive surveys at 2 sites in the vicinity of the historic Johnson (1954capp) and Pintler and Johnson (1958) tule perch occurrences mentioned above and observed no tule perch (Figure 3).

Fish Abundance Patterns

We detected tule perch in all 4 subreaches of the upper Russian River during dive surveys conducted in 2002 (Figure 4). Tule perch were detected in 92% of our 37 sample sites. The highest abundance at a sample site was in Alexander Valley subreach at 2,424 fish/km (Figure 4), although the Canyon subreach had the highest average abundance at 514.7 fish/km. The composition of tule perch in the upper Russian River ranged from 2.9% to 9.5% of all fish observed (Table 1).

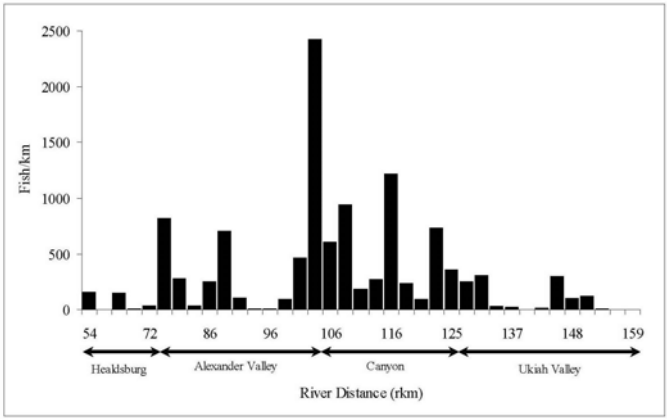

Figure 4. Relative abundance of Russian River tule perch in the upper Russian River Reach from visual encounter dive surveys conducted during summer 2002 at 37 sample sites. River distances were measured from the Russian River mouth at the Pacific Ocean (0 rkm) upstream. Russian River East and West Forks are located at 156 rkm. Arrows indicate upper Russian River subreaches shown on Figure 1.

Table 1. Fish composition of the upper Russian River based on percentage of all fish observed during visual encounter dive surveys conducted during summer 2002 at 37 sample sites. See Figure 1 for location of subreaches.

	Fish Composition (%)		
River Subreach	Tule perch	Other Natives[1]	Non-native[2]
Healdsburg	3.1	87.2	9.7
Alexander Valley	6.0	93.3	0.7
Canyon	9.5	90.0	0.5
Ukiah Valley	2.9	96.9	0.2

[1]Other native fish include: lamprey (*Lampetra* sp.), steelhead, Sacramento sucker, threespine stickleback (*Gasterosteus aculeatus*), sculpin (*Cottus* sp.), California roach (*Lavinia symmetricus*), Sacramento pikeminnow (*Ptychocheilus grandis*), and hardhead.
[2]Non-native fish include: smallmouth bass, green sunfish (*Lepomis cyanellus*), and common carp (*Cyprinus carpio*).

Our fish abundance studies using boat electrofishing in the Wohler Pool allowed us to evaluate the fish community (Table 2). During 5 years of sampling, tule perch comprised 12.6 percent of the almost 13,000 fish captured during the study. Also, tule perch composition was similar above and below the Wohler Pool at 13.1%, and 10.2%, respectively. The only fish in the Wohler Pool consistently captured in higher numbers compared to tule perch were non-native smallmouth bass (*Micropterus dolomuieu*) and native Sacramento sucker (*Catostomus occidentalis*). Native hardhead (*Mylopharodon conocephalus*) were captured in numbers similar to tule perch.

Table 2. Fish composition of the Wohler Pool area, Russian River based on percentage of all fish captures from boat electrofishing surveys conducted during August 2000 to 2004. See Figure 1 for location of survey sections.

	Fish Composition (%)		
Location	Tule perch	Other Natives[1]	Non-native[2]
Below Mirabel Dam	10.2	67.3	22.5
Wohler Pool	12.6	48.3	39.2
Above Wohler Pool	13.1	41.3	45.6

[1]Other native fish include: steelhead, Sacramento sucker, threespine stickleback, sculpin, California roach, hitch (*Lavinia exilicauda*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento pikeminnow, and hardhead.
[2]Non-native fish include: American shad (*Alosa sapidissima*), smallmouth bass, largemouth bass, bluegill, green sunfish, redear sunfish (*Lepomis microlophus*), crappie (Pomoxis sp.), common carp, black bullhead (*Ictalurus melas*), and white catfish (*Ictalurus catus*).

Age Structure

Our studies in the Russian River indicate that tule perch give birth in spring, fry grow rapidly, and adults greater than 1 year of age are rare. The rotary screw trap below Mirabel Dam captured adults from March 13 to July 1, during 2000 - 2008. Young of the year detections began in early May, suggesting that females give birth starting in May. Our fyke trap on the Russian River near Duncans Mills detected adult and recently born tule perch during spring (Figure 5). Most adults were captured from May 13 to May 28, 2009, and of these adults 62.1% were gravid females. Young of the year detections began on May 22, 2009. The average fork length of adults was 109.0 mm (*sd* = 11.2, n = 58) and young of the year were 35.0 mm (*sd* = 3.5, n = 26).

Our data indicate that young of the year tule perch double or triple in size the first year. Average fork length of young of the year tule perch caught at the Mirabel Dam rotary screw trap in May was 30.0 mm (*sd* = 4.3, n = 27) and then 44.9 mm (*sd* = 9.3, n = 38) in June. The mean fork length of young of the year tule perch near Duncans Mills was 31.7 mm (*sd* = 4.5, n = 26) in May and more than double this size by August at 83.5 mm (*sd* = 7.8, n = 78; Figure 6). The average summer growth rates of young tule perch between May 22 and August 28, 2007, was 0.55 mm/day. During 2008, growth rates were 0.35 mm/day between June 23 and August 26.

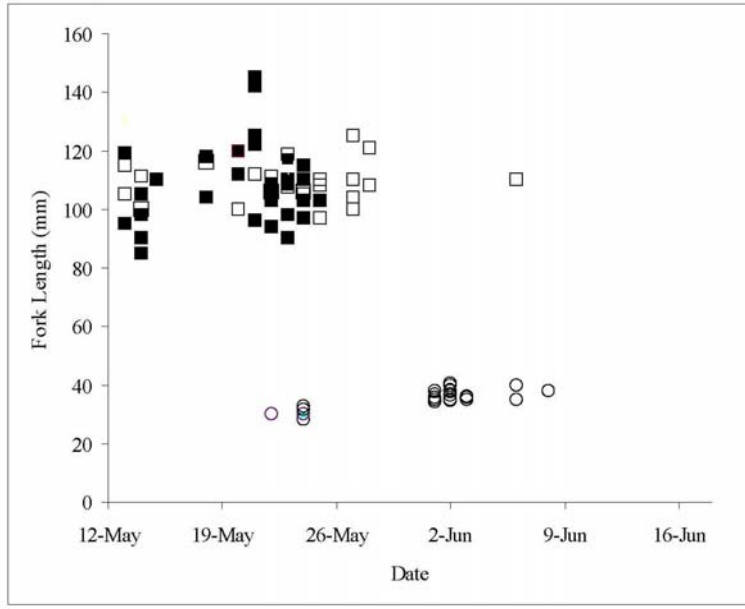

Figure 5. Fork lengths of Russian River tule perch captured by fyke trap, Russian River at 10.5 rkm, 2009. Captures included 58 adults and 26 young of the year based on size comparisons. Open circles are young of the year tule perch, open squares are adults, and solid squares are gravid females.

Based on length-frequency data, we found 3 age classes of tule perch present in the Wohler Pool (Figure 7). Most tule perch were young of the year (83.0%) followed by age 1+ (16.6%), and only a few age 2+ (0.4%) fish were detected. In contrast, tule perch sampled during beach seining in the Russian River near Duncans Mills were entirely young of the year, except one adult captured during June (Figure 6).

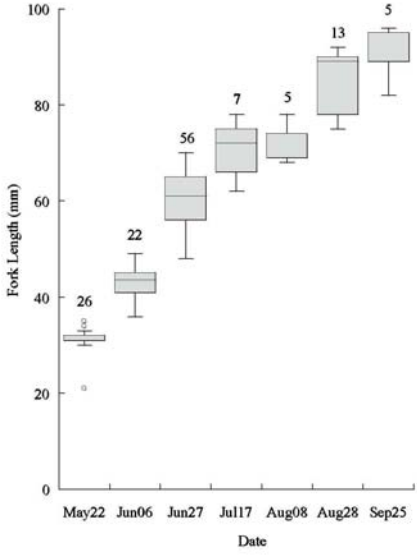

Figure 6. Lengths of young Russian River tule perch near Duncans Mills located at 9.5 rkm, 2007. Fish were caught by beach seine on a gravel shoreline with widgeon weed clumps. Boxes show 25-75 percentile and error bar whiskers. Numbers are n values. One adult tule perch outlier (FL = 124 mm) from June 27 is not shown.

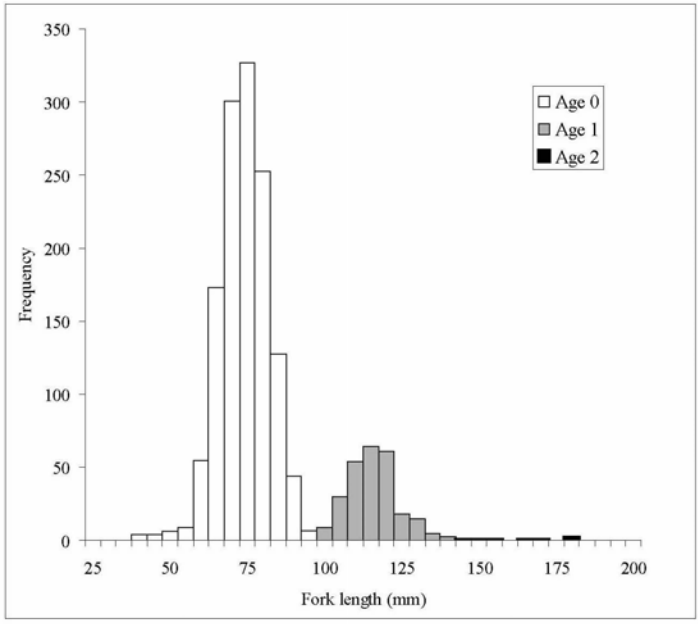

Figure 7. Length frequency histogram for tule perch in the Wohler Pool, Russian River. Fish were collected by boat electrofishing annually during August from 1999 to 2004 and 2006 (Chase et al. 2005app; Chase unpublished data). Fish captures included 1,435 (age 0), 286 (age 1), and 7 (age 2).

Habitat Use

Our standardized dive surveys for tule perch in the upper Russian River, coupled with dive observations at over 30 sites in the lower river, provided an opportunity to describe habitat where we observed tule perch. Tule perch were most often observed in small schools swimming in mid-water close to shore with an abundance of cover. Water velocities were usually slow with depths commonly 1 to 2 m. If approached slowly by a diver, tule perch would usually appear unaffected by our presence or slowly swim to nearby cover. Occasionally tule perch would appear curious about divers and approach within 1 m. In valley areas of the upper river, tule perch were typically found within 1 to 3 m of shoreline with overhanging riparian vegetation using dense submerged logs and branches as cover. We rarely encountered tule perch in the center of the river in open water. In the Canyon subreach, where water velocities are higher and riparian vegetative cover is limited, tule perch were often observed among boulders using slower-moving waters formed by eddies around large rocks.

Tule perch in the lower Russian River also used riparian areas as observed in valley reaches in the upper river. The downstream end of the river is broad and sluggish and we observed tule perch using widgeon weed (*Ruppia maritima*) on gravel shoals. This aquatic plant grows in large clumps in depths about 1 m in slow moving water and is tolerant of brackish water. Widgeon weed may be rearing habitat for tule perch. At our Duncans Mills seining site nearly all tule perch were young fish located in widgeon weed (Figure 6). In addition, this site is located downstream from our Duncans Mills fyke trap where we captured many pregnant females (Figure 5).

The confluence of Willow Creek with the Russian River is situated in the brackish estuary and it represents the downstream extent of tule perch distribution in the basin. The mouth of Willow Creek consists of a small mudflat and a <0.1 ha stand of tules (*Scirpus* sp.) along the shoreline. Widgeon weed is also present in slightly deeper water. Although tule perch occur exclusively in fresh water (Moyle 2002), salinity levels at Willow Creek mouth range from slightly brackish at the surface (0.2 ppt) to near full-strength seawater at the bottom (30.2 ppt). Estuarine species commonly seined along with tule perch at this site included shiner surfperch, topsmelt (*Atherinops affinis*), and staghorn sculpin (*Leptocottus armatus*). Tule perch are likely using freshwater microhabitats at this site as evidenced by the presence of freshwater-dependent species, including Sacramento sucker (*Catostomus occidentalis*), bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*).

DISCUSSION

Resilience to Wide-Spread Poisoning

Although the chemical treatment (poisoning) program in the Russian River watershed conducted a half century ago would be unlikely to occur today, this program did provide an opportunity to understand the response of the Russian River tule perch to a catastrophic event. The poisoning program killed an estimated 86.2 metric tons of fish in 460 km of streams, which represents approximately one-half of the entire length of perennial streams in the Russian River basin (Pintler and Johnson 1958). The effects of the poisoning were likely much more extensive than reported because "many times the estimated amount" of rotenone was applied in stream reaches to ensure localized fish kills. This plume of poison likely impacted fish farther downstream than anticipated. For example, the Russian River mainstem was treated and, because of higher river flows from rainfall, fish kills were observed as far as 54 rkm downstream at the mouth (Pintler and Johnson 1958). Rotenone is apparently very lethal to tule perch. Pintler and Johnson (1958) indicated that tule perch were second only to steelhead in sensitivity to rotenone. Surprisingly, tule perch were found in most areas only 1 to 2 years after poisoning and in some areas tule perch actually showed increases in post-treatment numbers (Elwell 1957app). Baltz and Moyle (1982) indicated that Russian River tule perch are specifically adapted to living in an unpredictable environment in which natural disasters (e.g., floods and droughts) occur annually. Coupled with our data indicating that tule perch are widespread, we find it encouraging that this locally endemic fish, although sensitive to toxins, has the resilience as a population to recover quickly from an acute catastrophic event.

Abundance and Distribution

Abundance of tule perch in the Russian River has been reported to be low. Hopkirk and Northen (1980app) indicated that Russian River tule perch were not common in the Russian River system and tule perch only represented 0.9% of their total catch. Phelps (1989app) indicated that tule perch were abundant only between Cloverdale and Hopland (i.e., Canyon subreach). However, their sampling method was limited to beach seining that may be ineffective in areas with large amounts of wood and boulder substrate, which appear to be important habitat elements for tule perch. Our dive surveys indicated that

visual observation is effective in detecting tule perch in the structurally complex habitats that tule perch prefer.

Moyle et al. (1995) indicated that Russian River tule perch appear to be less abundant than previously found during the early 1970s and were uncommon compared to other native and introduced fish in the river. More recent studies indicate that the tule perch is widespread in the Russian River basin. The current range of tule perch includes 94% of the mainstem Russian River from the estuary to upper Ukiah Valley and there are recent records from the West Fork of the Russian River as well as 7 other tributaries. Species composition of tule perch was as high as 9.5% in the Canyon subreach (Table 1). In the Wohler Pool study area, tule perch were the third most abundant species (12.6 % of the fish observed). However, we found no occurrences of tule perch in Lake Sonoma or Lake Mendocino, although they occurred in free-flowing waters there prior to the construction of these reservoirs. Tule perch also appear to be absent immediately downstream of Warm Springs and Coyote Valley dams. This is perhaps a result of the summer time release of cool hypolimnetic water from both reservoirs.

Although we did not seek to evaluate tule perch status in light of the Russian River's regulated water system, it is possible that current water supply, and to a lesser extent flood control, operations have benefited the population by moderating natural stochastic events. Water releases from the two dams have stabilized summer base flows in the Russian River by increasing flows several times above the historic natural flow (National Marine Fisheries Service 2008app). This has eliminated intermittent river conditions in all but the driest years. Although flows have been controlled to a degree, the Russian River has the most variation in seasonal flows compared to other drainages occupied by tule perch (Baltz and Moyle 1982).

ACKNOWLEDGMENTS

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