GUALALA ROACH
Lavinia parvipinnis (Snyder)

Status: Moderate Concern. Populations of Gualala roach could decline rapidly or become extirpated as the result of stream alteration and water withdrawal associated with development, especially conversion of forest lands to vineyards and residences.

Description: Gualala roach are small (adult size typically 50-80 mm), bronzy cyprinids most similar to the Navarro roach. However, this species differs from other roaches by having smaller scales (54-65 along the lateral line), shorter, more rounded fins, a short snout and a more robust body. Gualala roach have a mean of 8.0 dorsal fin rays (7-8) and 7.2 (6-8) anal fin rays (Hopkirk 1973). Snyder (1913 p. 66) described Gualala roach as having "a light lateral stripe 2 scales wide extending from upper edge of gill opening to base of caudal and entirely above the lateral line; below is a somewhat wider dark stripe, which in turn is followed by several narrower and very distinct dark stripes which grow lighter ventrally."

Taxonomic Relationships: Gualala roach were first collected by Snyder (1908c, p. 175) who recognized them as *Rutilus symmetricus* but said that they bore "a distinctive local stamp by which they can be recognized without difficulty." In 1913, Snyder revised the systematics of roach, describing the Gualala roach as one of six roach species and erecting a new genus, *Hesperoleucus*, to house them. Murphy (1948c), in an unpublished MS thesis, relegated the Gualala roach to a subspecies of *Hesperoleucus* (*Lavinia*) *symmetricus*. Although his thesis was never published, Murphy's (1948c) diagnosis was adopted by subsequent workers (Hopkirk 1973, Moyle 1976, Hubbs et al. 1979). For a comprehensive review of the history of roach systematics, see the Central California roach account in this report.

Despite the century-long controversy surrounding roach taxonomy, all workers since 1913, whether they used morphometric or genetic methods, have agreed that the Gualala roach is among the most distinct of all roach taxa. Recently, Aguilar et al. (2009) used both nuclear microsatellite (nDNA) and mitochondrial DNA (mtDNA) markers in the most comprehensive genetic study of *Lavinia* to date. Employed in tandem, these two genetic markers supply insights into both the relationships between populations (phylogenetics) and the distinctiveness of individual populations (taxonomy). Analysis of mtDNA identified roach from the Pit and Gualala rivers to be highly divergent from all other populations and reciprocally monophyletic for the haplotypes assayed, suggesting that these populations have been isolated for considerable time. In addition, the microsatellite analysis showed Gualala roach to be a distinct genetic unit.

In light of: (1) the recent genetic analysis (nuclear and mtDNA) that corroborates the distinctiveness of the species that Snyder (1913) originally described; and (2) the fact that Snyder's original species names were never properly submerged (i.e. through formal publication of an analysis in the peer-reviewed literature), it remains that *Lavinia. s. parvipinnis* (Murphy 1948c) is pre-occupied by *Lavinia parvipinnis* (Snyder 1913) and so the Gualala roach merits recognition as a valid full species.

Life History: No studies have been done specifically on Gualala roach life history but, presumably, their life history is similar to that of the Navarro roach (Fry 1936), Russian River roach and other roach species and subspecies (see the Central California roach account in this report for a detailed description of roach life history).

Habitat Requirements: Data pertaining to Gualala roach habitat requirements are lacking but it is assumed they are similar to those of Navarro roach (Fry 1936) and Russian River roach, as their most proximate relatives occupying similar northern coastal stream habitats. Stream surveys carried out by the California Department of Fish and Wildlife (CDFW) and others over the past several decades show that roach have increased in abundance, while coho salmon have almost completely disappeared and steelhead abundance has declined dramatically from the Gualala River (Higgins 1997). These population trends (increase of roach, decline of salmonids) are the direct result of warmer water associated with habitat degradation related to deforestation and development. Roach are a warm water-adapted species and can survive extremely warm water temperatures, while salmonids are highly cold water-dependent.

Distribution: Gualala roach are confined to the Gualala River and its tributaries. They are the dominant fish taxon (both in biomass and number) in the South and Wheatfield forks and most headwater streams (Entrix 1992, EIP 1994, DeHaven 2006, 2007) but occur in lesser numbers in the colder North Fork (Parker 1964c, Parker et al. 1964b, CDFG 1991). They are present in reduced numbers in the mainstem below its confluence with the North Fork (Kimsey 1952, DeHaven 2006, 2007) and have been recorded only in small numbers in the estuary (Brown 1986).

Trends in Abundance: Historically, Gualala roach were present throughout the Gualala river basin, but were likely less abundant than they are today (Higgins 1997). Although no population estimates have been conducted for roach in the Gualala watershed, salmonid surveys carried out by the CDFW and others indicate that roach may have increased in abundance due to habitat alterations favorable to warm water-tolerant species (Higgins 1997).

Nature and Degree of Threats: The hydrology of the Gualala River basin has been dramatically altered by past and ongoing land use practices, especially logging, which was historically intensive in the region. Simplification of stream habitats resulting from logging practices, particularly increases in sediment delivery and solar input, have led to decreased aquatic habitat in summer as flows become subsurface beneath aggraded gravel streambeds. In 2008, many perennial pools in the Wheatfield Fork went dry. Pool elevation dropped quickly and reached levels of desiccation never before observed (Boccone and Rowser 1977, DeHaven 2008). NMFS (2008) stated:

> "Very low summer flow conditions were noted by DeHaven in the extreme drought condition years of 1976-77 in larger streams of the Gualala River watershed. Three decades later many reaches of the same streams were observed to be dry even in normal water years, resulting in the loss of summer rearing habitat, which is

attributed to increased water diversions (both legal and illegal) and other anthropogenic activities…

Intensive logging and roading, along with recently developed vineyards in the Gualala River watershed are likely responsible for reduced summer flow that have been noted by biologists during the summer months."

Thus, while Gualala roach may have benefitted from the degradation of stream habitats in the past, their future persistence in the system may be threatened if present trends continue. Stressors potentially limiting roach abundance and distribution in the Gualala River watershed are: (1) agriculture, (2) rural residential development, (3) urbanization, (4) logging, (5) transportation (roads), (6) grazing, (7) fire, and (8) and alien species (Table 1). These impacts are not necessarily listed in order of severity and do not operate independently but, instead, must be viewed in aggregate as cumulative watershed impacts.

Agriculture. Historically, agricultural water use in the Gualala River watershed was minimal; however, vineyards are now being developed at a significant scale in the watershed and water used for irrigation and frost protection is significantly affecting flows in Gualala basin streams (J. Katz, personal observations, 2009). Pumping for frost protection in spring is an acute threat, as simultaneous withdrawal from multiple sources across large geographic areas can dry streams completely. Vineyard expansion may have either direct or indirect impacts (or both) on tributary flow if surface water is used for irrigation or if groundwater extraction lowers the water table. Deitch et al. (2009a,b) showed that water use for vineyard irrigation and frost protection is significantly affecting in-stream flow in Russian River tributaries in Sonoma County. It is likely these same impacts are occurring in the nearby Gualala watershed.

Conversion of forestlands to vineyards is a principal threat to fishes and other aquatic organisms in the Gualala watershed. The National Marine Fisheries Service (2008) highlighted some impacts to aquatic species from such conversions of timberland: "conversion of timber lands to new vineyard development in the basin are of particular concern for both sediment runoff and water usage because agricultural water use is highest during summer, when sufficient flow is essential." Of particular concern is a proposal for the largest conversion of forestland to vineyards in California, which is slated to occur in the Gualala watershed. This proposal calls for cutting more than 1600-acres of forest and converting 200-acres of grassland to grape cultivation. In addition, 90 "vineyard estates" are proposed. This project has apparently been halted by the proposed purchase of the lands by a consortium of conservation organizations (Santa Rosa Democrat, February 27, 2013) but the fundamental threat of landscape conversion in other parts of the watershed remains.

Fertilizers and other agricultural pollutants are also of concern in that they are known to augment algal production in rivers with elevated temperatures; the Gualala River is listed as impaired by both excessive sediment and high temperature (US EPA 2002), increasing the risk of algal blooms and eutrophication of streams in the Gualala watershed.

Marijuana cultivation may also be an increasing threat, although no studies specific to the Gualala watershed have been performed to document impacts from water withdrawls or pollutant inputs from fertilizers.

Rural residential development. The northern coastal basins of California are increasingly developed for rural residences. While roach can apparently persist in degraded habitats, populations may decline or become extirpated due to a combination of increased water diversion during low-flow periods, polluted inflow from septic tanks or other non-point sources, siltation from roads, and loss of complex habitat through bank stabilization projects. In the mid-1990s, it was projected that rural residential development resulted in the use of up to 2.5 cubic-feet-per-second of surface water from the Gualala River, on a basin-wide scale (EIP 1994). Water withdrawls are now likely much higher, in light of ongoing rural and viticultural development over the past 20 years. The cumulative ecological impacts of development on such a large scale are of high concern, particularly in how they contribute to degradation of aquatic habitats in the Gualala basin.

Increasingly, residential water demand during low flow periods (late summer and early fall) is being supplemented by trucking in water pumped from other sources. In the face of climate change and possible reductions or temporal shifts in annual precipitation, the fact that demand, at times, already exceeds the Gualala basin's water supply is of great concern.

Urbanization. Although the Gualala basin is largely rural, the river supplies water to two municipal water districts that service the towns of Gualala, Mendocino County, and Sea Ranch, Sonoma County. Both areas continue to grow, along with demand for water, resulting in controversy surrounding the appropriative water rights of the North Gualala Water Company.

Logging. The Gualala River watershed was heavily logged beginning in the mid-1800s and has continued to support substantial timber harvest for over 150 years. Aerial photos from as late as 1952 "show mature stands of trees in the forested areas of the watershed, with very few roads." However, "…by 1965, aerial photos of the watershed show large areas denuded of trees and intensively scarred by roads and skid trails. The logging practices of the time had little consideration for water quality and fisheries, as evidenced by the common practice of using stream channels as roads and landings" (California Regional Water Quality Control Board 2001). By the 1980s, most Gualala basin forestlands contained second or third growth redwoods and Douglas fir, along with tanoak and other deciduous trees. The consequent reduced value of these timberlands is a principal reason for recent conversion of forestlands to vineyards, resulting in further reductions in stream flows and increasing stream temperatures. Ironically, timber harvest has likely benefited Gualala roach by contributing to increased stream temperatures and eliminating cold water-requiring competitors and predators (albeit native ones), such as steelhead and coho salmon. However, the large-scale conversion of a diverse forested landscape to one dominated by agricultural land use is likely to eliminate large areas of roach habitat through reduced stream flows, further degraded habitats and increased pollution input.

Transportation. Roads to facilitate logging, rural development and vineyard expansion are widespread throughout the Gualala basin; this extensive road network changes the annual hydrograph by facilitating more runoff during storm events and inhibiting groundwater (aquifer) storage, which is critical for maintaining stream base flows during low flow periods. Ranch and logging roads are also the largest source of sediment delivery to Gualala system streams (Klampt et al. 2002) and are a high priority

for erosion control projects by CDFW. Culverts and other road crossing may create barriers to upstream fish movement which can lead to the isolation of populations or prevent recolonization of stream reaches.

Grazing. Impacts from grazing in the Gualala watershed are pervasive but are likely reduced from historic levels (J. Katz, unpublished observations, 2009). Impacts are likely similar to those described for the Navarro River basin (see the Navarro roach account in this report).

Instream mining. Past gravel mining in the vicinity of the confluence of the South and Wheatfield Forks simplified habitats, reduced water quality (increased turbidity) and impeded natural geomorphic processes such as pool scour and deposition (NMFS 2008). Legacy effects may continue to contribute to decreased habitat quality and quantity in this portion of the watershed.

Fire. Fire is a natural, if historically infrequent, process in the Gualala River watershed. However, fires are now more frequent and their effects are more severe because of land management practices and associated changes to the landscape. Long-standing fire suppression policies have increased fuel loads, while historic logging has dramatically increased solar input in deforested areas and led to drier fuels. Thus, more severe and frequent wildfires, coupled with predicted reduction in annual precipitation associated with climate change, may threaten roach habitats or eliminate localized populations, especially in smaller headwater tributaries in more arid portions of the basin.

Recreation. Little direct threat to roach exists from recreation, except when large woody debris is removed from streams to facilitate recreational boating or impoundments are created for 'summer swimming holes.'

Alien species. Roach populations decline and can be eliminated in the presence of alien fishes, especially centrarchids such as green sunfish (*Lepomis cyanellus*) and black basses (*Micropterus* spp.) (Moyle 2002). Centrarchids have been recorded in stream surveys in the Gualala drainage (Entrix 1992, EIP 1994) and may threaten roach populations in portions of the basin. Thus, expansion of existing alien populations, transportation of alien fishes over natural barriers by humans, or escape of non-native fishes from stock ponds during high flow periods when ponds spill and become interconnected with adjacent streams, all pose a serious threat to the persistence of roach in the Gualala watershed.

	Rating	Explanation
Major dams	n/a	No major dams in watershed
Agriculture	High	Water withdrawals associated with expanding viticulture and rural development have increased dramatically
Grazing	Medium	Grazing is common throughout the watershed and cattle often concentrate in riparian areas
Rural residential	Medium	Residential water withdrawal is increasing and contributes to decreased base flows in small streams throughout the watershed
Urbanization	Low	Sea Ranch and the North Gualala Water Company both draw from the Gualala River Aquifer
Instream mining	Low	Localized gravel mining has simplified habitats, increased turbidity and contributed to drying of intermittent pools; greater impact in the past
Mining	n/a	No known threats from hardrock mining
Transportation	Medium	Much of the Gualala River and its tributaries are bordered by paved roads, while a network of logging and ranch roads contributes to siltation, channelization, and habitat loss
Logging	Low	Logging continues in the watershed; much greater impact in the past but legacy effects persist due to intensive historic timber harvest in the region
Fire	Medium	More frequent and intense fires may cause local extirpations, especially in smaller headwater tributaries
Estuary alteration	Low	Relatively intolerant to salinity
Recreation	Low	Minor alterations occur in summer (e.g., impoundment building for swimming and water play)
Harvest	n/a	
Hatcheries	n/a	
Alien species	High	Intolerant of introduced predatory fishes, especially centrarchids (e.g., green sunfish)

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of Gualala roach. 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: Gualala roach are well adapted to the warm, arid conditions of California's Mediterranean climate. However, their frequent dependence on intermittent pools suggests that they are also particularly susceptible to increasing aridity associated with climate change. Roach are one of the few native fish that are able to endure life in isolated, warm pools with low dissolved oxygen levels in intermittent streams. However, increasing water demands, coupled with predicted climate change impacts, may lead to more widespread drying of stream segments and elimination of roach populations. The middle reaches of Wheatfield Fork dried completely in 2008, indicating that limiting flow conditions already exist and further reductions in precipitation and aquifer recharge may pose a substantial threat to roach and other native fishes. Moyle et al. (2013) rate Gualala roach as "highly vulnerable" to extinction as the result of climate change in conjunction with existing stressors.

Status Determination Score = 3.0 – **Moderate Concern** (see Methods section Table 2). Gualala roach should remain a Species of Special Concern, given increasing threats from agricultural development (e.g., viticulture), rural residential development, climate change, and legacy impacts from logging and other land uses which dramatically altered aquatic habitats in the Gualala watershed. The Gualala roach is listed by NatureServe as "G5T1T2, Critically Imperiled."

Metric	Score	Justification
Area occupied	1	Confined to the Gualala River and its tributaries
Estimated adult abundance	5	Populations assumed to be large but survey data are lacking
Intervention dependence	3	The Gualala River watershed is rapidly changing; frequent fish monitoring and management is needed; possible reintroductions required
Tolerance	5	Remarkably resilient fish
Genetic risk	4	No known threats to genetic integrity
Climate change	1	Highly vulnerable in combination with growing human water demands
Anthropogenic threats	2	See Table 1
Average	3.0	21/7
Certainty (1-4)	2	

Table 2. Metrics for determining the status of Gualala roach, 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: Additional studies, particularly related to the life history of Gualala roach, should be performed to better inform our understanding of their needs. The Gualala River fish community has changed over time from one dominated by salmonids to one that favors warm water tolerant species, such as Gualala roach. If ongoing watershed restoration projects succeed and cold water flows are maintained year-round, the fish community structure should shift back to one dominated by salmonids (Higgins 1997). However, the Gualala watershed is being rapidly converted to

open agricultural lands with surrounding patchy forests that are highly altered; as such, future stream flows are likely to continue to decrease. Thus, it is important to establish a monitoring program to document the distribution and status of Gualala roach, coho salmon, steelhead trout and other native fishes throughout the watershed. It is equally important to monitor the distribution and abundance of alien species (e.g., centrarchids) in order to prioritize management and conservation measures to protect native fishes.

The Gualala River Watershed Assessment Report (prepared by the California Resources Agency and California Environmental Protection Agency, for guidance on water demand and water supply in the Gualala River, 2003) states: "Any water extraction from surface or groundwater supplies, depending on the amount, location, and season, can affect streamflow, water quality, and consequently fish habitat."

With this in mind, pressure from rural residential development, along with forestland conversion and vineyard expansion, must be carefully weighed against the limited water resources in the Gualala basin. The establishment of minimum base flows in the Gualala River and its tributaries to support Gualala roach, coho salmon, and steelhead trout is of particular importance. Along with maintaining flows, restoration activities should focus on minimizing sediment delivery to streams, restoring healthy riparian zones and establishing refuge stream segments that are managed to benefit native aquatic species.

In addition, Merenlender et al. (2008) developed GPS-based water resource analysis tools which seek to quantify and balance water needs and water resources on a watershed scale. These tools were created to aid in sustaining instream flow while simultaneously enhancing water security for local landowners and vineyard operators. This powerful modeling program can be used to evaluate various water-policy scenarios, estimate the cumulative effects of water extraction methods on the natural hydrograph across a large spatial scale (including temporal variation), and provide information for watershed-level planning required to recover environmental flows. Such tools would be of great value in the Gualala basin, especially in light of the many stressors facing aquatic habitats and fishes in this highly altered landscape.

Figure 1. Distribution of Gualala roach, *Lavinia parvipinnis* (Snyder), in California.