Petition to List the Clear Lake Hitch (*Lavinia exilicauda chi*) As Endangered or Threatened Under the Endangered Species Act

Submitted To: U. S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, CA 95825

Secretary of the Interior
Department of the Interior
1849 C Street, N.W.
Washington, DC 20240

Submitted By: Center for Biological Diversity

Date: September 25, 2012

EXECUTIVE SUMMARY

The Center for Biological Diversity petitions the U.S. Fish and Wildlife Service to list the Clear Lake hitch (*Lavinia exilicauda chi*) as an endangered or threatened species under the federal Endangered Species Act. The Clear Lake hitch is a fish species endemic to Clear Lake, California and its tributaries. A large minnow once so plentiful that it was a staple food for the original inhabitants of the Clear Lake region, the Clear Lake hitch has declined precipitously in abundance as the ecology of its namesake lake has been altered and degraded.

Clear Lake hitch once spawned in all of the tributary streams to Clear Lake. The hitch life cycle involves migration each spring, when adults make their way upstream in tributaries of Clear Lake, spawning, and then return to Clear Lake. The biologically significant masses of hitch were a vital part of the Clear Lake ecosystem, an important food source for numerous birds, fish, and other wildlife. Hitch in "unimaginably abundant" numbers once clogged the lake's tributaries during spectacular spawning runs. Historical accounts speak of "countless thousands" and "enormous" and "massive" numbers of hitch.

The Clear Lake basin and its tributaries have been dramatically altered by urban development and agriculture. Much of the former stream and wetlands habitat suitable for hitch has been destroyed or degraded, and barriers that impede hitch migration have been built in many streams which formerly had spawning. Hitch can no longer reach the majority of former spawning areas, and are forced to spawn opportunistically in ditches and wet meadows during high flows. In recent years, hitch have been able to spawn in significant numbers in only two streams, Kelsey Creek and Adobe Creek, both located in the Big Valley drainage. Subsequently, the spawn has become sensitive to very localized events. A toxic spill or water use issues of limited size could results in spawn failure for the entire population.

Hitch abundance has plummeted from millions of spawners historically to only a few thousand spawning fish currently. Clear Lake hitch populations have collapsed due to: loss of spawning habitat and nursery areas; migration barriers that block hitch passage to former spawning grounds; alteration of creek habitat by in-channel mining, temporary road building through channels and water pumping; predation by and competition from introduced invasive fish; and the impacts of pollutants.

Few Clear Lake streams currently offer habitat that can be navigated by hitch, used for spawning, or offer passage for adults and fry to return to Clear Lake. Clear Lake hitch have adapted to a very brief period of suitable stream conditions for their annual spawning run and water diversions have caused streams to prematurely dry progressively earlier. Increased drought and rapid climate change due to global warming will likely accelerate this trend, causing further spawning failures. The hitch's closest relative, the endemic Clear Lake splittail, formerly spawned somewhat later than the hitch, and drying of tributary streams and migration barriers contributed to its extinction by the 1970s.

Although the Clear Lake hitch is listed as a California "Species of Special Concern," existing state and federal regulatory mechanisms are inadequate to prevent the extinction of the species. Endangered Species Act protections and strong and immediate recovery actions are needed to prevent the hitch from going the way of the Clear Lake splittail.

NOTICE OF PETITION

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Petitioner Center for Biological Diversity formally requests that the U.S. Fish and Wildlife Service ("USFWS") list the Clear Lake hitch (*Lavinia exilicauda chi*) as an endangered or threatened species under the federal Endangered Species Act ("ESA"), 16 U.S.C. §§1531-1544. Petitioners also request that critical habitat be designated concurrent with the listing, as required by 16 U.S.C. 1533(b)(6)(C).

This petition is filed pursuant to the authorities of 5 U.S.C. §553(e), 16 U.S.C. §1533(b)(7) and 50 C.F.R. part 424.14. The Clear Lake hitch is a freshwater fish and the USFWS has jurisdiction over this petition. This petition sets in motion a specific administrative process as defined by §1533(b)(3) and 50 C.F.R. §424.14(b), placing mandatory response requirements on USFWS and very specific time constraints upon those responses. The listing decision must be made solely on the basis of the best scientific and commercial data available, under 16 U.S.C. §1533(b)(1)(A).

Petitioner Center for Biological Diversity is a national nonprofit organization with more than 375,000 members and online activists dedicated to the protection of endangered species and wild places, through science, policy, education, citizen activism and environmental law.

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A. NATURAL HISTORY

1. Description

Clear Lake hitch (*Lavinia exilicauda chi*) are fairly large minnows with an average length of 13 inches and weight of 15.5 ounces. Moyle et al. (In Review) give the following description for Clear Lake hitch:

> Hitch are cyprinids with laterally compressed bodies, small heads and upward pointing mouths. They can grow to over 35 cm SL and have moderately large scales and decurved lateral lines. The body tapers to a narrow caudal peduncle (the feature responsible for the specific etymology) which supports a large forked tail and the belly lacks a sharp keel. The long anal fin (11-14 rays) separates the species from other California minnows. The origin of the dorsal fin (10-13 rays) is behind that of the pelvic fins. There are 54-62 lateral line scales and 17-26 gill rakers. The pharyngeal teeth (0-4 or 0-5) are long and narrow, slightly hooked, and have reasonably broad grinding surfaces. Small hitch are silvery with a black spot at the base of the tail. Older fish lose the spot and become darker. Large fish appear yellow-brown to silvery white on the back. The body becomes deeper as the length increases (Moyle 2002). There is little change in pigmentation during the breeding season (Hopkirk 1974). Clear Lake hitch are a lake-adapted form distinguished by their deeper body, larger eyes, larger scales and more gill-rakers than Sacramento hitch.

2. Taxonomy

Hitch (*Lavinia exilicauda*) are in the minnow family (Cyprinidae) and are most closely related to the California roach (*Lavinia symmetricus*), with which they can hybridize to produce either fertile or infertile hybrids, depending on the population (Avise and Ayala 1976). Documented hybrids are lacking from the Clear Lake Basin (Moyle et al., In Review). Hitch can also hybridize with Sacramento blackfish, but the hybrids are sterile (Moyle and Massingill 1981). In the past hitch hybridized with the now extinct thicktail chub (*Gila crassicauda*) (Miller 1963).

Populations of hitch (*Lavinia exilicauda*) are found in the following areas in California: throughout the Central Valley, from the Tulare Lake basin in the southern San Joaquin River drainage to Shasta Reservoir in the northern Sacramento River drainage; throughout Clear Lake and Lake County; in the San Francisco Bay drainages of Coyote Creek, Alameda Creek, and other creeks in Santa Clara, Contra Costa, and Alameda counties; near Monterey Bay in the Pajaro and Salinas reservoirs and in large tributaries; and also in the Russian River (Moyle 2002). Hitch once exhibited a wide distribution in the large streams within the Sierra Nevada foothills but now occur there only as scattered populations (Moyle and Nichols 1974). Several distinct subspecies of hitch have been identified: Sacramento hitch in drainages of the Sacramento and San Joaquin rivers (*Lavinia exilicauda exilicauda*); Monterey hitch in the Pajaro and Salinas rivers and Monterey Bay (*Lavinia exilicauda harengus*); and Clear Lake hitch (*Lavinia exilicauda chi*) in Clear Lake and its tributaries (Miller 1945; Hopkirk 1973; Moyle et al. 1995).

The Clear Lake subspecies was first described by Hopkirk (1973) as a lake-adapted form, primarily because of its greater number of fine gill-rakers. Clear Lake hitch differ from other hitch physiologically by having larger eyes, small mouths, a slightly extended lower jaw, a decurved lateral line, deeper, rounder bodies, and more gill rakers (Hopkirk 1973). Analysis of 10 microsatellite loci supported subspecific designation of Clear Lake hitch (Aguilar and Jones 2009).

The Clear Lake basin is a center of geographic isolation and speciation, with numerous native fish that are geographically restricted and which represent lake-adapted forms of species found in the Central Valley (Hopkirk 1973). Clear Lake is the largest natural freshwater lake located entirely in California and is one of the oldest lakes in North America. Fish populations in Clear Lake are unique due to the geologic history of Clear Lake. Clear Lake once drained westward into the Russian River, but parallel faulting, mountain generation, and volcanic activity caused a new eastward outflow into the Sacramento River. Hitch likely came to Clear Lake by the way of Cache Creek from the Sacramento River drainage and evolved into a separate subspecies.

There has been some discussion among Clear Lake tribes regarding the origin of the subspecies name “chi,” which is a Pomo Indian name that either referred to hitch or Clear Lake splittail. The vernacular name “hitch” is also of Indian origin and is the typical name given to Clear Lake hitch. The Pomo tribes living on the north and west sides of Clear Lake apply this name to the Clear lake hitch, but tribes living on the east and south shores call the fish “chi” (Murphy 1948; P. Windrem pers. comm., 2010).

3. Range and Distribution

Clear Lake hitch are endemic to Clear Lake and its tributary streams, in Lake County, California. See Figure 1 below for a map of Clear Lake and its tributaries.

The largest tributaries to Clear Lake are the Scotts Creek and Middle Creek watersheds (Richerson et al. 1994), which enter the lake from the north through Rodman Slough. Hendricks, Robinson and Pool Creeks are tributaries to Scotts Creek and Blue Lakes overflows in the wet season into a channel at its southern end that flows into Scotts Creek. With the exception of small Lyons Creek, all north shore tributaries and marshlands empty into Rodman Slough, and then into northern Clear Lake. Cooper Creek flows into Tulelake, a large floodplain of Clear Lake that is partially leveed and dammed, and is drained early in the growing season to allow for planting. Tulelake, Clover Creek and its tributary Alley Creek drain into Middle Creek.

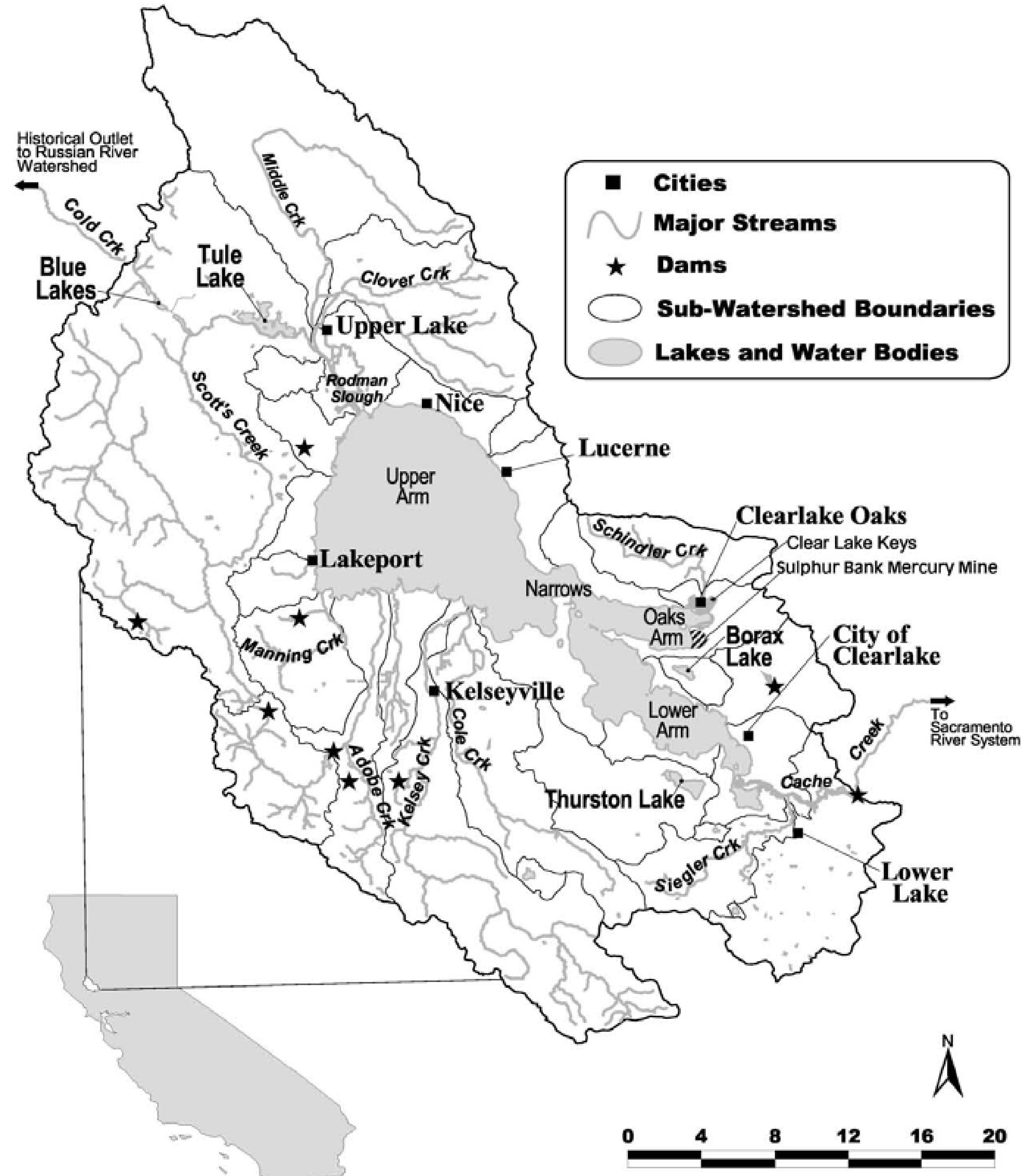

Figure 1. Map of Clear Lake and tributaries from Suchanek et al. 2002

On the northeast shore, Morrison Creek flows through Lucerne and Schindler Creek through Clearlake Oaks directly into Clear Lake.

Cole Creek, Kelsey Creek and Adobe Creek are the main tributaries draining areas south and southwest of the lake, with minor tributaries from the south being Manning Creek and Hill Creek, which flows into McGaugh Slough.

Other minor tributaries to Clear Lake include Forbes Creek on the west, Burns Valley Creek and Molesworth Creek in the southeast, and Seigler Creek, which flows through Lower Lake and Anderson Marsh to enter Cache Creek above the dam.

Clear Lake itself discharges into Cache Creek through the Clear Lake Dam, which is approximately 5 miles downstream of the lake. The 5-mile portion of Cache Creek between Clear Lake and the Clear Lake Dam is often referred to as the Clear Lake outlet channel. Copsey Creek discharges into the Cache Creek channel.

Clear Lake hitch spawn in intermittent tributary streams to Clear Lake. Historically, hitch likely spawned in all of the 17 stream systems tributary to Clear Lake, which were accessible to hitch due to the relatively low gradients in their lower reaches (RREC 2012). In recent years, hitch have been documented spawning in biologically significant numbers only in Kelsey Creek and Adobe Creek, as discussed below. Small numbers of hitch have also been reported recently in formerly significant spawning streams such as Middle, Scotts, Cole, and Manning Creeks, although not used every year. The remainder of the smaller tributary creeks to Clear Lake that have been surveyed had very small or non-existent hitch spawning runs from 2005-2012.

4. Habitat Requirements

Clear Lake hitch have specific requirements to complete their life-cycle, including access for unimpeded migration up tributary streams to suitable spawning habitat during the spring, and the ability for adults and young to return downstream to Clear Lake before tributary streams run dry or reduced flows and water depth result in migration barriers.

Adult Clear Lake hitch are usually found in the limnetic zone of Clear Lake. Juveniles are found in the nearshore shallow-water habitat and thought to move into the deeper offshore areas after approximately 80 days, when they are between 40-50 mm SL (Geary 1978). While in the nearshore environment, juveniles require vegetation for refuge from predators. The Robinson Rancheria Environmental Center ("RREC") has observed fingerlings heading to shaded areas (such as boulders and riparian vegetation) near creek banks, where their counter-shading apparently helps to hide them from predators (S. Franson, pers. comm., 2009).

During the reproductive season, adults migrate into low gradient tributary streams where they migrate upstream and spawn (Geary 1978; Moyle 2002) Hitch currently spawn in the lower reaches of these streams, mostly in gravel-bottomed sections that often run dry during the spawning period (Ringelberg and McGinnis 2009), but it is unclear if this is their preferred spawning habitat. Due to migration barriers and lowered aquifers, the lower reaches may be the only stream habitat currently accessible to hitch. Clean gravel bottoms and shallow rapidly flowing water seem to be preferred though this preference is by no means absolute. Hitch are capable swimmers, but because they very rarely jump, hitch spawning runs are easily blocked by small dams and other structures. Any barrier that requires jumping to traverse will likely impede upstream hitch migration. Hitch appear to avoid swift currents and to require resting pools that are found in healthy instream habitat.

Gichuki and Garibay (2012) visited creeks in the Big Valley sub-basin (Forbes, Manning, Adobe, Kelsey and Cole) on a weekly basis during the 2012 hitch run. The creeks which support hitch spawning runs better than others (Adobe, Cole and Kelsey) have good water quality (with appropriate dissolved oxygen, conductivity and turbidity) and sustained water flows. Hitch have high fecundity in these creeks, indicating there are still some good habitats for spawning. Large numbers (in the thousands) of young hitch were seen in Adobe, Cole and Kelsey creeks in 2012 and the spawning was especially good in Adobe Creek. In May 2012, there were huge mats of algae (Cladophora) which seemed to support young fish. This was best exemplified at Adobe Creek, where large numbers of young hitch were seen grazing on the algae for bacteria and peripyton. Adobe Creek also seemed to have good habitats and substrates which enabled the eggs to hatch and produce large numbers of young fish. Water quantity was the most important factor in sustaining young hitch in the creeks before they could move into Clear Lake.

In the past there have been observations of hitch spawning on gravel beaches on the shore of Clear Lake, and a self-sustaining population of hitch in a pond from which a minnow dealer was harvesting hitch for bait (Kimsey 1960). Kimsey (1960) suggested that some hitch are “obligatory stream spawners” while others can spawn in a pond.

5. Life History

The deep compressed body, small upturned mouth, and long slender gill rakers of hitch reflect the zooplankton-feeding strategy of this open-water feeder (Moyle 2002). Hitch greater than 50 mm feed almost exclusively on *Daphnia*, small, planktonic crustaceans known as “water fleas” (Geary 1978; Geary and Moyle 1980). Juveniles (less than 50 mm) in the shallower, nearshore environment feed primarily on the larvae and pupae of chironomid midges, planktonic crustaceans including *Bosmina* and *Daphnia* (Geary 1978), and (formerly) the eggs, larvae, and adults of the Clear Lake gnat (*Chaoborus astictopus*) (Lindquist et al. 1943; Geary 1978). Gnat populations have been depressed by human pesticide applications to the lake and by introduced planktivorous fishes so that current Clear Lake gnat populations represent just a very small fraction of historic abundances (Moyle et al., In Review). Hitch switch to feeding on *Daphnia* after moving into the offshore limnetic habitat, although when insects are abundant they may be taken at the surface (Lindquist et al. 1943). Geary (1978) found that stomachs of hitch caught early in the morning were empty, while fish caught in the afternoon had fed, indicating that hitch feed primarily during the daylight hours.

Indicative of Clear Lake's extreme productivity, hitch grow faster and reach larger size there than populations of Sacramento hitch in a less productive high-elevation reservoir in the Sierra Nevada foothills. Clear Lake hitch grow fairly rapidly (Murphy 1948; Geary 1978), reaching 44 mm SL within three months and 80-120 mm SL by the end of their first year (Geary 1978). In contrast, hitch in Beardsley Reservoir are only 40-50 mm by the end of their first year (Nicola 1974). Geary (1978) attributed this rapid growth rate in Clear Lake hitch to high productivity and warm water temperatures in Clear Lake. The largest hitch caught in a tagging efforts was 410 mm SL, and the heaviest spawning adult was 794 grams (Ringelberg and McGinnis 2009). Hitch longer than 25 cm SL are rare and few likely live longer than 6-7 years (Moyle et al., In Review).

Female hitch become mature by their second or third year, whereas males tend to mature in their first or second year (Kimsey and Fisk 1960). Mature females are also larger than males (Geary 1978). The larger size of Clear Lake hitch translates to greater fecundity. Accordingly, females in Clear Lake average 36,000 eggs (Geary and Moyle 1980) compared to an average of 26,000 eggs for Beardsley Reservoir (Nicola 1974). In the Clear Lake Basin, spawning occurs in tributary streams, and the spawning migrations, which resemble salmon runs on a miniature scale, usually take place from mid-March through May and occasionally into June, depending on stream flow (Murphy 1948; Kimsey and Fisk 1960; Swift 1963; Moyle et al. 1995; CCCLH 2009). In wet years, hitch also will opportunistically ascend and spawn in various unnamed tributaries and drainage ditches (R. Macedo, pers. comm., as cited in Moyle et al., In Review) and even flooded meadows (S. Hill, Chi Council, pers. comm., as cited in Moyle et al., In Review). Some hitch in the past were observed to spawn along the shores of Clear Lake, over clean gravel in water 1 to 10 cm deep where there was wave action to keep the gravels clean of silt (Kimsey and Fisk 1960); however, the contribution to recruitment by such shore-spawners may have been minimal because of potentially heavy predation on eggs and larvae by carp and other introduced fishes (Kimsey and Fisk 1960).

Clear Lake hitch spawn after winter rains and often after heavy rains. They spawn in riffles, runs, and back water areas in very shallow water at the streams edge; they prefer clean, fine-to-medium gravel, and water temperatures from 14-18 ºC for spawning (Murphy 1948; Kimsey and Fisk 1960). When spawning, each female is pursued by 1-5 males that fertilize the eggs as they are released (Murphy 1948; Moyle 2002). After spawning, the adults do not die as salmon do, but instead make their way back to Clear Lake. It is hypothesized that the females swim downstream immediately after spawning, but that the males may linger in the creeks in hopes of finding another opportunity to breed (Moyle 2002); current hitch studies by a coalition of Clear Lake tribes are investigating this question. Eggs are large and non-adhesive, drifting then sinking to the bottom after fertilization, where they become lodged among the interstices in the gravel. Eggs swell to about four times their original size within about 30 minutes of extrusion and are then lodged in gravel interstices, protected by the cushion created (Murphy 1948). At times, the white eggs, which resemble silica aquarium sand, can be see piled up on the gravel beds "by the millions" (Moyle et al. 1995). The embryos hatch out after approximately seven days and the larvae become free-swimming after another seven days (Swift 1965). Larval fish must then move downstream to the lake quickly before the streams dry up (Moyle 2002). In the lake, larvae remain inshore and are thought to depend on stands of tules (*Schoenoplectus acutus*) for cover until they reach approximately 50 mm and assume a pelagic lifestyle until they reach breeding age and are ready to begin the cycle again (Moyle 2002; Moyle et al., In Review).

6. Natural Mortality

Clear Lake hitch are a vital part of the Clear Lake ecosystem and are an important food source for many of the birds that visit Clear Lake, as well as a significant source of prey for native fish. Hitch are preyed upon by mergansers, herons, egrets, grebes, bald and golden eagles, hawks, osprey, terns, cormorants, white pelicans, belted kingfishers, and other birds, and taken opportunistically during spawning runs by raccoons, otters, skunks, minks, and very rarely, black bears (Moyle et al. 1995; RREC 2007). Mergansers are the most numerous fish-eating bird seen on the streams during spawning runs, followed by herons and ospreys (P. Windrem, pers. comm., 2010). Mallards are frequently observed feeding on hitch eggs (P. Windrem, pers. comm., 2010). Predation from introduced fish species is also significant, although no formal studies have been conducted Moyle et al., (In Review). Hitch are routinely found in the stomachs of bass caught in the lake (R. Macedo, pers. comm. 2009, as cited in Moyle et al., In Review).

B. CHANGES IN DISTRIBUTION AND ABUNDANCE

1. Historical and Current Distribution

<u>Historical Distribution</u>

Historically, hitch likely spawned in all of the tributaries to Clear Lake, since all of these streams have relatively low gradients in their lower reaches and would have been accessible to spawning hitch (RREC 2011). Early accounts discuss hitch spawning in all tributary streams and tribal elders from Pomo tribes living around the lake recount that hitch formerly spawned in all tributary streams (RREC 2011). Longtime residents also recall hitch spawning in every tributary to Clear Lake, including numerous unnamed small tributary creeks. For example, members of Elem Indian Colony historically collected hitch from Seigler Creek (D. McGinnis, pers. comm., 2012)

Hitch also spawned in Blue Lakes, Tulelake, and their tributaries, such as Mendenhall Creek (Coleman 1930; S. Franson, pers. comm., 2009). Hitch also formerly spawned in marshlands, wetlands, streams, and flooded fields around the lake.

A California Department of Fish and Game survey in 1925 reported that Clear Lake hitch “run up all the creeks” tributary to Clear Lake and that hitch were also found in Blue Lakes (Coleman 1930). Spawning hitch were observed in the 1940s in Scotts Creek and its tributaries Middle and Clover Creeks (Shapovalov 1940; Murphy 1948). Spawning hitch were observed in the 1960s in Seigler Canyon, Adobe, Middle, Kelsey, and Scott Creeks (Swift 1965; Hopkirk 1973). The spawning distribution of hitch was already significantly reduced by the 1970s (Hopkirk 1973).

Hitch spawning was known to occur in the 1980s in Kelsey, Seigler, Adobe, Middle, Cole, Scotts, and Manning Creeks (Moyle et al. 1989). The major spawning streams used by hitch in the early 1990s were, in roughly decreasing order of importance: Kelsey, Adobe, Middle, Scotts, Seigler Canyon, Cole, and Manning Creeks (Moyle et al. 1995; P. Windrem, pers. comm., 2010). Seigler Canyon Creek in Anderson Marsh Historic Park was "one of the better places to observe the still spectacular spawning runs" in the early 1990s (Moyle et al. 1995).

Current Distribution

Currently, Clear Lake hitch spawn regularly in significant, but vastly reduced numbers in only two streams in one drainage basin, in Kelsey Creek and Adobe Creek. Kelsey and Adobe creeks continued to be the main spawning areas for Clear Lake hitch from 2005-2012, but at much smaller numbers than historical runs. In recent years, no hitch at all have been sighted in some major tributaries during the spawning season. Only small numbers of spawning hitch have been reported in recent years in Middle, Scotts, Cole and Manning Creeks. No spawning hitch were found in Seigler Canyon Creek during surveys from 2004-2011. Reports of juvenile hitch need to be verified since introduced silversides can easily be misidentified as juvenile hitch.

A multi-year investigation into the current population numbers, status, and rate of return of hitch, as well as an assessment of correlations to environmental variables, is being completed by a coalition of Clear Lake tribes, funded in part by the U.S. Fish and Wildlife Service. This investigation consisted of two years of capturing and RFID tagging of hitch during the spawning run at multiple locations (Ringelberg and McGinnis 2010).

Windrem (2004) reported the presence of spawning hitch in 7 out of 11 (64%) tributaries of Clear Lake surveyed in 2004. The Chi Council for the Clear Lake Hitch ("CCCLH") and Robinson Rancheria Environmental Center ("RREC") have conducted opportunistic annual observational surveys of spawning hitch since 2005, which are useful for determining hitch presence or absence in tributary streams during the spawning season. However, some of the reported spawning observations have not been confirmed and these volunteer-based surveys may have some limitations for drawing conclusions about fish distribution and abundance. CCCLH is an all volunteer effort; despite their appreciated efforts there are issues with identification of fish and the potential for overestimating the numbers of individual fish in observed schools.

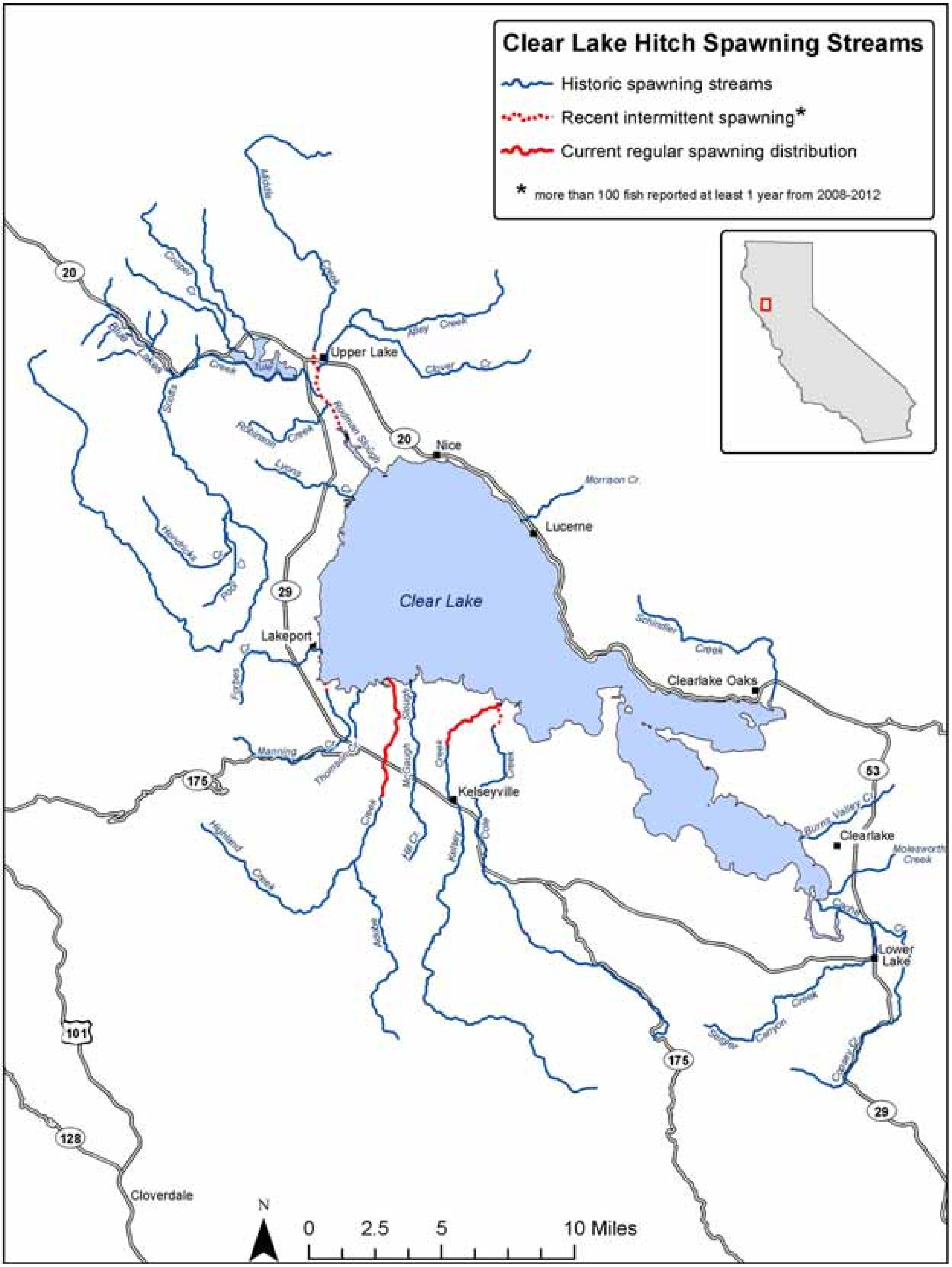

Figure 2. Map of Clear Lake and tributaries showing former and current extent of hitch spawning

From the CCCLH hitch spawning survey reports:
2005: hitch in 12 of 17 (71%) tributary streams surveyed, although relatively large numbers were found only in Kelsey and Adobe Creeks
2006: hitch in 12 of 21 (57%) tributary streams surveyed, with large numbers found only in Adobe Creek
2007: hitch in 7 of 21 (33%) tributary streams surveyed, with large numbers only in Adobe Creek
2008: hitch in 6 of 18 (33%) tributary streams surveyed, with large numbers found only in Kelsey and Adobe Creeks
2009: hitch in 7 of 15 (47%) tributary streams surveyed, with large numbers found only in Adobe and Kelsey Creeks
2010: hitch in 8 of 20 (40%) tributary streams surveyed, with large numbers reported only in Adobe, Kelsey and Manning Creeks
2011: hitch in 9 of 22 (41%) tributary streams surveyed, with large numbers found only in Adobe Creek
2012: hitch in 7 of 13 (54%) tributary streams surveyed, with large numbers found only in Kelsey and Adobe Creeks

Most importantly, from 2005-2012 large numbers of spawning hitch with significance for successful reproduction have been documented regularly in only 2 of the 14 (14%) watersheds tributary to Clear Lake; Kelsey and nearby Adobe Creeks (CCCLH 2012). To give an idea of the recent level of effort of spawning surveys, the CCCLH annually surveys up to 31 streams and tributaries; more than 330 observational surveys were conducted in 2011 in 22 streams. The RREC surveyed 67 observation stations on 22 Clear Lake tributaries in 2007.

In recent years, the furthest distances upstream from Clear Lake that spawning hitch have been observed in the tributaries were 3 miles up Kelsey Creek, 5 miles up Adobe Creek, 2.5 miles up Middle Creek, 1 mile up Cole Creek, 0.3 miles up Manning Creek, 3.5 miles up McGaugh Slough, and 3 miles up Hill Creek (Windrem 2004). Runs further upstream in Kelsey, Adobe, Scotts, Middle, and Manning Creeks have been blocked by barriers, but for which spawning hitch would have migrated further upstream (P. Windrem, pers. comm., 2010).

2. Historical and Current Abundance

Historical Abundance

Hitch were once a staple food for the Pomo tribes living around Clear Lake. Schools of migrating adult Clear Lake hitch were once almost unimaginably abundant, and the fish annually clogged the lake’s tributary streams during spawning runs (RREC 2008). Longtime residents vividly recall vast numbers of spawning hitch in every tributary to Clear Lake and Native American tribal elders remember that one could “walk across Kelsey Creek on the backs of the chi.”

Jordan and Gilbert (1894) described Clear Lake hitch as “very common.” Before the 1920s, Clear Lake “swarmed with countless thousands of native minnows. Not only did these fish cause Livingston Stone difficulty in fording some of its tributary streams by horse when they ran upstream to spawn, but in more recent years they died in such quantities that the stench was almost intolerable to the lakeshore residents. Every year large quantities of dead fish had to be buried…” (Dill 1997). Coleman (1930) noted that Clear Lake hitch were “the most abundant fish” in Clear Lake and the Blue Lakes in 1925 and remarked that during spawning runs, hitch were then “so abundant that one can hardly step without stepping on several.” Lindquist et al. (1943) noted “the spawning runs up the creeks of split-tails and hitch give some indication of the great numbers in the lake…tens of thousands of split-tails and hitch have been observed moving in a solid mass up a small creek only 4 feet wide.” Murphy (1948) recounted “in the past, enormous numbers of hitch moved into the streams after the late rains…Kelsey Creek…has been so choked with stranded fish that one could literally walk across the stream on the backs of fish.”

Cook et al. (1964) took over 1,700 hitch from Clear Lake during sampling from June 1961 to June 1963. As late as the 1970s, Clear Lake hitch still numbered “in the hundreds of thousands” (Moyle 2002). Manning Creek was reported to have “massive numbers” of spawning hitch in the 1980s. Tulelake, Scotts Creek, Blue Lakes and their tributaries once supported large runs of hitch, with the last observed spawning in these areas in the 1980s. Clear Lake hitch seemed to still be “common” in Clear Lake in the late 1980s and early 1990s but the populations compared to past abundances were “undoubtedly diminished” (Moyle et al. 1989; Moyle et al. 1995). The hitch spawning run in Kelsey Creek in 1990 was described as “excellent” and although the run in 1991 was weaker, numbers still were recorded as “substantial” (Moyle et al. 1995). In 1992, surveys of the three main hitch spawning streams - Seigler Canyon, Kelsey and Adobe Creeks - indicated “good” runs of hitch (Moyle et al. 1995).

Current Abundance

By the early 2000s, the numbers of Clear Lake hitch seen on spawning runs had dwindled dramatically to only a few thousand fish (Moyle 2002). Spawning hitch are currently observed migrating into only a few of Clear Lake’s many tributaries and only in relatively small numbers. The populations in the Blue Lakes have apparently been extirpated - hitch are no longer observed in surveys of Blue Lakes (J. Rowan, CDFG, T. Taylor, Entrix, pers. comm., 2009, as cited in Moyle et al., In Review).

The CCCLH annual observational surveys for spawning hitch in many of the Clear Lake tributaries have been conducted since 2005. The surveys occur when fish are expected or present, typically from January through early May. From observations, hitch move upstream at a fairly constant rate and seem quick to migrate, spawn, and return to Clear Lake. It is very rare for CCCLH observers to see hitch moving downstream and very little is known about when and how they move downstream. The CCCLH surveys record all observations and total numbers of fish migrating over the duration of the spawning season. These surveys are useful for establishing the relative level of spawning activity in each stream, but not total numbers of fish. No attempt has been made to count or calculate all the fish in a run. Although the level of effort, observation locations, and experience of surveyors may vary widely, the CCCLH surveys likely capture much of the spawning activity in all of the monitored tributaries (P. Windrem, pers. comm., 2010).

Potential problems with the CCCLH surveys are that the observations are done by different observers at different times and locations, do not meet any consistent scientific standard, many of the numbers of fish given are estimates, and hitch behaviors include the same mass or cohort of fish moving back and forth along the same stream reach, which could lead to confounding and duplicative observations. Other native and introduced fish that may share habitat with hitch such as shad, silverside, Sacramento sucker, carp and Sacramento pikeminnow can be confused with Clear Lake hitch.

Clear Lake hitch in Kelsey Creek in 2009

The maximum number of spawning hitch reported by CCCLH observers at any one time in any of the tributary creeks in recent years has varied, but has been consistently lower than historical numbers: about 300 fish in 2004; 5,000 fish in Kelsey Creek in 2005; 1,000 fish in Adobe Creek in 2006; 2,000 fish in Adobe Creek in 2007; 2,000 fish in Kelsey Creek in 2008; 5,000 fish in Kelsey Creek in 2009; 10,000+ fish in Kelsey Creek in 2010; 2,000 fish in Adobe Creek in 2011; and 1000+ fish in Kelsey Creek and in Adobe Creek in 2012 (Windrem 2004; CCCLH 2012).

CCCLH observations are not made with the intention of counting the total numbers of fish in the streams, but rather their relative numbers at any one sighting.[1] With these

[1] There are many more recorded observations on some streams than others. What the CCCLH surveys document is whether or not fish are observed and, if so, how many are observed at any one time. From that information it can be determined which streams have more total fish spawning than others. If no fish are seen over the course of the spawning season, as has been the case with Seigler Canyon Creek in recent years, it can be concluded that there are few, if any, fish spawning in that stream.

significant limitations of observations in mind, CCCLH surveys from 2005-2012 in the most important tributary streams known from the 1980s and 1990s (Adobe, Kelsey, Middle, Scotts, Cole, Seigler Canyon, and Manning Creeks) were as follows:

Adobe Creek

In Adobe Creek the largest numbers of hitch reported at any one time during spawning runs were 1000+ fish in 2005, 1,000+ fish in 2006, 2,000 fish in 2007, 600 fish in 2008, 800 fish in 2009, 1,000+ fish in 2010, 2,000 fish in 2011, and 1,000+ fish in 2012.

Kelsey Creek

In Kelsey Creek the largest numbers of hitch reported at any one time during spawning runs were 5,000+ fish in 2005, 100 fish in 2006, 1,000 fish in 2007, 2,000+ fish in 2008, 5,000 fish in 2009, 10,000+ fish in 2010, only 30 fish in 2011, and 1,000+ fish in 2012.

Middle Creek

Only 1 hitch was reported in 2004. The largest numbers of hitch reported at any one time during recent spawning runs were 400+ fish in 2005, 0 fish in 2006, 100 fish in 2007, 30 fish in 2008, 20 fish in 2009, 200 fish in 2010, 0 fish in 2011, and 350 fish in 2012.

Scotts Creek and tributaries Hendricks and Pool Creeks

No spawning hitch were reported in Scotts Creek during 8 surveys in 2004 (Windrem 2004). The largest numbers of hitch reported at any one time during recent spawning runs were 100+ fish in 2005, 50 fish in 2006, 0 fish in 2007, 20 fish in 2008, and 0 fish from 2009-2011. In the tributary Hendricks Creek, the largest numbers of hitch reported at any one time during spawning runs were 100+ fish in 2005, 2 fish in 2007, 0 fish in 2008, 2 fish in 2009, 30-35 fish in 2010, 1 fish in 2011, and 0 fish in 2012 (no surveys were done during 2006). In the tributary Pool Creek the largest numbers of hitch reported at any one time during spawning runs were 100 fish in 2006, and no hitch were observed during surveys in 2007-2008 or 2010-2011.

Cole Creek

There were 3 spawning observations during 7 surveys in 2004 (Windrem 2004). The largest numbers of hitch reported at any one time during spawning runs were 200+ fish in 2005, 30 fish in 2006, 11 fish in 2007, 120 fish in 2008, 70 fish in 2009, 50 fish in 2010, and 1,000 fish in 2011.

Seigler Canyon Creek

No spawning hitch were reported in Seigler Canyon Creek during surveys from 2005-2011, and a single hitch was reported in 2012.

Manning Creek

There was 1 spawning observation during 8 surveys in 2004 (Windrem 2004). The largest numbers of hitch reported at any one time during recent spawning runs were 100 fish in 2005, 50 fish in 2006, 0 fish during surveys from 2007-2009, the “best run in 30 years” in 2010 with 1,000+ fish, 100+ fish in 2011, and 0 fish in 2012.

The remainder of the smaller tributary creeks to Clear Lake that have been surveyed had very small or non-existent hitch spawning runs from 2005-2012:

Burns Valley Creek
Burns Valley Creek had no reported spawning during surveys from 2005-2009 and 2012.

Clover Creek and tributary Alley Creek
The largest numbers of hitch reported at any one time during spawning runs in Clover Creek were 100+ fish in 2005, 0 fish in 2006 and 2007 (although the RREC documented 3 hitch in Clover Creek at Bridge Arbor Drive on 3/29/06), 35+ fish in 2008, 20 fish in 2009, 50-70 fish in 2010, 0 fish in 2011, and 1 fish in 2012. Alley Creek had no reported spawning during surveys in 2008 and 2010-2011.

Cooper Creek
The largest number of hitch reported at any one time during spawning runs in Cooper Creek (in the Bachelor Valley/Witter Springs area) was 12 fish in 2009, 50 fish in 2010, and 0 fish in 2011.

Copsey Creek below the dam
Only 4 hitch were reported in Copsey Creek in 2005, and no spawning was reported during surveys from 2006-2008 and in 2010.

Ditch Creek in Lakeport
Fifty-plus spawning hitch were reported from an unnamed ditch near Soda Bay Road in 2011, no hitch were seen during surveys in 2012.

Eickoff Creek
Eickoff Creek had no reported hitch spawning during surveys in 2006.

Forbes Creek
In Forbes Creek, the largest number of hitch reported at any one time during spawning runs was 75+ fish in 2006; no spawning hitch were reported during surveys in 2005 and from 2007-2009 and 2011.

Henderson Creek
No spawning hitch were reported in Henderson Creek during surveys in 2010.

Herndon Creek
No spawning hitch were reported in Herndon Creek during surveys in 2011.

Highland Springs Creek
The largest number of hitch reported at any one time during spawning runs in Highland Springs Creek was 100 fish in 2007; no hitch were seen during surveys in 2011; and 6 fish were reported in 2012.

Lyon Creek
Only 8 hitch were reported in Lyon Creek in 2005, and no spawning was reported during surveys from 2008-2009.

McGaugh Slough and tributary Hill Creek
The largest numbers of hitch reported at any one time during spawning runs in McGaugh Slough were 10 fish in 2005, 100-200 fish in 2006, and 0 fish during surveys from 2007-2012. Hill Creek had no spawning reported during surveys in 2005 or 2010-2011, and the largest numbers of hitch reported at any one time during surveys in 2006 was 100 fish.

Mendenhall Creek
No spawning hitch were reported in Mendenhall Creek during surveys in 2010.

Molesworth Creek
No spawning hitch were reported in Molesworth Creek during surveys in 2008.

Morrison Creek
No spawning hitch were reported in Morrison Creek during 2005-2007 or 2009-2012 surveys.

Robinson Creek
The largest numbers of hitch reported at any one time during spawning runs in Robinson Creek were 50 fish in 2005, 35-40 fish in 2006, 0 fish during surveys from 2007-2009 (the RREC recorded 3 hitch in Robinson Creek in 2008), 50 fish in 2010, and 35 fish in 2011.

Rodman Slough
Ten hitch were reported in Rodman Slough in 2006.

Schindler Creek
Schindler Creek had no reported spawning during surveys from 2005-2010; 12 fish were reported in 2011, and 25 fish in 2012.

Stokes Creek
The largest numbers of hitch reported at any one time during spawning runs in Stokes Creek in 2006 was 100+ fish.

Thompson Creek
No spawning hitch were reported in Thompson Creek during surveys from 2005-2009; 75 fish were reported in 2011.

3. Population Trends

Spawning numbers of hitch have gone from estimated millions historically, to hundreds of thousands in the 1970s, to the low tens of thousands, or even thousands today. Schools of hitch numbering up to 1,000 or more fish have been regularly observed recently in

Adobe and Kelsey Creeks, but these numbers are dramatically less than historic runs, and fish in vastly greater numbers were once observed spawning in all the major tributaries, not just two streams. CCCLH surveys cover all of the potential major potential spawning streams for the duration of the hitch spawning run, so it is unlikely any significant hitch spawning runs are going undetected. Hitch spawning populations have clearly declined even from 2005 to 2012, despite an increased level of survey effort and more thorough monitoring of potential spawning streams. Clear Lake hitch observation data by the RREC (2008) and the CCCLH from 2005-2012 indicate that hitch numbers are at record lows and still in serious decline. The CCCLH has concluded that the numbers of hitch that spawn in the creeks each year appear to be declining. Sizeable hitch spawning runs have occurred recently on only two creeks, Kelsey and Adobe, and in diminishing numbers.

The only lake surveys that could give some indication of hitch abundance in Clear Lake are annual beach seine surveys conducted by the Lake County Vector Control District from 1988 to 2004 (see Figure 3 below), which also indicate a declining trend in hitch abundance.

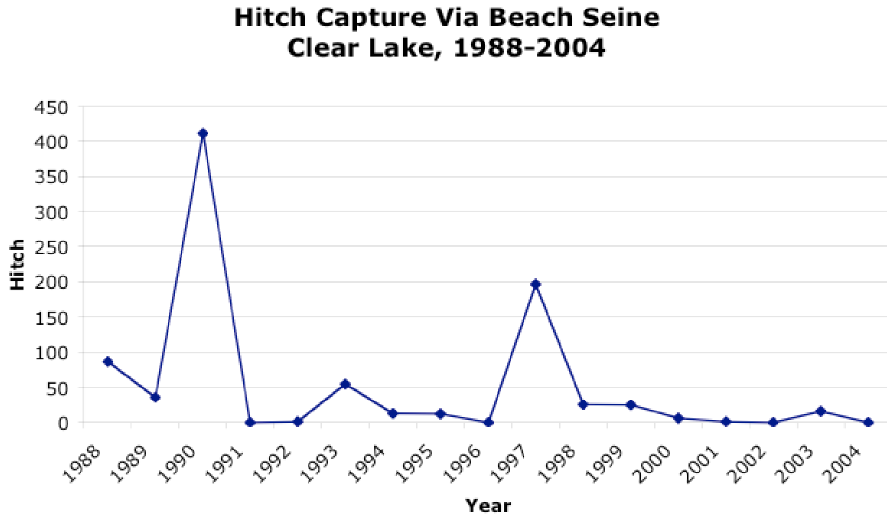

Figure 3. Hitch captured via beach seine 1988 through 2004. Lake County Vector Control District. Unpublished data.

Moyle et al. (In Review) concluded that extinction of Clear Lake hitch “is expected if measures are not taken to improve spawning and lake habitats.”

II. CRITERIA FOR ENDANGERED SPECIES ACT LISTING

The Clear Lake hitch indisputably merits listing under the Endangered Species Act. The listing decision must be made solely on the basis of the best scientific and commercial data available, in compliance with 16 U.S.C. § 1533(b)(1)(A). The legislative history of this provision clearly states the intent of Congress to "ensure" that listing decisions are "based solely on biological criteria and to prevent nonbiological criteria from affecting such decisions" (H.R. Rep. No. 97-835, 97th Cong. 2d Sess. 19 (1982)). As further stated in the legislative history, "economic considerations have no relevance to determinations regarding the status of species." Therefore, political and economic arguments may not be considered by the USFWS in its determination of whether to list this species. The numerous factors threatening the continued survival of the Clear Lake hitch are detailed below.

A. THE CLEAR LAKE HITCH IS A LISTABLE ENTITY UNDER THE ESA

The Clear Lake hitch (*Lavinia exilicauda chi*) has been consistently recognized as a distinct species, geographically isolated and morphologically differentiated from other hitch subspecies and populations (Miller 1945; Hopkirk 1973; Avise and Ayala 1976; Moyle et al. 1995; Moyle 2002). The Clear Lake basin is a center of geographic isolation and speciation, with numerous native fish that are geographically restricted and which represent lake-adapted forms of species found in the Central Valley (Hopkirk 1973). Fish populations in Clear Lake are unique due to the geologic history of Clear Lake. Clear Lake once drained westward into the Russian River, but parallel faulting, mountain generation and volcanic activity caused a new eastward outflow into the Sacramento River. Hitch likely came to Clear Lake by the way of Cache Creek from the Sacramento River drainage and evolved into a separate subspecies. As a distinct species, the Clear Lake hitch is a listable entity under the Endangered Species Act.

B. THE CLEAR LAKE HITCH IS ENDANGERED OR THREATENED UNDER THE ESA

The Endangered Species Act defines an "endangered" species as "any species which is in danger of extinction throughout all or a significant portion of its range…" and a "threatened" species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The threats to a species' survival may be categorized according to the Endangered Species Act as:

(A) the present, or threatened destruction, modification, or curtailment of its habitat or range;
(B) over-utilization for commercial, recreational, or educational purposes;
(C) disease or predation;
(D) inadequacy of current regulatory mechanisms; or
(E) other natural or manmade factors affecting its continued existence.

The Clear Lake hitch indisputably merits immediate listing under the Endangered Species Act as an endangered or threatened species due to a combination of all of these factors, which threaten the continued survival of the Clear Lake hitch, as detailed below.

1. Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Suchanek et al. (2002) thoroughly reviewed the multiple anthropogenic stresses to the aquatic ecosystem of Clear Lake and its tributaries, including anthropogenically influenced fires and flooding, increased nutrient loading, logging and deforestation, dam construction, and other creek modifications. Some of the principal threats to Clear Lake hitch are the loss of spawning habitat and nursery areas, and migration barriers in spawning streams, factors which contributed strongly to the extinction of the hitch's closest relative, the Clear Lake splittail (*Pogonichthys ciscoides*), which has not been seen since the 1970s (Moyle 2002).

Human land use has altered hydrologic patterns and stream morphology of Clear Lake tributaries, causing streamflow to go subsurface in these streams earlier in the season than previously. Dams and diversions, groundwater pumping, and sedimentation all contribute to the problem by either lowering the water table or filling the stream channel with aggregate and thereby causing flows to go subsurface. Conversely, instream gravel mining can strip the channel of suitable aggregate for spawning and cause water tables to decrease. Logging, grazing and urban development have all also exacerbated the problem by reducing the rate of rainwater infiltration. Nearly all creeks tributary to Clear Lake have been altered by some combination of dams, pump and diversion irrigation systems, development, gravel mining, levee systems, road crossings, bridge aprons, conversion of adjacent land to agricultural uses, and off-road vehicle use.

<u>Loss of Spawning Habitat and Nursery Areas</u>

Clear Lake hitch have evolved to use tributary streams at specific times. After spawning, hatchlings must be able to make their way downstream to creek deltas, sloughs, and nearshore environments in Clear Lake and adults must return to the lake before tributaries dry up in summer months. The lower reaches of most hitch spawning streams dry up annually and probably did so naturally. However, these streams now go dry much earlier in the season, primarily due to stream alteration that has resulted in deeper channels that increase the rate shallow groundwater releases to surface water, thereby shortening the period of flow for these creeks. Other factors are stream diversions and lower groundwater levels from drawdown by irrigation wells used for farming, and changes due to urban development (such as more wells pumping groundwater, clearing of vegetation, and loss of riparian habitat and seasonal wetlands and the resulting loss of aquifer-regenerating habitat). Although there is very little direct stream diversion from tributary creeks during the springtime, sporadic groundwater pumping occurs in April and early May for frost protection of pears and wine grapes. Such groundwater pumping can deplete nearby surface water and dramatically reduce creek flows, as has been shown in the Napa and Russian River valleys (see for example SWRCB 1997; Deitch et al. 2009). Heavy groundwater pumping to irrigate pears begins in early June.

Some of the tributary streams that used to run perennially now flow only after heavy rains. The streams drying earlier results in spawning failures for hitch, especially during dry years, when some of these streams that previously flowed for months now only have significant flow for a few weeks. Other native Clear Lake fishes that required tributary streams for spawning, such as the Clear Lake splittail and Sacramento pikeminnow, are now absent from the lake (Moyle et al., In Review). Only the blackfish (*Orthodon microlepitus*), a lake spawner, has apparently maintained stable populations (Moyle et al., In Review). The Clear Lake splittail formerly spawned somewhat later than did the hitch, and the drying up of streams undoubtedly contributed to the demise of this species (Guisti 2009). Continuation of this progressively earlier drying of streams may seriously affect the hitch population as well, because its spawning period already is relatively limited. Water diversions affecting stream flow can delay spawning to the point where the adults and/or developing young can become stranded in the drying streams. Former hitch spawning and riparian habitats have been lost to flood protection projects and urban development. For example, in the Middle Creek system, the quality of riparian habitat has been reduced as trees and bushes are cleared from creek and levee systems.

Tributaries of Clear Lake have experienced significant loss of native riparian habitat to agriculture, flood control, urban development and recreation. Healthy riparian habitat is essential for shade, woody debris, cover, habitat diversity, and insect prey needed by hitch. The two main spawning creeks, Adobe and Kelsey, have numerous “temporary road crossings” which consist of large piles of sand and gravel pushed by bulldozer to allow road traffic during the summer. Other creeks have additional small and large scale in-channel gravel mining operations. Many of the marshy areas that once ringed Clear Lake have been destroyed or altered, limiting the habitat available to larval hitch (Moyle et al. 1995). Clear Lake has lost over 85% of its original natural wetlands habitat (Suchanek et al. 2002; Giusti 2009). What used to be a system that naturally filtered through extensive stands of tule, large areas of wetland and marshland, with natural meandering creeks and riparian forest has been dramatically altered. Loss of aquatic, lakeshore, riparian, and instream vegetation has resulted in reduced cover and foraging habitat for fish species. Juvenile life stages of the hitch require cover in tule beds or other aquatic vegetation to avoid predators such as introduced carp and bass species (Moyle et al. 1995).

<u>Hydrologic Changes</u>

Aquifers in the Clear Lake basin are lower than they were even 25 years ago, and streams that once ran freely from the fall through late spring or even early summer now run intermittently or only during heavy storm runoff (RREC 2011). Lake County has a regular monitoring system for a number of wells; well and groundwater levels near hitch spawning streams should be evaluated, especially in Big Valley. Urban development has brought an increasing number of wells drawing from the aquifer, as well as water diversions and pumping for agriculture (particularly pears and increasingly, grapes). Winegrape vineyards are also increasingly irrigated for frost protection.

Gichuki and Garibay (2012) visited creeks in the Big Valley sub-basin (Forbes, Manning, Adobe, Kelsey and Cole) on a weekly basis during the 2012 hitch run. Although in the past water flowed in these creeks for 7 months out of the year, in 2012 the stream flow was only sustained for less than 2 months. Gichuki and Garibay (2012) noted very many illegal connections for agriculture and there seemed to be a competition among farmers to extract as much water from the creeks as possible once they realized that the season was going to have less rainfall. Water pumped out of the creeks contained young hitch – this water was kept in small dams for later use in irrigation. Farmers do not seem to be inclined to use groundwater from wells, which may be due to the attendant costs of pumping, but instead preferred to pump water from the creeks. By end of May 2012, most of the creeks in the Big Valley sub-basin were running dry with young hitch still stuck in isolated pools of water; these pools dried up and many young hitch died without being able to reach the lake.

Dams and Migration Barriers

The Cache Creek Dam was built in 1914 to control lake outflows and levels and to provide water for Yolo County agriculture. The effects of lake drawdown on hitch populations are not known but it is possible that young-of-year hitch could be forced from cover as water levels dropped, making them more vulnerable to predation (Moyle et al., In Review). Dams on tributary streams likely have a greater impact on hitch by blocking migratory routes and decreasing stream flows necessary for spawning. The impact of tributary dams and impoundments, such as Adobe Creek Dam (1962); Allen Dam (1955, on tributary of Kelsey Creek); Graham (1959, on tributary of Highland Creek); Highland Creek Dam (1962); North Lake (1980, on tributary of Manning Creek); and Spring Valley (1968) need to be investigated.

Numerous physical barriers such as road crossings, bridges, dams, and weirs on tributaries to Clear Lake block hitch passage to former spawning grounds. Many old bridges and stream crossings in Lake County were not designed with hitch in mind. Two of the largest tributaries, Kelsey and Middle Creek, both have bridges that are well documented barriers to migration. By changing the direction or velocity of stream flows or creating waterfalls of one or more feet, bridges can delay migration or completely block upstream access for spawning hitch. Clear Lake hitch often cannot pass barriers, because unlike salmon, they do not jump out of the water to surmount barriers. This species had no reason to develop exceptional swimming and jumping abilities because native spawning streams were gradually sloped and devoid of waterfalls and rapids. Construction of structures (such as on Kelsey Creek and Scotts Creek) intended to aggrade gravel and raise the streambed present additional barriers to fish migration, especially during periods of low flow (Moyle et al. 1995; Windrem pers. comm. 2010). Many of these structures are in fact complete barriers or they retard migration to varying degrees. Hitch that do make it past barriers are often left unprotected in shallow water (Moyle 2002).

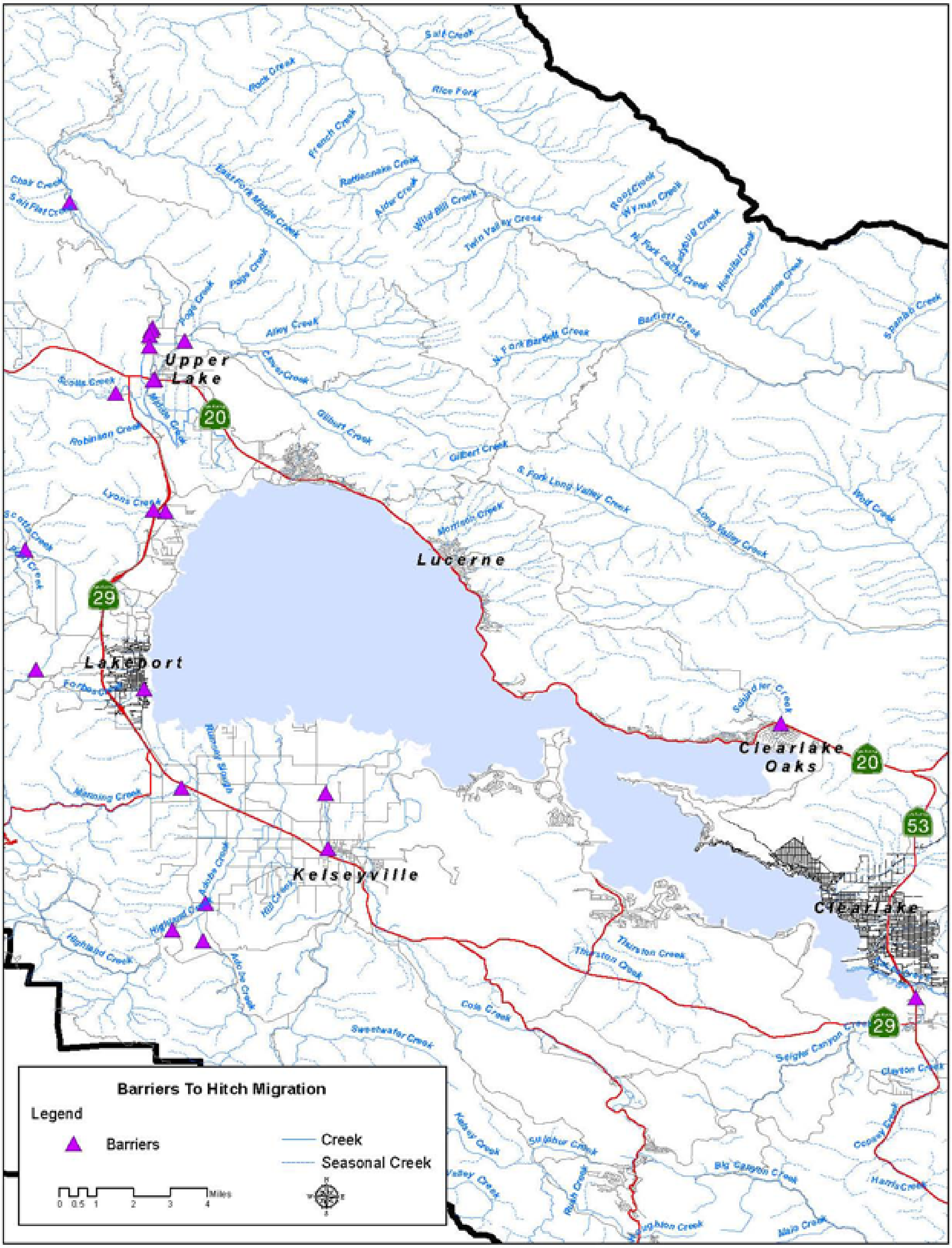

Figure 4. Locations of major hitch passage barriers, courtesy of Habematolel Pomo of Upper Lake

Barriers can delay spawning to the point where the adults and/or developing young become stranded in the drying streams. Barriers can also lead to increased competition for habitat between developing eggs and juveniles. Masses of hitch eggs can be seen lining the bottoms of streams below barriers. The lower layers of eggs will suffocate due to depletion of oxygen from high concentrations of nitrogenous wastes, a by-product of egg development. A similar problem can occur when stream sections become overpopulated with juveniles. If spawning had been possible throughout the length of these streams, egg and juvenile survival would have been much greater.

Physical barriers in Kelsey, Scotts, Middle and Clover Creeks such as rock weirs constructed to protect the footings of bridges, low water crossings, dams, and culverts have deprived hitch of access to miles of historic spawning beds for over 30 years. In streams such as Adobe and Kelsey Creeks, upstream areas that were once used for spawning are now partially blocked by road crossings and other obstructions (McGinnis and Ringelberg 2008).

The California Department of Fish and Game, in cooperation with Lake County and the California Department of Transportation, have begun to try to correct some of these fish passage problems, but many barriers remain. Caltrans engineers reportedly now consider hitch migration in their road and bridge designs in Lake County. Lake County personnel have assisted Fish and Game in improving conditions at some county facilities. This cooperative effort has begun to improve conditions for Clear Lake hitch, but much more is needed.

The known potential fish migration barriers by drainage are:

Alley Creek

Alley Creek has an altered channel above Pitney Lane, and it has been diverted into Clover Creek south of Pitney Lane. Alley Creek historically supported hitch runs (RREC 2011). Migrating hitch can access Alley Creek via the Clover bypass but not via Clover Creek when the diversion has silt or sand obstructing it.

Adobe Creek

There is a flood control dam on Adobe Creek above Bell Hill Road that is impassable to hitch (P. Windrem, pers. comm., 2010). There are two culverts on Adobe Creek at Bell Hill Road that are barely passable to spawning hitch when the water flows and velocity are not too great, but these culverts were documented to block hitch migration in 2006 (CCCLH 2006).

Clover Creek

There was a diversion barrier on Clover Creek, a tributary of Middle Creek, which prevented fish passage into Clover Creek and Alley Creek. In 2004 the Robinson Rancheria received a Tribal Wildlife Grant to mitigate the diversion barrier. The work has been completed and the barrier has been modified and no longer obstructs fish passage. However, hitch must pass a concrete diversion structure at the junction with Alley Creek to the northwest of Upper Lake to gain the upper reaches of Clover Creek.

This diversion structure can become occluded with gravel and sediment. The Robinson Rancheria Environmental Center has proposed investigating a stream redesign in coordination with the Middle Creek Restoration Project that will open more habitat for migrating and spawning hitch.

Forbes Creek
Forbes Creek has a concrete storm water diversion structure that has impeded fish passage.

Highland Springs Creek
There is a flood control dam on Highland Springs Creek, a tributary to Adobe Creek, which is impassable to hitch.

Kelsey Creek
On Kelsey Creek, the main barriers to hitch migration are a detention dam 2 to 3 miles upstream of Clear Lake, and the Main Street Bridge in Kelseyville. The rock and concrete weir constructed at the base of the Main Street Bridge is a total barrier to the passage of hitch (P. Windrem, pers. comm., 2010). The structure has a fish ladder which is non-functional and the site is nonetheless a total barrier to hitch (McGinnis and Ringelberg 2008). The Kelsey Creek detention structure below Dorn Crossing has retractable gates which can be opened during the hitch spawning season. However, altered flow patterns and slight increases in the slope of the streambed have been enough to reduce the number of spawning hitch that can pass through the detention structure and move upstream. Also, rock riprap situated below the retention dam seems to have impeded the upstream migration of hitch and needs to be modified to provide a clear channel for fish transit.

A number of drop-structures in Kelsey Creek intended for gravel aggradation, although not complete barriers, can impede free migration. Some of these do not seem to impede hitch passage under current conditions, but hitch navigate them with difficulty especially on the downstream passage. Further upstream, culverts that once tended to clog with debris and block fish migration at the Merritt Road crossing have been removed and replaced by a bridge that poses no impediment to hitch passage.

Lyons Creek
A high culvert on Lyons Creek at Lakeshore Drive prevents hitch from moving upstream (CCCLH 2008). Lyons Creek also has a concrete barrier at the County’s Juvenile Hall facility that completely prevents fish passage.

Manning Creek
A dam on private land upstream of known hitch spawning areas in the lower reaches of Manning Creek may prevent hitch from spawning further upstream (CCCLH 2007).

Middle Creek
On Middle Creek, a rock and concrete weir at the Rancheria Road Bridge has been a total fish passage barrier for hitch. Remedial work has been done downstream, with more weirs installed in an effort to elevate the gradient so that hitch could surmount the barrier

and work was done to improve their stability after high flows, but it remains to be seen if this will allow hitch passage. Similar weirs to capture and hold gravel were installed many years ago in Adobe Creek and Kelsey Creek that do not impede hitch passage, but there is concern the installed weirs on Middle Creek may be potential barriers to hitch. A downstream weir at Rancheria Road is a partial barrier and improperly sized rip rap at this location acts as partial migration barrier (McGinnis and Ringelberg 2008). Hitch were seen recently at Middle Creek Bridge and Highway 20 and although there are no obvious barriers, they did not appear to be able to navigate the swift currents there due to the lack of resting pools. If hitch could surmount Rancheria Bridge, many additional miles of spawning grounds would be accessible to hitch up to areas south of Hunter Bridge, where habitat suitability ends because the channel is braided and shallow due to gravel mining.

Scotts Creek
On Scotts Creek, a rock and concrete weir constructed on private land at the Decker Bridge is a total barrier to the passage of hitch (P. Windrem, pers. comm., 2010). In recent years as water levels have been lower, a barrier at the lower end of Tulelake appears to be problematic for fish passage to Tulelake and its tributary Mendenhall Creek, Scotts Creek and tributaries, Bachelor Valley/Witter Springs area tributaries, and Blue Lakes and tributaries. There is a one-way flow gate on the Blue Lakes outlet at Scotts Creek that would prevent hitch from entering Blue Lakes.

Seigler Canyon Creek
There are two barriers to hitch migration into Seigler Canyon Creek, an exposed sewer pipe and a road crossing. The sewer pipeline which crosses Seigler Canyon Creek for Anderson Marsh State Park was modified in the 1990s and now seems to completely block hitch access to that creek, once a major spawning tributary.

The CCCLH is currently assembling a migration barrier database with photographs of obstructions, and has identified five priority barriers for removal:

- Bridge protection structure across Kelsey Creek at Main Street Bridge, Kelseyville
- Bridge protection structure across Middle Creek at Rancheria Road Bridge, Upper Lake
- Bridge protection structure across Scotts Creek at Decker Bridge, Lakeport
- Kelsey Creek gravel detention structure
- Sewer line across Seigler Canyon Creek, Lower Lake

<u>Levees</u>

In the northern Clear Lake watershed, former hitch habitat was altered as floodplains were claimed for crops and streams were channeled for irrigation. Most tributaries have been altered in some way. Many miles of Middle Creek above Rodman Slough are leveed, Scotts Creek from Tulelake to Rodman Slough is leveed, and what used to be Robinson Lake is now the greatly reduced Robinson Slough. Much of the original natural channels with healthy native riparian vegetation reinforcing stream banks and filtering out silt have disappeared. Dynamic channels that by nature change over time no longer exist in most of the northern watershed. Water that originally flowed in winding channels with woody debris and boulders in low gradient streams now has more force as it is channeled into long, straight cleared stretches. Hitch are not strong swimmers and do not handle strong currents well. Channeling of major creeks in the 1950s and 1960s impaired hitch access to smaller tributaries.

The entire eastern edge of Rodman Slough is a levee that contains floodwaters within the slough. It was constructed by the reclamation district from 1920 to 1959, when the U.S. Army Corps of Engineers built a levee upon it. The floodplain to the east has been farmed since then. Scotts, Middle and Clover Creeks flow into the slough, and these creeks have been straightened and channeled, and significant reaches are contained by levees to protect agricultural lands and residential homes. However, the levees block natural flows and filtration. The Army Corps of Engineers is working on a plan to allow a breach of the levee system to regenerate wetlands and marshlands east of the slough.

Mining and Grazing

Many of the tributary streams to Clear Lake have been degraded from past mining and resultant erosion (Moyle 2002). Gravel mining can strip the channel of suitable aggregate for spawning and cause water tables to decrease. In the early 1970s, Lake County began permitting mining of large volumes of gravel from Scotts, Middle, Kelsey, Adobe, Forbes, Cole, and Burns Valley creeks (Suchanek et al. 2002). Gravel mining was common until 1987. The mining dramatically changed the level of stream beds, caused destabilization and increased erosion during flooding, and sent high loads of sediments and associated nutrients downstream (Zalusky 1992). Gravel mining on Kelsey, Adobe, Scotts, and Middle creeks has lowered the level of stream beds and the water table as much as 15 feet in some places. Instream gravel mining has been curtailed by Lake County and the California Department of Fish and Game, and Lake County adopted a Creek Management Plan in 1981 and an Aggregate Resource Management Plan as element of its General Plan in 1992 to control gravel-mining operations in stream channels. However, the damaging legacy effects of historical mining continue to simplify habitat and lower the water table, contributing to earlier drying of streams.

Historic mining at the former Sulphur Bank Mercury Mine on the eastern shore of Clear Lake, now a USEPA Superfund site, is believed to have contaminated the lake with mercury, arsenic and antimony (Sims and White 1981; Chamberlin et al. 1990; Suchanek et al. 1993, 1997). Sulfur mining began here in 1865 and the site converted to a mercury mine in 1873. Large-scale open-pit mining operations began in 1927. Open-pit practices included bulldozing mine tailings and waste rock directly into Clear Lake. Mining continued intermittently into the 1950s, with the final mine closure in 1957. The mine dumped mining waste (~193,600 cubic yards) containing mercury directly into the Oaks Arm of the lake and shore. Mercury contaminated mine wastes continued to erode into Clear Lake over the next 35 years (Giusti 2009). Mercury contamination continues to exercise its influence through health advisory warnings on fish consumption and persistent evidence of its existence within the lake’s food web (Giusti 2009). Elevated levels of mercury have been found in fish and waterfowl. A current health advisory (first issued in 1986) recommends that not more than one fish from Clear Lake be consumed per week. The water column does not seem to contain high concentrations of methyl mercury, in contrast to some lake sediments. Indirect effects from mercury exposure include behavior disruption (prey capture, inhibition of reproduction), reduced growth rate, and disruption of physiological functions (olfaction, thyroid function, blood chemistry; Suchanek et al. 2008), potentially making hitch more vulnerable to predation.

Heavy grazing of Clear Lake watersheds has occurred since the 1870s and has likely contributed to sedimentation and nutrient loading of the lake (Suchanek et al. 2002). Today stock numbers are much reduced but past soil compaction from stock may still contribute to increased runoff during winter, decreasing aquifer recharge and contributing to earlier drying of streams (Moyle et al., In Review).

Mining, grazing, and subsequent human-induced landscape modifications involving heavy earthmoving equipment resulted in increased erosion and sedimentation rates and the associated excessive nutrient input into the lake, culminating in algae blooms and reduced surface water quality through most of the 20th century (Osleger et al. 2008).

Residential Development

As Clear Lake became popular as a resort area in the 19th century, the lakeshore became increasingly developed with vacation and permanent homes. This development removed wetlands which trapped sediment and nutrients, added septic tank effluent to the lake, and caused large-scale application of pesticides to the lake to control pestiferous gnats. While hitch persisted despite the changes to the shoreline, it is likely they declined in abundance as cover, such as tule beds and dead trees, became less abundant. Development also uses large amounts of water that either is diverted from streams or pumped from ground water, which is connected to streams, causing streams to lose flow. Today, continued residential developments that rely on shallow wells adjacent to or near streams exacerbate already diminished streamflow in Clear Lake tributaries. The many small towns around the lake also contribute to eutrophication through sewage spills, increase in sedimentation, and removal of wetlands (Moyle et al., In Review). Development is ongoing in Lake County and two large proposed developments are currently making their way through the permitting process; Crystallago northwest of Lakeport and south of Scotts Creek, and Provinsalia, south of Clear Lake on Cache Creek. Both developments will require substantial water resources. Developments also result in inter-basin transfer of water; treated wastewater from the Clear Lake basin is transferred south to use at The Geysers.

2. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial Fishing

California Fish and Game Code § 8437 allows Cyprinid fish such as hitch to be taken for commercial purposes pursuant to regulations adopted by the state Fish and Game Commission. Hitch have been commercially harvested on occasion from Clear Lake, but commercial harvest has been minor because demand has been low. Hitch are sometimes used as bait, and have also been sold in fish markets for human consumption (Wang 1986). Harvesting regulations may need to be formulated if a demand for hitch increases in the future. In the 1990s there typically were 3 to 4 commercial fishing licenses utilized on Clear Lake, mostly focused on Sacramento blackfish and common carp, which typically were sold to markets in the San Francisco Bay region, but in recent years carp and blackfish have been in relatively low abundance (Suchanek et al. 2002). The commercial fishery for blackfish and carp has harvested some hitch as by-catch (Moyle et al. 1995; Moyle 2002). Recent commercial fishery permits require release of hitch back into Clear Lake (Moyle et al., In Review). Commercial fishing of undetermined quantity of numerous fish species for live-fish export to San Francisco's Asian food markets continues and may continue in the future (Giusti 2009).

Recreational Fishing

California Fish and Game Code § 8463 allows Cyprinid fish such as hitch to be taken in traps in lakes and impounded waters for use as bait. There are no restrictions or limits on recreational harvest of Clear Lake hitch listed in the California Fishing Regulations, despite its status as a California Species of Special Concern. Hitch can be taken by any means, including clubbing. Clear Lake hitch are taken by recreational fishers for fun, bait, or fertilizer. Fish that reach spawning areas are vulnerable in shallow water to the longstanding local sport of "hitching" whereby the fish are clubbed and thrown on the shore (Moyle 2002).

Tribal Harvest

Clear Lake hitch have been an important component of the diet and culture of the local Native Americans (Pomo tribes) that lived and still live on the shores of Clear Lake. Many members of local tribes still utilize hitch as a traditional food source. Although hitch presently are used less than before, renewed interest in traditional foods led to an increase in the early 1990s of requests by tribal members to harvest hitch from State Park areas (Moyle et al. 1995). In the 1990s there was an annual gathering to smoke and dry hitch, but the tribal harvest numbers were low (Moyle et al. 1995). Any catch limits for hitch should provide an exception for tribal harvest to allow continued cultural practices that likely have minimal impact on hitch population numbers.

3. Disease or Predation

Predation on hitch by non-native fish species in Clear Lake is a significant threat to the species, as discussed in the section on introduced fish below.

Until recently, disease was not known to be a factor in the decline of Clear Lake hitch. Gichuki and Garibay (2012) observed that most if not all the hitch caught in the Big Valley sub-basin in 2012 had been infected by parasites. The most prominent one is the parasitic infestation by a copepod of the family *Lernaeidae* (Anchor worm), which may have been brought into Clear Lake by introduced fish species such as bass. Bass caught during the Clear Lake bass competition in 2012 were observed to have the same parasite. Gichuki and Garibay (2012) counted an average of 16 infections and lesions per hitch. This parasite is associated with secondary bacterial infections, which appeared as lesions on the fish. Infected fish are prone to high mortality rates due to reduced swimming ability and greater predation rates as they are slow in movement (generally most of the energy is taken by the parasite from the host) and try to swim at the surface, exposing themselves to predators. Gichuki and Garibay (2012) also noted other lesions which could have been caused by the fish trying to rub off the parasite. The major pathological effects were found to be greater on smaller fish because the attachment organ of the parasite penetrated more deeply into the body of the fish, often causing damage to internal organs.

4. Inadequacy of Existing Regulatory Mechanisms

<u>Federal Regulatory Mechanisms</u>

The Clear Lake hitch currently has no federal protected status.

Overlap With Federally Listed Species

The range and suitable habitat for Clear Lake hitch do not overlap with any species listed under the federal Endangered Species Act that could conceivably provide some protection to habitat for hitch.

Habitat Conservation Plans

The Clear Lake hitch is not a covered species in any federal Habitat Conservation Plans under the Endangered Species Act, and its range and suitable habitat do not overlap with any approved or pending Habitat Conservation Plans.

National Environmental Policy Act

The National Environmental Policy Act ("NEPA") requires that federal agencies fully and publicly disclose the potential environmental impacts of proposed projects, but NEPA lacks even the minimal substantive provisions of CEQA, as discussed below.

Clean Water Act

Under Section 404 of the Clean Water Act, 33 U.S.C. §§ 1251 et seq. ("CWA"), discharge of pollutants, including dredged or fill material, into "Waters of the U.S." is prohibited absent a permit from the U.S. Army Corps of Engineers. Theoretically the CWA should provide some protection for stream and wetland habitats used by the hitch. However, the implementation of the CWA regulatory scheme and the Section 404 program in particular have fallen far short of Congress's intent to protect wetlands and water quality. A National Research Council report entitled "Compensating for Wetland Losses Under the Clean Water Act" concluded that the goal of no net loss has not been achieved through the Army Corps regulatory program, and that applicants often do not follow through on promised mitigation packages (National Research Council 2001). These failures of the Army Corps regulatory scheme are due in part because the Corps' implementation of the individual permitting process has allowed too much development while requiring too little avoidance and mitigation. The CWA has been and will continue to be inadequate to ensure the continued survival of the Clear Lake hitch.

State Regulatory Mechanisms

Overlap With State Listed Species

The range and suitable habitat of the Clear Lake hitch do not overlap with any species state listed under the California Endangered Species Act that could conceivably provide some protection to habitat for the species.

Species of Concern

The Clear Lake hitch is listed as a California state "Species of Special Concern." The practical benefit of this designation to the hitch has been minimal. Clear Lake hitch are still open for unrestricted fishing (CDFG 2012). "Special Concern" status should call attention to the species and prompt more information to be collected about the loss of its habitat in environmental review documents, but in practice Environmental Impact Reports and Mitigated Negative Declarations for projects around Clear Lake have not contained any actual research regarding impacts to hitch or enforced restrictions to protect hitch habitat. "Special Concern" status has not halted habitat loss or other factors causing the decline of hitch.

California Environmental Quality Act

The environmental review process under the California Environmental Quality Act, California Public Resources Code §21000 et. seq. ("CEQA"), should theoretically provide some protection to Clear Lake hitch. CEQA declares that it is the policy of the state to prevent "the elimination of fish or wildlife species due to man's activities, ensure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities" (California Public Resources Code, section 21001(c)). The CEQA process is triggered when discretionary activities of state agencies may have a significant effect on the environment. When the CEQA process is triggered, it requires full disclosure of the potential environmental impacts of proposed projects. The operative document for major projects is usually the Environmental Impact Report.

Theoretically, besides ensuring environmental protection through procedural and informational means, CEQA also has substantive mandates for environmental protection. The most important of these is the provision requiring public agencies to deny approval of a project with significant adverse effects when feasible alternatives or feasible mitigation measures can substantially lessen such effects (*Citizens for Quality Growth v.*

City of Mt. Shasta, 198 Cal.App.3d 433, 440_441 (1988); CA. Pub. Res. Code § 21002; 14 Cal. Code Regs. §§ 15002(a)(3), 15021(a)(2) and (c), 15041(c), 15364, 15370). In practice, however, this substantive mandate is not implemented, particularly with regard to instream projects, water diversions, mining permits, and projects causing pollution and sedimentation that have impacted and continue to impact habitat for the Clear Lake hitch.

Specifically, hitch are rarely noted as present in the species documentation, project alternatives to avoid impacts are rarely developed, and trustee agencies are often not provided notification. The state Department of Fish and Game's Natural Diversity Database, which is intended to help inform permitting agencies about wildlife observations and occurrence, does not have updated information on numerous hitch observations submitted into the database since 2008, allows CEQA documents to ignore the presence of hitch since it does not come up in a database search.

In practice, alternatives that would protect the Clear Lake hitch and its habitat as well as other wildlife are frequently dismissed as "infeasible," and mitigation, if required, is often ineffective or only marginally effective. If significant impacts remain after all mitigation measures and alternatives deemed feasible by a lead agency have been adopted, a lead agency is allowed under CEQA to approve a project despite environmental impacts if it finds that social or economic factors outweigh the environmental costs. Neither CEQA nor any other state or local regulatory mechanism provide protection from factors adversely impacting Clear Lake hitch such as invasive fish, pollutants and pesticides, and climate change.

Streambed Permits

The California Department of Fish and Game ("CDFG") regulates the modification of the bed, bank, or channel of streams, rivers, and lakes under Sections 1601-1607 of the California Fish and Game Code. Also included are modifications that divert, obstruct, or change the natural flow. A person who proposes an activity that may modify a feature regulated by the Fish and Game Code must notify CDFG before project construction. CDFG will then decide whether to enter into a Streambed Alteration Agreement with the project applicant either under Section 1601 (for public entities) or Section 1603 (for private entities) of the Fish and Game Code (CDFG, 2002). However, the existence of these codes has not prevented construction of structures that are migration barriers to hitch or prevented stream diversions and groundwater pumping harmful to hitch.

Other Fish and Game Codes

There are no California Fish and Game Codes that specifically protect hitch from take or protect hitch habitat. There are Fish and Game Codes that allow for commercial and bait harvest of hitch, as discussed above. California Fish and Game Code § 5931 requires passage for fish over or around any dam, but this provision is typically enforced only for salmon, steelhead, and other anadromous fish, and has not been fully utilized for providing fish passage for Clear Lake hitch into their former spawning streams. California Fish and Game Code § 5937 requires the owner of any dam to "allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or through the dam to keep in good condition any fish that may be planted or exist below the dam," but state agencies charged with implementation and enforcement have not always respected this requirement (Bork et al. 2012), and § 5937 has not been utilized to attempt to restore adequate stream flows for hitch in any Clear Lake tributaries.

Regional and Local Government Plans

The petitioners have been unable to discover any local ordinances or regulations designed for the protection of the Clear Lake hitch.

Lake County General Plan

Lake County adopted a Creek Management Plan in 1981 and an Aggregate Resource Management Plan as an element of its General Plan in 1992 to control gravel-mining operations in stream channels, but the damaging legacy of historical mining on creek habitat for the hitch persists.

The Lake County General Plan was updated in 2008 (MDG and M&A 2008). The plan only superficially mentions the Clear Lake hitch as a state species of concern. The plan contain goals and policies aimed at protecting water quality and biological resources, but some of the policies are couched in qualifiers such as "should" or "shall consider" and "whenever possible."

Among the county's General Plan goals that could conceivably benefit hitch:

Goal OSC-1; To preserve and protect environmentally sensitive significant habitats, enhance biodiversity, and promote healthy ecosystems throughout the County.

Goal OSC-7a; To manage and preserve fish and wildlife habitat areas and areas of natural scenic beauty, while enhancing the water quality of Clear Lake**.**

Among the policies in the county's General Plan that could conceivably benefit hitch:

Policy OSC-1.1 Protection of Rare and Endangered Species; The County should ensure the protection of environmentally sensitive wildlife and plant life, including those species designated as rare, threatened, and/or endangered by State and/or Federal government.

Policy OSC-1.2 Development in Environmentally Sensitive Areas; The County shall limit the encroachment of development within areas that contain a moderate to high potential for sensitive habitat, and direct development into less significant habitat areas.

Policy OSC-1.4 Protect Riparian Corridors; The County shall require that buildings and other forms of development be set back from riparian corridors to avoid damage to habitat.

Policy OSC-1.5 Creek Management Plans and Mineral Reclamation Plans; Creek Management Plans and Mineral Reclamation Plans shall include measures to protect and maintain riparian resources and habitats.

Policy OSC-1.6 Management of Wetlands; The County shall support the management of wetland and riparian plant communities for passive recreation, groundwater recharge, and wildlife habitats.

Policy OSC-1.9 Open Space Buffers; The County shall require buffer areas between development projects and significant watercourses, riparian vegetation, and wetlands.

Policy OSC-1.14 Requirement for Biological Studies; Prior to approving a specific plan or project, the County shall require a biological study to be prepared by a qualified biologist for proposed development within areas containing a moderate to high potential for sensitive habitat, sensitive wildlife species, and/or sensitive plant species. As appropriate, the study shall include the following activities: (1) inventory species listed in the CNPS Manual of California Vegetation; (2) inventory species identified by USFWS, DFG, and NMFS; (3) inventory special-status species listed in the CNDDB; and (4) conduct field surveys of the project site by a qualified biologist.

Policy OSC-1.15 Protect Natural Resources; The County shall strive to protect natural resource areas, fish and wildlife habitat areas, scenic areas, open space areas, and parks from encroachment or destruction by incompatible development and invasive species.

Policy OSC-1.16 Development Proposals Review; The County shall review development proposals against the most updated CNDDB to assist in identifying potential conflicts with sensitive habitats or special-status species.

Policy OSC-1.17 Project Mitigation Measures; The County shall consider using appropriate mitigation measures for future projects (i.e., community area plans or individual projects) based on mitigation standards or protocols adopted by the applicable statute or agency (e.g., CDFG, USFWS, NMFS, etc.) with jurisdiction over any affected sensitive habitats or special-status species.

Policy OSC-7a.1 Preserve Aquatic Habitats; The County should ensure the preservation and enhancement of the diverse fish and wildlife, and aquatic habitats of Clear Lake and should coordinate and support efforts for the public acquisition of environmentally significant lands.

Policy OSC-7a.2 Restoration of Wetlands; Opportunities to return portions of the reclamation area south of Upper Lake to wetlands should be promoted to provide habitat for waterfowl and other wildlife, and to reduce nutrient load into Clear Lake.

Policy OSC-7a.3 Minimize Development Impacts; The County should ensure that development around Clear Lake and along major tributaries occurs in a manner which minimizes the potential impact of land disturbance and erosion on the water quality of the lake, and minimizes the potential for pollution discharge from sewage disposal systems and other potential polluting sources. Whenever possible, the County should require that older developments without adequate sewage and stormwater disposal systems upgrade these systems to conform to current standards.

Policy WR-1.7 Stream Management.; Primary groundwater recharge in the County is from stream channels and coarse sediment deposits near the edges of the valley floors. The County will therefore work to manage stream systems and their watersheds in a sustainable manner, which maintains critical groundwater recharge functions.

Notwithstanding the good intentions of these goals and policies, the General Plan contemplates significant urban development and growth that will impact wildlife habitat and streams. The plan concludes that cumulative impacts to biological resources are significant and unavoidable and that "additional population growth in Lake County will result in the loss of resources and habitat that currently support native plant, wildlife, and fish species within the County."

5. Other Natural or Anthropogenic Factors

Introduced Fish

Prior to European settlement, there were 13 naturally occurring fish species in Clear Lake, four of which were endemic (Hopkirk 1973). The composition and population levels of fish species in Clear Lake and its tributary streams have been significantly affected by the introduction of non-native fish species, as exotic species have dramatically altered natural predator-prey relationships. By the early 1990s, Clear Lake had lost two-thirds of its native fish fauna and was dominated by introduced fish (Moyle and Yoshiyama 1992). As of the late 1990s, Clear Lake and its tributaries supported an estimated 29 fish species, 13 of them native and 16 introduced (Jones & Stokes Associates 1997). The current fish community consists of 21 species, only four (19%) of which are native to the lake (Suchanek et al. 2002). Most of Clear Lake's native fish species were not able to persist in large numbers following establishment of the 16 exotic species (Geary and Moyle 1980). The proliferation of non-native fish species in Clear Lake such as threadfin shad, Mississippi silverside, and largemouth bass are a major threat to Clear Lake hitch, through predation and competition.

Native fish species that still persist in Clear Lake include the Clear Lake hitch, Sacramento blackfish (*Orthodon microlepidotus*), tule perch (*Hysterocarpus traski*), prickly sculpin (*Leptocottus armatus*), Sacramento sucker (*Catostomus occidentalis*), and possibly Pacific lamprey (*Lempetra tridentata*) (Suchanek et al. 2002; McGinnis, pers. comm., 2012). Extinct native species include the thicktail chub (*Gila crassicauda*), California roach (*Lavinia symmetricus*), Clear Lake splittail (*Pogonichthys ciscoides*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento perch (*Archoplites interruptus*), and threespine stickleback (*Gasterosteus aculeatus*) (Moyle 2002; Suchanek et al. 2002; J. Katz, pers. comm. 2012).

Common introduced fish in Clear Lake include: common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*), introduced in the 1880s; bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*), introduced in 1910; goldfish (*Carassius auratus*), channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), and Western mosquitofish (*Gambusia affinis*), introduced in the 1920s; green sunfish (*Lepomis cyanellus*), introduced in 1935; white crappie (*Pomoxis annularis*), introduced in 1955; Mississippi silverside (*Menidia audens*), introduced in 1967; and threadfin shad (*Dorosoma petenense*), introduced in 1985 (Suchanek et al. 2002).

The introduction of the Mississippi silverside in 1967 for gnat control had a huge impact on the Clear Lake fish community (Li et al. 1976). Silversides quickly established themselves as one of the most abundant fish in the lake and the dominant planktivore of the littoral zone, reducing zooplankton populations in the nearshore regions and out-competing other planktivorous fishes (Moyle 2002). The introduction of the silverside was a major factor in the final demise of the planktivorous Clear Lake splittail, a species already in serious decline (Moyle 2002). September of 2008 saw a huge population explosion of silverside. Abundances were so vast as to be “unquantifiable” (J. Rowan CDFG, pers. comm., 2009, as cited in Moyle et al., In Review). Although it is not certain that competition from silversides has altered the diet or growth rate of Clear Lake hitch (Geary and Moyle 1980), high densities of silversides and/or shad have the capacity to greatly deplete plankton food resources for hitch and are likely a major negative factor affecting hitch abundance (Moyle et al., In Review).

The introductions of centrarchid sportfishes such catfish and largemouth bass have also had dramatic impacts on the structure of the lake’s aquatic community. Catfish and bass were associated with a decline of the native cyprinids, and the presence of largemouth bass and other exotic predators resulted in the elimination of the pikeminnow and thicktail chub (Moyle 2002). Largemouth bass are known to be voracious predators of native hitch (Moyle et al. 1995) and likely play a large role in the decline of hitch (P. Moyle, pers. comm., 2010). There was an explosion in bass numbers in Clear Lake in the 1970s following the introduction of the Florida strain of bass. Bass in Clear Lake are known to congregate at the mouth of streams during the spring hitch spawning season and feed on hitch (CCCLH 2008). The large population of large-sized bass in Clear Lake also prevents hitch from growing to a large size, which would allow them to reduce the impacts of competition from silverside and shad.

By 2006 largemouth bass numbers had greatly increased, as had the frequency of large bass, increasing the likelihood of serious predation impacts, especially during years when alternative prey populations are low (Eagles-Smith et al. 2008). Two record largemouth bass from the lake both contained large hitch, and several channel catfish captured by CDFG were observed to have eaten hitch (Moyle et al. 1995). Recent electro-shocking surveys by CDFG show a decease in the frequency of large bass, as well as very low recruitment for the 2007 and 2008 year classes, suggesting that for the next several years medium sized bass (3-5 lbs) should predominate in the lake (J. Rowan, CDFG pers.

comm. 2009, as cited in Moyle et al., In Review). Because of the heavy mercury loads of large bass, which makes them unhealthy to eat, and the catch-and-release philosophy of local bass tournaments, the largest bass are kept in the lake population despite recreational fishing pressure.

There is concern that bass may contribute to disturbance of the female to male ratio in the hitch population, contributing to lower hitch numbers. Out of 15 adult hitch that were found dead in the Big Valley sub-basin during spawning runs in 2012, Gichuki and Garibay (2012) only identified one male. The average size of the hitch was 16 inches for the 14 retrieved females and 9 inches for the only male. This lends credence to the concerns that there are fewer males in Clear Lake due to the fact that the males are easier prey for bass, owing to their smaller size.

The most recent fish introduction to Clear Lake was that of the threadfin shad in 1985 (Anderson et al. 1986). The planktivorous threadfin shad feeds on *Daphnia*, a principal food of hitch, and its establishment has tended to greatly reduce populations of zooplankton (Moyle et al. 1995; Moyle 2002; Suchanek et al. 2002). In 1988, threadfin shad constituted 70 percent of the fish caught in beach seine samples by the Lake County Mosquito Abatement District (Moyle et al. 1995). Shad themselves go through very large population fluctuations as evidenced by numerous die-offs that have occurred since their introduction. These generally occur in winter (as occurred during the winters of 1990-1991, 1998-1999, and in 2007) and likely are due to their poor tolerance for and difficulty of feeding in cold water (Griffith 1978). Threadfin shad populations have rebounded from die-offs rapidly, reaching high populations which support vast numbers of predatory grebes. The shad introduction has lead to greatly fluctuating zooplankton populations in the lake, which has had documented cascade effects on largemouth bass, and the abundance of shad has a strong positive correlation with that of piscivorous birds (Colwell et al. 1997). These strong interactions suggest that if shad ever establish permanently high densities it may result in dramatic changes throughout the ecosystem, perhaps greater than the changes caused by any previous fish introduction (Suchanek et al. 2002). It is possible that periods of high threadfin shad abundance reduce zooplankton food and increase predator densities for hitch, especially fish-eating birds. Capture of hitch as incidental prey by predators attracted to the lake by the high abundances of shad and silverside may also affect hitch populations.

Recent concerns over the spread of Dressenid mussels (quagga and zebra), New Zealand mud snails, and commercially sold aquarium fish species highlight the constant threat of adding more invasive species and the potential new stresses to the lake’s ecosystem (Giusti 2009).

Pollutants and Pesticides

Water pollution is a serious threat to Clear Lake hitch (Moyle 2002). A wide variety of toxic substances are released into Clear Lake hitch habitat as a result of human activities. Oil and other toxic run-off from roads, the application of numerous chemicals for agriculture, urban/suburban landscape maintenance, and pest control programs, and runoff of fine sediment and silt may all have negative effects on hitch populations. The effects of pesticides, herbicides, fungicides, and nitrogen fertilizers on Clear Lake have begun to be addressed only recently. Clear Lake has been designated by the State of California as an impaired water body under Section 303d of the Clean Water Act, a water body that does not meet designated beneficial uses.

Clear Lake has a history of aquatic application of pesticides and herbicides to control insects and aquatic weeds. Clear Lake is infamous for being the first site at which the deleterious effects of large concentrations of organochlorine pesticides on bird populations were documented (Hunt and Bischoff 1960; Carson 1962; Rudd 1964).

Dichloro diphenyl dichloroethane (DDD) was applied to the lake in the 1940s and 1950s in order to reduce populations of the Clear Lake gnat. The Clear Lake gnat is a non-biting midge that historically occurred in Clear Lake in such astounding numbers that large piles of dead adults would gather beneath streetlights and it was regarded as a pest. The gnat was the primary food resource for the Clear Lake splittail and likely provided a very important food source for the hitch and other Clear Lake native fishes (Lindquist et al. 1943). The gnats developed resistance while the DDD killed many other benthic invertebrates and had a devastating impact on resident breeding populations of the western grebe. The legacy of DDD application continues because DDD accumulates in the fatty tissues of animals and may effect survival and reproduction (Hunt and Bischoff 1960). While gnat numbers rebounded subsequent to DDD in the late 1950s, applications of other pesticides in the 1960s and 1970s reduced gnat populations to near zero. Malathion was applied to tree and shrub resting areas of adult gnats around the lake in the 1960s, and methyl parathion was applied in the lake from 1962 to 1975 to control gnats, until they again developed a resistance (Suchanek et al. 2002). Malathion is an organophosphate insecticide that has a very high immediate toxicity for aquatic insects, and poses an acute hazard to fish. After the last treatment of methyl parathion in 1975, gnat numbers never regained historic numbers and today they are near historic lows (D. Woodward, Lake County Vector Control, unpublished data, as cited in Moyle et al., In Review).

The aquatic weed *Hydrilla verticillata* aggressively invaded Clear Lake beginning in 1994. Since 1996 annual efforts to control and eliminate this weed have been undertaken using two aquatic herbicides containing copper sulfate and fluridone. During the mid- to late-1990s, large quantities of the aquatic weed control agents Komeen (copper-ethylenediamine complex and copper sulfate) and Sonar (fluridone) were used in the *Hydrilla* eradication program; applications post-2000 were orders of magnitude smaller and used in strategic amounts and at strategic locations. Because copper is applied in relatively high concentrations locally, and because mercury is an ongoing contaminant in Clear Lake, there is the potential for an interaction of copper and mercury on the behavior and reproduction of aquatic biota in the lake (Suchanek et al. 2002). High concentrations of copper may inhibit fish reproductive success and the survival of fish eggs and larvae (Pimentel 1971). Pesticides recently (since 2002) applied to Clear Lake for pest control include glyphosate, diquat dibromate [dibromide], copper carbonate, potassium salts of endothall, and triclopyr (Giusti 2009).

There is widespread terrestrial use of highly toxic organophosphate and organochlorine pesticides in the watersheds surrounding and draining to Clear Lake, due to intensive agricultural production, particularly vineyards and orchards. High value crops grown in the basin include pears, grapes, walnuts, apples, peaches, and wild rice. Pesticides are also used widely for landscaping, right of ways, and pest control. Terrestrially applied organophosphate pesticides are transported by runoff of surface water and sediment into Clear Lake, with potential impacts to the aquatic community. Fish and aquatic invertebrates are particularly sensitive to these compounds.

The 10 most heavily used pesticides reported under the California Pesticide Use Reporting requirements in Lake County in the 1990s were petroleum oil, sulfur, lime-sulfur, ziram, mineral oil, azinphos-methyl, methyl bromide, phosmet, chlorpyrifos, and methyl parathion (Suchanek et al. 2002). The amount of active ingredients of pesticides reported applied in Lake County in from 2004-2010 averaged about 564,000 pounds annually; 704,033 pounds in 2004; 757,574 pounds in 2005; 525,120 pounds in 2006; 571,885 pounds in 2007; 602,776 pounds in 2008; 367,113 pounds in 2009; and 419, 249 pounds in 2010 (CDPR 2012). The most recent pesticide use data currently available for Lake County is from 2010 (CDPR 2012). The top pesticide applications in Lake County from 2008-2010 were for pears and wine grapes, with smaller applications for regulatory pest control and landscape maintenance (CDPR 2012).

For Lake County pears, 367,531 pounds of active ingredients were applied in 2,670 applications over 51,355 acres in 2008; 160,026 pounds in 2,374 applications in 2009; and 294,625 pounds in 2,613 applications in 2010. The top pesticides used for pears from 2008-2010 were mineral oil, petroleum oil, ziram, lime-sulfur, and sulfur. For Lake County wine grapes and grapes, 192,172 pounds of active ingredients were applied in 2,091 applications over 62,645 acres in 2008; 186,073 pounds in 2,101 applications in 2009; and 120,164 pounds in 1,832 applications in 2010. The top pesticides used for wine grapes from 2008-2010 were sulfur, petroleum distillates, alpha-(para-nonylphenyl)-omega-hydroxypoly (oxyethylene), glyphosate, mineral oil and polyethylene glycol. For Lake County regulatory pest control, 17,162 pounds of active ingredients were applied in 2008; 7,837 pounds in 2009; and 282 pounds in 2020. The top pesticides used for regulatory pest control from 2008-2010 were copper ethylenediamine, fluridone, glyphosate, imazapyr, and clopyralid. For Lake County landscape maintenance, 367,531 pounds of active ingredients were applied in 2,670 applications over 51,355 acres in 2008; 5,214 pounds over 7 applications in 2009; and 631 pounds in 2010. The top pesticides used for landscape maintenance from 2008-2010 were endothall, diuron, simazene, glyphosate, and sulfur.

There are also many private and residential uses of pesticides that are not subject to state pesticide use reporting that have the potential to enter Clear Lake. Actual pesticide use may be up to several times the state reported use, since pesticide applications not made by professional applicators - particularly home and garden use and most industrial, commercial and institutional uses - do not have to be reported to the state. The San Francisco Estuary Project's report *Pesticides in Urban Surface Waters*: *Urban Pesticides*

Use Trends Annual Report 2005 estimated that about 73 percent of California pesticide use in 2003 did not require reporting.

Azinphos-methyl is a widely used agricultural insecticide commonly applied to fruit orchards. Azinphos-methyl is highly toxic to freshwater and marine fish and invertebrates. Azinphos methyl has been documented to cause massive fish kills throughout the U.S. and there is evidence that it kills aquatic organisms. Amounts of azinphos methyl reported applied on pear crops in Lake County were 273 pounds in 2008, 238 pounds in 2009, and 0 pounds in 2010.

Chlorpyrifos is an organophosphate insecticide with both agricultural and urban uses. It was once the most widely used insecticide in the U.S. and consequently has been detected in groundwater and in surface water in many areas. Chlorpyrifos has very high immediate toxicity for fish and aquatic insects. Long-term exposure to chlorpyrifos can affect the growth of fish. Synergistic interactions have been observed between chlorpyrifos and other chemicals, enhancing its toxicity (Cox 1995). Virtually all homeowner uses of chlorpyrifos were banned in the U.S. in 2001. Amounts of chlorpyrifos reported applied on wine grape, pear, and walnut crops in Lake County were 100 pounds in 2008, 120 pounds in 2009, and 92 pounds in 2010.

Copper in high concentrations may inhibit fish reproductive success and the survival of fish eggs and larvae (Pimentel 1971). Reported copper use around the lake appears to be decreasing: amounts of pesticide formulations with copper, such as copper carbonate, copper ethylenediamine, copper hydroxide, and copper sulfate, reported applied for regulatory pest control, landscape maintenance, and grape and pear crops in Lake County were over 20,000 pounds in 2008, 7,620 pounds in 2009, and 675 pounds in 2010.

Diuron is a highly persistent herbicide with a half-life of longer than six months. Amounts of diuron reported applied, primarily for landscape maintenance, pears, and wine grapes in Lake County were 2,782 pounds in 2008, 636 pounds in 2009, and 580 pounds in 2010.

Endothall is a moderately toxic selective contact herbicide used to control aquatic plants. Endothall is toxic to some species of fish and has a medium toxicity to aquatic insects. Long-term ingestion may cause severe damage to the digestive tract, liver, and testes of fish. Amounts of endothall reported applied for landscape maintenance in Lake County were 2,421 pounds in 2008, 1,360 pounds in 2009, and 0 pounds in 2010.

Fluridone is an herbicide used to control aquatic plants. Fluridone is moderately toxic to fish and aquatic insects. Amounts of fluridone reported applied, primarily for regulatory pest control, in Lake County were 923 pounds in 2008, 1,193 pounds in 2009, and 282 pounds in 2010.

Glyphosate is a moderately toxic broad-spectrum herbicide that is practically nontoxic to fish but may be slightly toxic to aquatic invertebrates. Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid or to surfactants used in the formulation. Amounts of glyphosate reported applied, primarily for wine grapes, pears, and landscape maintenance, in Lake County were over 12,000 pounds in 2008, 7,443 pounds in 2009, and 7,423 pounds in 2010.

Phosmet is a broad-spectrum insecticide that can pose acute and chronic risk to aquatic species if applied at a high rate and frequency. Phosmet has very high acute toxicity to freshwater fish and invertebrates. The EPA voluntarily cancelled certain uses of phosmet in 2001. Amounts of phosmet reported applied on pears and alfalfa in Lake County were 31 pounds in 2008, 219 pounds in 2009, and 0 pounds in 2010.

Sulfur and lime-sulfur are not acutely toxic to wildlife at low doses, but high application rates have the potential to increase sulfur loading into Clear Lake, which also may interact with sulfate-reducing bacteria in the conversion of inorganic mercury to methyl mercury (Compeau and Bartha 1985). Amounts of sulfur and lime-sulfur reported applied, primarily for wine grapes, pears, and other fruit crops, in Lake County were over 200,000 pounds in 2008, 170,000 pounds in 2009, and 182,212 pounds in 2010.

Triclopyr is an organochlorine herbicide. The immediate toxicity of triclopyr is low to high for fish. Triclopyr has been detected in groundwater and its long-term effects include suspected carcinogenic and mutagenic impacts for mammals. Amounts of triclopyr reported applied, primarily for landscape maintenance and right-of-ways, in Lake County were 73 pounds in 2008, 45 pounds in 2009, and 3 pounds in 2010.

Ziram is an agricultural fungicide that may be moderately toxic to fish. Amounts of ziram reported applied, primarily for pears, in Lake County were over 43,000 pounds in 2008, 8,761 pounds in 2009, and 419, 249 pounds in 2010.

Climate Change

Drought and global warming are ecological phenomena likely to impact the Clear Lake hitch increasingly in the future. Climate change - specifically an increase in global temperatures and average temperatures in western North America - is a very real threat to all native species, but in particular to those species that cannot migrate (such as fish confined to a lake and a small number of specific spawning streams).

Human-induced global warming has already contributed to the extinction of numerous species (Parmesan 2006). During the past century, global surface temperatures have increased by 1.1°F, but this trend has dramatically increased to a rate approaching 3.6°F/century during the past 25 years, the fastest rate of warming in the past 1,000 years (IPCC 2001). Continuation of current greenhouse gas emission trends are projected to raise the average global temperature by 3-4 degrees Celsius, leading to catastrophic extinction events, and even a hopeful scenario of limiting the increase to less than 1 degree Celsius will cause many species extinctions (Hansen et al. 2006). Models predict that 12-24% of all species globally will be driven to extinction if current warming trends continue (Thomas et al 2004; Malcolm et al 2006). Climate studies indicate that California is likely to see average annual temperatures rise by 3–4 degrees Fahrenheit over the next century, with winters 5–6 degrees and summers 1–2 degrees warmer (Field et al. 1999). Increased drought and significant changes in rainfall patterns are projected as a result of climate change (Field et al. 1999) and the magnitude and duration of regional droughts are expected to increase (IPCC 2001).

Climate changes are likely to negatively impact stream habitat for Clear Lake hitch, as there will be an increased risk of lowering of aquifers and the water table and of streams drying up earlier in the season, with the potential for spawning failures. Clear Lake hitch have evolved to make use of creeks and standing water before they dry up in the summer. Timing is vital, as hatchlings must be able to make their way back to creek deltas and nearshore environments of Clear Lake and sloughs before passage is no longer possible, and the adults must return to the lake environment after spawning. The primary threat to hitch, water availability in tributaries during spring spawning migrations, is likely to be exacerbated by a climatic shift towards greater aridity and/or variability in rainfall. Near complete spawning failure of hitch has been observed during dry years in the past (Murphy 1948, 1951; Moyle 2002). A long lifespan of 5 to 7 years may allow hitch populations to weather bad spawning years, but an increase in the length of dry seasons, especially for consecutive years, combined with increased mortality in the lake could result in extinction (Moyle et al, In Review). Climate change would presumably increase water temperatures and create lower lake levels on a more frequent basis, and could increase the range of water levels as well as the rate that water level changes. This could result in decreased water quality, less cover (tule beds), improved conditions for alien predators, and other factors that would have a negative effect on hitch in Clear Lake (Moyle et al, In Review). Climate change predictions also indicate that the frequency and intensity of winter storm events will increase, potentially increasing sedimentation, nutrient loading and pollution (from mine wastes) into Clear Lake (Suchanek et al. 2002). Prolonged drought in Lake County could potentially act in concert with one or more of the previously discussed threats to the species and exacerbate their effects on the Clear Lake hitch.

<u>Potential Loss of Genetic Integrity and Random Stochasticity</u>

Species for which population numbers fall below a critical level are subject to inbreeding and genetic drift. The resulting loss of genetic variation can result in depressed reproductive success and reduced ability to respond to changes in the physical environment, parasites, and disease. In turn, these effects can increase a population's risk of extirpation. It is unknown what the critical population size is for the Clear Lake hitch, but the dramatic reduction in range and abundance of hitch, as well as the confinement of significant spawning to only two streams, should be cause for alarm.

There is a substantial body of literature on the risks that small, isolated populations face, including environmental and demographic stochasticity (e.g. Gilpin and Soulé 1986, Goodman 1987, Mode and Jacobson 1987, Lande 1993). A small effective population size predisposes a population to a higher risk of extinction. It is a widely recognized ecological principle that, in general, small isolated or fragmented populations are more vulnerable to extinction than large ones (Pimm 1991; Noss and Cooperrider 1994). Noss and Cooperrider (1994) identified four major factors that predispose small populations to extinction: (1) environmental variation and natural catastrophes like unusually harsh weather, fires, or other unpredictable environmental phenomena; (2) chance variation in age and sex ratios or other population parameters (demographic stochasticity); (3) genetic deterioration resulting in inbreeding depression and genetic drift (random changes in gene frequencies); and (4) disruption of metapopulation dynamics (i.e., some species are distributed as systems of local populations linked by occasional dispersal, which wards off demographic or genetic deterioration).

III. CRITICAL HABITAT

Petitioners request that critical habitat for the Clear Lake hitch be designated concurrent with the listing, as required by 16 U.S.C. 1533(b)(6)(C). The Secretary of the Interior is required by the Endangered Species Act ("ESA") to designate critical habitat concurrent with a determination that a species is endangered or threatened (16 U.S.C. 1533(a)(3A)). Critical habitat is defined by Section 3 of the ESA as: "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species" (16 U.S.C. §1532(5)).

Designation and protection of critical habitat is one of the primary ways to achieve the fundamental purpose of the ESA, which is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved," (16 U.S.C. §1531(b)). In adding the critical habitat provision to the ESA, Congress clearly saw that species-based conservation efforts must be augmented with habitat-based measures: "It is the Committee's view that classifying a species as endangered or threatened is only the first step in insuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence . . . If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat" (House Committee on Merchant Marine and Fisheries, H.R. Rep. No. 887, 94th Cong. 2nd Sess. At 3 (1976)).

Clear Lake hitch will benefit from critical habitat designation in all of the ways described above. The added layer of protection provided by critical habitat will allow the FWS to designate reasonable and prudent alternatives to activities that are impeding recovery but not necessarily causing immediate jeopardy to the continued survival of the species. For these reasons we request that critical habitat designation be concurrent with listing.

Critical habitat should encompass all areas within the Clear Lake watershed necessary for the survival and recovery of the hitch, including essential habitat within Clear Lake itself and all current and potential spawning habitat and associated riparian corridors, upland buffers, and adequate near shore shallow-water habitat for juvenile hitch. At a minimum, critical habitat should consist of suitable and potential hitch spawning habitat in the following watersheds: Adobe, Alley, Burns Valley, Clover, Cole, Cooper, Copsey, Forbes, Hendricks, Highland Springs, Hill, Kelsey, Lyon, Manning, Middle, Morrison, Pool, Robinson, Schindler, Scotts, Seigler Canyon, Stokes, and Thompson creeks; McGaugh and Rodman sloughs; and Tulelake and its tributaries. Critical habitat should also include wetlands and marshlands with potential to serve as spawning or nursery habitat such as Anderson Marsh, wetlands around Clear Lake State Park, and the Siegler Creek and Kelsey Creek deltas.

IV. RECOMMENDED MANAGEMENT AND RECOVERY ACTIONS

The following management and recovery actions are recommended to benefit Clear Lake hitch:

List the hitch as a threatened or endangered species under the Endangered Species Act. Critical areas that require protection should be identified and designated as critical habitat. Spawning streams and marshy areas near the mouths of streams should receive special protection as hitch spawning and nursery areas. Develop a comprehensive basin-wide recovery plan for the species.

Human-made barriers across spawning streams that are presently insurmountable to hitch should be modified to facilitate the passage of hitch during spawning migrations. Potential barriers on the important spawning streams must be built with fish passageways of proven effectiveness for cyprinids. Remediation of barriers will require coordination with U.S. Fish and Wildlife Service, California Department of Fish and Game, Tribes, tribal organizations, Caltrans, Lake County and private landowners.

Determine the major causes of stream flow loss, with an emphasis on period of flow, for all streams and find ways to increase spawning opportunities for hitch. Water diversions, groundwater pumping, and or manipulation of tributary streams should be carefully evaluated with regard to their potential ecological effects on hitch and other aquatic organisms. Water diversions and pumping should be controlled such that they do not threaten the spawning runs. Groundwater use prior to and during hitch runs should also be evaluated and models developed to determine safe yields by water year type. Enforce regulations that prohibit illegal stream diversions and wells adjacent to streams, and establish stream gages where needed to monitor flows. Evaluation of water diversions and use would require close coordination by the Flood Control and Water Conservation District, the Lake County Planning Commission and state resource agencies such as California Department of Fish and Game, State Water Resources Control Board and the regional Water Quality Control Board.

Evaluate lake management impacts on hitch. Evaluate benefits of increasing cover in areas along the lakeshore, including expanding tule beds near the mouths of streams, allowing fallen trees to stay in the water, and other means of creating shoreline complexity. Determine if and how the management of Cache Creek Dam affects lake levels while juvenile hitch are rearing in tule beds along shore. If draw-down exposes hitch to increased predation by forcing them from this habitat, it should be halted until juvenile hitch have left the habitat voluntarily.

The impact of tributary dams and impoundments should be investigated. Manage upstream dams to retain some water for fish during the rainy season, for release to hitch spawning creeks during the dry season and periods of juvenile out-migration to Clear Lake, to ensure hitch can complete their life cycle in the creeks and enable recruitment of hitch to Clear Lake. This should be evaluated at Hill Spring Dam and Adobe Reservoir, which are upstream of Adobe Creek, the most promising spawning area in terms of hitch numbers and spawning capability.

Determine the direct and indirect effects of fisheries (including the commercial fishery) on hitch populations. This includes determining the impact of predation and competition from alien species on hitch populations.

Annual surveys of spawning runs should be continued and expanded, with a systematic monitoring and fish tagging program to record timing and abundance of spawning for all hitch streams. Statistical methods should be developed to better determine fish abundance and distribution and key spawning habitats. Between-spawn lake use should also be investigated, as should competitive interactions with other species.

Develop a systematic and coordinated research program on the biology of hitch. This should include a thorough life history investigation of the species and its needs in Clear Lake, as well as physiological studies to determine environmental tolerances including temperature, dissolved oxygen, and exposure to pollutants. Five Clear Lake tribes, the Robinson Rancheria, Habematolel Pomo of Upper Lake, The Elem Indian Colony, Scotts Valley Band of Pomo Indians and Big Valley Rancheria, have received Tribal Wildlife Grants and are collaborating on hitch studies. Tribal involvement in monitoring, educational, and recovery efforts is essential for the conservation of this species. Funding for this work and continued tribal participation in recovery and habitat restoration efforts should be expanded.

Develop ways to restore hitch spawning runs to historic spawning streams, through artificial rearing if necessary. Several tribes are researching and initiating a captive breeding program and a hatchery rearing facility, and Robinson Rancheria has a hatchery for hitch in its initial operating phase. Before hatchery programs are instituted careful consideration needs to be given to the impact of such a program, especially in light of recent results from salmonid fishes that show artificial propagation can significantly and permanently reduce fitness.

Restore Clear Lake hitch to the Blue Lakes, after first figuring out what caused their demise. Develop at least one back-up population of Clear Lake hitch as insurance against extinction of the lake population. Hitch could also be established in some large off-lake ponds for backup.

The impact of largemouth bass on hitch populations should be carefully investigated and if bass are determined to be a major source of mortality, an action plan to reduce bass predation should be implemented. Possible measures could be protection zones around the mouths of hitch spawning streams through improved habitat and seasonal trapping and removal of bass.

Expand existing informational campaigns to increase awareness of and pride for the Clear Lake hitch as a unique feature of the Clear Lake basin. Efforts should be made to educate the local communities about hitch, their importance as a California native and Clear Lake endemic, their role in local food chains (such as their probable importance as forage for breeding osprey), and their niche in the traditional culture of the local Native Americans.

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