

State of California
Department of Fish and Wildlife

Memorandum

Date: May ~~19~~²⁸, 2014

To: Sonke Mastrup
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director



Subject: **Status Review of Clear Lake Hitch**

The Department of Fish and Wildlife (Department) has prepared the attached Status Review for receipt by the Fish and Game Commission (Commission) at its June 4, 2014 meeting in Fortuna. This Status Review regards the proposal to list Clear Lake hitch (*Lavinia exilicauda chi*) as threatened pursuant to the California Endangered Species Act (CESA), specifically Fish and Game Code section 2074.6. At a future meeting, the Commission will consider the Status Review report and other relevant information it receives to determine whether there is sufficient information to indicate the petitioned action is warranted (Fish & G. Code § 2075.5). I look forward to discussing this issue and our recommendation at that future Commission meeting.

You will recall that on January 31, 2013, the Department recommended to the Commission that there was sufficient information in the petition to indicate that listing may be warranted. On March 6, 2013, the Commission voted to accept the petition and initiate a review of the status of the species in California. Upon publication of the Commission's notice of determination, the Clear Lake hitch was designated a candidate species on March 22, 2013.

Following the Commission's determination, the Department notified affected and interested parties and solicited data and comments on the petitioned action per Fish & G. Code section 2074.4 (see also Cal. Code Regs, Title 14 § 670.1 (f)(2)). Subsequently, the Department commenced its review of the status of the species as required by Fish & G. Code section 2074.6 and Cal. Code Regs, Title 14, section 670.1 (f)(2). The attached Status Review represents the Department's final written review of the status of Clear Lake hitch. In preparing the evaluation and recommendation, the Department adhered to its legal obligation to base the document upon the best scientific information available at the time of preparation (Fish & G. Code § 2074.6)

The Department has reviewed the scientific information as guided by CESA and concluded that several factors represent a threat to the continued existence of the species. The Department considers present or threatened modification or destruction of habitat, predation, and competition to threaten the continued existence of the species (Cal. Code Regs, tit. 14, § 670.1 (i)(1)(A)). In addition, the anticipated impacts from climate change on native aquatic species also may cause threats to the continued existence of the species.

Sonke Mastrup, Executive Director
Fish and Game Commission
May 19, 2014
Page 2

Having considered the CESA specific factors, the Department concludes that the best scientific information available to the Department indicates that the Clear Lake hitch's continued existence is threatened. It is the Department's recommendation that Clear Lake hitch is likely to become an endangered species in the foreseeable future in the absence of the protections and management efforts required by CESA, and the petitioned action is warranted.

If you have any questions or need additional information, please contact Dan Yparraguirre, Deputy Director, Wildlife and Fisheries Division at 916-653-4673 or Stafford Lehr, Chief, Fisheries Branch at 916-445-3181.

Attachment

ec: Dan Yparraguirre, Deputy Director
Wildlife and Fisheries Division
Dan.yparraguirre@wildlife.ca.gov

Stafford Lehr, Chief
Fisheries Branch
Wildlife and Fisheries Division
Stafford.lehr@wildlife.ca.gov

**State of California
Natural Resources Agency
Department of Fish and Wildlife**

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF CLEAR LAKE HITCH (*Lavinia exilicauda chi*)

May 2014



Clear Lake hitch adult. Photo courtesy of Rick Macedo

**Charlton H. Bonham, Director
California Department of Fish and Wildlife**



Report to the Fish and Game Commission
A STATUS REVIEW OF CLEAR LAKE HITCH

This page left blank intentionally

Table of Contents

LIST OF FIGURES.....	iii
LIST OF APPENDICES	iv
LIST OF ACRONYMS.....	v
EXECUTIVE SUMMARY	1
INTRODUCTION.....	3
Petition History.....	3
Department Review.....	3
BIOLOGY.....	5
Species Description	5
Taxonomy.....	5
Range and Distribution.....	6
Life History.....	8
Habitat that May be Essential to the Continued Existence of the Species	9
SPECIES STATUS AND POPULATION TRENDS.....	11
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE.....	21
Present or Threatened Modification or Destruction of Habitat	21
Spawning Habitat Exclusion and Loss.....	21
Overexploitation.....	33
Cultural Harvest.....	34
Predation and Competition	34
Disease and Parasites	36
Other Natural Occurrences or Human Related Activities	36
REGULATORY AND LISTING STATUS.....	39
Federal.....	39

State.....	39
Other Rankings	40
EXISTING MANAGEMENT EFFORTS.....	41
Resource Management Plans.....	41
Monitoring and Research	43
Habitat Restoration Projects	43
Impacts of Existing Management Efforts	43
SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE HITCH IN CALIFORNIA	45
Present or Threatened Modification or Destruction of Habitat	45
Overexploitation.....	46
Predation	46
Competition.....	46
Disease.....	47
Other Natural Occurrences or Human-related Activities.....	47
SUMMARY OF KEY FINDINGS.....	48
RECOMMENDATION FOR PETITIONED ACTION	49
PROTECTION AFFORDED BY LISTING	50
MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES	51
PUBLIC RESPONSE	52
PEER REVIEW.....	53
ACKNOWLEDGEMENTS.....	54
LITERATURE CITED	55

LIST OF FIGURES

Figure 1. Map depicting Clear Lake and tributaries.	7
Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and one data extrapolation.....	13
Figure 3. The number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013.	15
Figure 4. Summary of Clear Lake Hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010.	16
Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001.	18
Figure 6. Photo from 1890s depicting spawning fish being stranded in Kelsey Creek.	20
Figure 7. Clear Lake levels from 1990 to 2012 recorded at U.S. Geological Survey storage gage 11450000.	23
Figure 8. Clear Lake hitch spawning barriers located on tributaries throughout the watershed.....	26
Figure 9. Average January through June flows on Kelsey Creek as recorded at USGS Station 11449500.	28

LIST OF APPENDICES

Appendix A. Summary graphs of spawning observations between 2005 and 2013.

Appendix B. Figures depicting CLH observations on spawning tributaries.

Appendix C. Description of barriers associated with CLH spawning tributaries.

Appendix D. Comments from affected and interested parties on the petitioned action.

Appendix E. Comments from peer reviewers on the Status Review report.

LIST OF ACRONYMS

AMP	Adaptive Management Plan
BLM	U.S. Bureau of Land Management
BMPs	best management practices
CAP	Conceptual Area Protection Plan
CCCC	California Climate Change Center
CCCLH	Chi Council for Clear Lake Hitch
CDFG	California Department of Fish and Wildlife (formerly Game)
CDFW	California Department of Fish and Wildlife
CEPA	California Environmental Protection Agency
CESA	California Endangered Species Act
CLH	Clear Lake hitch
CLIWMP	Clear Lake Integrated Watershed Management Plan
cm	centimeters
CPUE	catch per unit effort
DDD	dichlorodiphenyldichloroethane
EPA	U.S. Environmental Protection Agency
EPEC	Erosion Prevention and Education Committee
GIS	geographic information system
IBI	index of biological integrity
KHV	koi herpes virus
LCVCD	Lake County Vector Control District
NEPA	National Environmental Policy Act
NGO	non-governmental organization
OHV	off-highway vehicle
RREC	Robinson Rancheria Environmental Center

SL	standard length
SSC	species of special concern
TMDL	total maximum daily load
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
YCFCWCD	Yolo County Flood Control and Water Conservation District

Executive Summary

EXECUTIVE SUMMARY

On September 25, 2012, the Fish and Game Commission (Commission) received the petition from the Center for Biological Diversity to list Clear Lake Hitch (*Lavinia exilicauda chi*) (CLH) as threatened under the California Endangered Species Act (CESA) (Center for Biological Diversity 2012). The Commission accepted the Petition on March 6, 2013 and that action initiated the status review that culminated in this document.

The Clear Lake hitch (CLH) is a native minnow of the cyprinid family (Cyprinidae) that can be found only in Clear Lake, Lake County, CA. They ascend tributaries between February and June each year to spawn. Juvenile CLH migrate to the lake and remain near shore as they grow to adults, at which time they migrate to open water where physical adaptations allow for a limnetic lifestyle.

Historically, native fishes were abundant at Clear Lake. Accounts from Pomo tribe members and early European settlers speak of runs of native fish so thick the creeks were difficult to ford. Pomo tribes used CLH for food as well as trade for supplies unavailable to them in their native lands. Tribal members speak of capturing and drying thousands of fish per year to use as food and for trade.

Qualitative information indicates that both the number of spawning individuals and the number of occupied spawning tributaries are greatly reduced from historical levels. There is no quantitative scientific information over a long term, thus population trends are based on a combination of qualitative surveys conducted over the past 60 years.

This qualitative survey information indicates the population of CLH has fluctuated over the past century and the number of spawning tributaries used by CLH has fluctuated as well. This information adds to uncertainties about possible cause and effect relationships among and between CLH and threats to their continued existence.

The Department considers that there is sufficient scientific information to indicate that several factors are threats to the continued existence of CLH. Present or threatened modification or destruction of habitat is impacting the ability of CLH to spawn and rear young. Spawning tributaries and rearing habitat have been degraded by the creation of barriers to spawning areas, diversion of water for municipal and agricultural use, removal and redistribution of substrate for mining, impaired water quality from the introduction of excess nutrients and contaminants, and the removal of wetland habitat around the shoreline. Predation and competition with non-native fishes is impacting the ability of CLH to survive and reproduce. CLH are vulnerable to predation from a variety of non-native fishes that have been introduced for recreational fisheries. Sport fishes such as black bass, sunfish, and catfish are known to prey on all life stages of CLH. Clear Lake hitch must compete directly with non-native fishes for access to spawning area, rearing habitat, and food resources. Qualitative information indicates that a

Executive Summary

primary driver for CLH population fluctuations may be competition with other non-native limnetic foragers in the lake. In addition, the anticipated impacts from climate change on native aquatic species also may cause threats to the continued existence of the species.

There is no scientific information indicating other factors, such as overexploitation, disease, and other natural occurrences or human-related activities, are threats to the continued existence of the species.

The Department has provided a list of management actions to improve the likelihood of the continued existence of CLH, including the need for: a scientifically valid population estimate or index; a thorough assessment of barriers to fish movement on primary spawning streams; an analysis of spawning habitat in primary spawning streams and recommendations for restoration actions; a review of reservoir operations at Highland Springs, Adobe Creek, and Kelsey Creek detention dams to assess water release operations that may be impacting CLH including development and implementation of guidelines for minimizing impacts and, other specific actions that could improve the status of CLH.

The Department provides this status review report to the commission based on the best scientific information available pursuant to Fish and Game Code section 2074.6. Based on the best scientific information available to the Department, the Department recommends that the petitioned action to list CLH as threatened under CESA is warranted at this time.

INTRODUCTION

This Status Review report addresses the Clear Lake hitch (*Lavinia exilicauda chi*) (CLH), which is the subject of a petition to list the species as threatened under the California Endangered Species Act (CESA) (Fish & G. Code § 2050 *et seq.*).

Petition History

On September 25, 2012, the Fish and Game Commission (Commission) received a petition from the Center for Biological Diversity (Petitioner) to list the CLH as a threatened species under CESA.

On September 26, 2012 the Commission sent a memorandum to the California Department of Fish and Wildlife (Department, CDFW, and CDFG) referring the petition to the Department for its evaluation.

On October 12, 2012, as required by Fish and Game Code, section 2073.3, notice of the petition was published in the California Notice Register (Cal. Reg. Notice Register 2012, Vol. 41-Z, p.1502).

On December 12, 2012 the Commission granted a 30-day extension on the submission date for the Department's Initial Review of Petition to List the CLH as threatened under CESA.

On January 31, 2013, the Department provided the Commission with its Initial Review of Petition to List the CLH as threatened under CESA. Pursuant to Fish and Game Code, section 2073.5, subdivision (a) (2), the Department recommended that the petition provided sufficient information to indicate the petitioned action may be warranted.

On March 6, 2013 at its scheduled public meeting in Mt. Shasta, California, the Commission considered the petition, the Department's petition evaluation and recommendation, and comments received, and found that sufficient information existed to indicate the petition may be warranted and accepted the petition for consideration.

Subsequently, on March 22, 2013 the Commission published its Notice of Findings for CLH in the California Regulatory Notice Register, designating the CLH as a candidate species (CA Reg. Notice Register 2013, Vol. 12-Z p. 488).

Department Review

Following the Commission's action to designate CLH as a candidate species, the Department notified affected and interested parties and solicited data and comments on

Introduction

the petitioned action, pursuant to Fish and Game Code, section 2074.4 (see also Cal. Code Regs., Title 14, § 670.1(f)(2)) (CDFW 2013). All comments received are included in Appendix D to this report. The Department commenced its review of the status of the species as required by Fish and Game Code section 2074.6.

The Department sought independent and competent peer review, on its draft Status Review report, by scientists with acknowledged expertise relevant to the status of CLH. Appendix E contains the specific input provided to the Department by the individual peer reviewers, as well as a brief explanation on the evaluation and response to the input and any amendments made to the draft Status Review report (Fish & G. Code § 2074.6; Cal. Code Regs., Title 14, § 670.1(f)(2)).

BIOLOGY

Species Description

Clear Lake hitch is a member of the cyprinid family, growing to 35 centimeters (cm) standard length (SL), and with laterally compressed bodies, small heads and upward pointing mouths (Moyle et al. 1995). They are separated from other California minnows by their long anal fin consisting of 11 to 14 rays. The dorsal fin (10 to 12 rays) originates behind the origin of the pelvic fins. Juvenile CLH are silvery with a black spot at the base of the tail. As CLH grow older the spot is lost and they appear yellow-brown to silvery-white on the back. The body becomes deeper in color as the length increases (Hopkirk 1973; Moyle 2002). CLH show little change in pigmentation during the breeding season (Hopkirk 1973). The deep, compressed body, small upturned mouth, and numerous long slender gill rakers (26 to 32) reflect the zooplankton-feeding strategy of a limnetic (well-lit, surface waters away from shore) forager (Moyle 2002). This lake adapted subspecies also has larger eyes and larger scales than other hitch subspecies.

Taxonomy

Hopkirk (1973) described CLH as a lake-adapted subspecies based primarily on the greater number of fine gill rakers. CLH are distinguished from other subspecies of hitch by their deeper body, larger eyes, larger scales and more gill rakers (Hopkirk 1973). Recent research on 10 microsatellite loci supports Hopkirk's description of CLH as a distinct subspecies (Aguilar and Jones 2009). However, mitochondrial DNA analysis was not able to distinguish CLH as a distinct subspecies from other hitch in California (Aguilar and Jones 2009). Yet, based upon the morphological and microsatellite analysis there is sufficient evidence to warrant the designation of CLH as a distinct subspecies of hitch (Hopkirk 1973; Moyle et al. 1995; Aguilar and Jones 2009).

CLH can hybridize with other Cyprinidae species and hybridization is known to occur with the genetically similar California roach (*Lavinia symmetricus*) (Miller 1945b; Avise and Ayala 1976; Moyle and Massingill 1981; Moyle et al. *in review*). However, there is no documentation of these hybrids in Clear Lake or its tributaries. CLH were known to hybridize in Clear Lake with the now extinct thickettail chub (*Gila crassicauda*) (Moyle et al. *in review*).

Biology

Range and Distribution

The entire CLH population is confined to Clear Lake, Lake County, California, and to associated lakes and ponds within the Clear Lake watershed such as Thurston Lake and Lampson Pond (Figure 1). Populations previously identified in the Blue Lakes, west of Clear Lake, have apparently been extirpated (Macedo 1994).

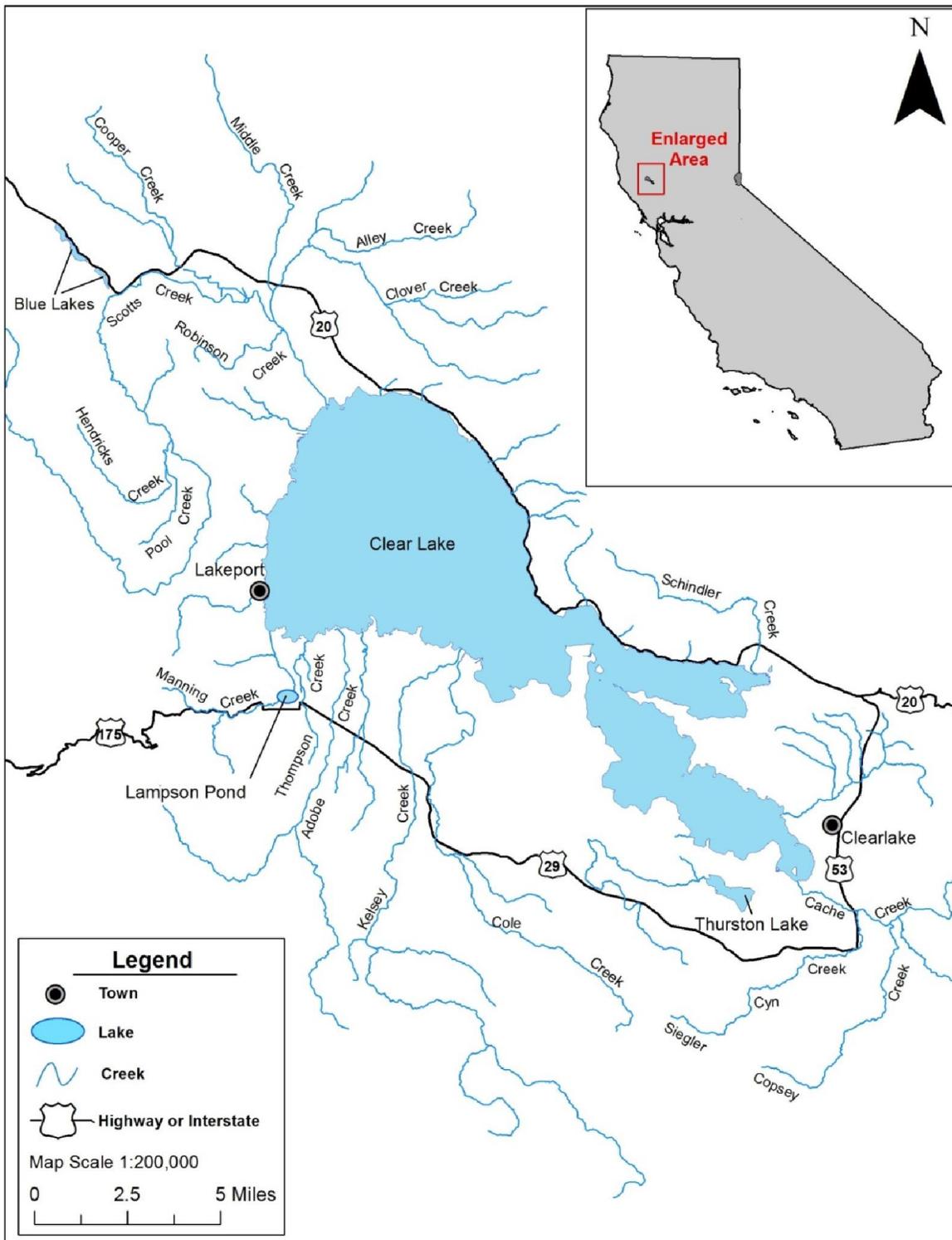


Figure 1. Map depicting Clear Lake and tributaries.

Life History

Physical adaptations to lake conditions allow CLH greater than 50 mm SL to feed largely on water fleas (*Daphnia* spp.) (Geary 1978; Geary and Moyle 1980; Moyle 2002). Stomach analysis indicates that CLH feed primarily in the day rather than at night (Geary 1978). Juveniles less than 50 mm SL are found in shallow, littoral zone (near-shore) waters and feed primarily on the larvae and pupae of Chironomidae; planktonic crustaceans including the genera *Bosmina* and *Daphnia*; and historically on the eggs, larvae, and adults of Clear Lake gnat (*Chaoborus astictopus*) (Lindquist et al. 1943; Geary 1978; Geary and Moyle 1980). Growth in CLH is faster and total size greater than that of other hitch sub-species (Nicola 1974). By three months CLH have reached an average of 44 mm SL and will continue to grow to between 80 and 120 mm by the end of their first year (Geary and Moyle 1980). Females mature in their second or third year, whereas males tend to mature in their first or second year (Kimsey 1960). Scale analysis indicates CLH live up to 6 years but it is likely that some individuals live longer (Moyle 2002). Females grow faster and are larger at maturity than males (Hopkirk 1973; Geary 1978; Ringelberg and McGinnis 2009). The larger size of CLH in comparison to hitch from other locations translates to greater fecundity. Accordingly, spawning females in Clear Lake average 36,000 eggs each year (Geary and Moyle 1980) compared to an average of 26,000 eggs for hitch in Beardsley Reservoir (Nicola 1974).

Clear Lake tributaries are numerous and located around the lake basin (Figure 1). Most streams have headwaters located at higher elevations in surrounding foothills; others have headwaters in lower elevations of the basin, and nearly all are low gradient in their lower reaches as they enter the lake. Some streams are more substantial than others and may have flowing water year round. However, most are seasonal, becoming disconnected with isolated pools by late spring, and are dry during summer months. Those that retain water year round often have long stream sections that are ephemeral. CLH spawn in these low-gradient tributary streams to Clear Lake and have spawning migrations that resemble salmonid runs. Spawning migrations usually occur in response to heavy spring rains, from mid-February through May and occasionally into June (Murphy 1948b; Kimsey 1960; Swift 1965; Chi Council for Clear Lake Hitch (CCCLH) 2013 (unpublished data)). During wet years, CLH spawning migrations may also opportunistically extend into the upper reaches of various small tributaries, drainage ditches, and even flooded meadows (Moyle et al. *in review*). CLH have also been observed spawning along the shores of Clear Lake, over clean gravel in water 1 to 10 cm deep where wave action cleans the gravel of silt (Kimsey 1960). The success of these spawning events is not clearly understood and may be limited due to losses from egg desiccation and predation on eggs and larvae (Kimsey 1960; Rowan, J. personal communication, October 10, 2013, unreferenced).

CLH spawn at water temperatures of 14° to 18°C in the lower reaches of tributaries. Egg deposition occurs along margins and mid-channel of streams in very shallow riffles

Biology

over clean, fine-to-medium sized gravel (Murphy 1948b; Kimsey 1960, Taylor, T., personal communication, February 10, 2014, unreferenced). Eggs are fertilized by one to five males as they are released from the females (Murphy 1948b; Moyle 2002). Eggs are non-adhesive and sink to the bottom after fertilization, where they become lodged among the interstices in the gravel. The eggs immediately begin to absorb water and swell to more than double their original size. This rapid expansion provides a protective cushion of water between the outer membrane and the developing embryo (Swift 1965) and may help to secure eggs in gravel interstices. The embryos hatch after approximately 7 days, and the larvae become free-swimming after another 7 days (Swift 1965). Larvae must then move downstream to the lake before stream flow disconnects with the lake (Moyle 2002).

Within Clear Lake, larvae remain near shore and are thought to depend upon stands of tules (*Schoenoplectus acutus*) and submerged weeds for cover until they assume a limnetic lifestyle (CDFG 2012). Juvenile CLH require rearing habitat with water temperatures of 15° C or greater for survival (Moyle 2002; Franson 2012 and 2013). Juveniles are found in littoral shallow-water habitats and move into deeper offshore areas after approximately 80 days, when they are between 40 and 50 mm SL (Geary 1978; CDFG 2012). Adult CLH are usually found in the limnetic zone of Clear Lake. The limnetic feeding behavior of adult fish is supported by stomach analysis of CLH where very little content of benthic midges was found, even though the fish were collected in the profundal (deep-water) habitat during the survey (Cook et al. 1964). Additional data collected by the Department during the early 1980s indicate CLH are present in the littoral zone from April to July and are scarce in this habitat during other months (Week 1982).

Adult CLH are vulnerable to predation during their spawning migration by many species including mergansers (*Mergus* spp.), herons (*Ardea* spp.), bald eagles (*Haliaeetus leucocephalus*), other birds, river otter (*Lontra canadensis*), northern raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*) (Bairrington 1999). In addition, CLH have been recovered from the stomachs of black bass (*Micropterus* spp.) caught in the lake (Bairrington 1999).

Habitat that May be Essential to the Continued Existence of the Species

Fish and Game Code section 2074.6 requires that a Status Review report include preliminary identification of the habitat that may be essential for the continued existence of the species. At various life stages CLH use stream and lacustrine (lake) habitat present in the watershed (Figure 1). Adult fish spawn in some tributaries of the lake during the spring and juvenile fish emerge from the tributaries and utilize near shore habitat to continue growth and seek refuge from predators. As juveniles mature into adults they move to the main body of the lake and assume a limnetic lifestyle until returning to spawn in the tributaries or shoreline the following spring. The use of

Biology

tributaries varies from year to year based on habitat conditions present during the spawning period.

SPECIES STATUS AND POPULATION TRENDS

Assessing the status of CLH should include statistically valid population estimates conducted over time, to provide population data and trends. CLH studies to date have consisted primarily of qualitative sampling and are not suitable for deriving population estimates; however, these study results can provide insight into the current status of the species.

The population trends for this Status Review report focus on three sets of data available to the Department for analysis. Commercial catch records, submitted to the Department by operators on Clear Lake, contain incidental catch information on CLH dating back to 1961. Operators were required to keep records of CLH caught incidentally while operations focused on other species in the lake. The Lake County Vector Control District (LCVCD) has been conducting sampling efforts along the shoreline of Clear Lake since 1987. Although sampling efforts are not specific to CLH, incidental data on CLH captured during each sampling were recorded. The CCCLH spawning observation data have been collected by volunteers since 2005. Spawning observation data provides an estimate of the number of CLH in any given spawning tributary during the observation period. Results are summarized by the CCCLH each year following the completion of the spawning season. Information on population trends prior to 1961 is focused on small sampling efforts, published articles, and traditional ecological knowledge from tribal members. Although not quantifiable these data provide an idea of the status and distribution of CLH prior to larger qualitative sampling efforts.

Environmental conditions required for successful spawning and biological impacts to the survivorship of CLH are highly variable from year to year and often result in multiple years with reduced numbers of fish observed spawning or reduced recruitment into the population. The information presented in Figure 2 comes from three qualitative sampling efforts conducted at Clear Lake and an extrapolation of data provided in Bairrington (1999). Trend data in commercial catch records were represented for a given year by totaling the number of CLH captured per year and dividing by the number of days commercial operations occurred. Commercial catch data are comprised primarily of adult CLH. The CLH spawning trend data were calculated by totaling the number of CLH observed and dividing by the number of observation periods. LCVCD data on CLH captures represent the total number of CLH captured per year. LCVCD data are considered to be comprised primarily of juvenile CLH. The data represented in Table 6 of Bairrington (1999) were calculated by using 20,000 as a total catch baseline for percent of total catch for CLH. This graph does not reflect population numbers but rather trends in the abundance of CLH in any given year. As a proxy for changes in an established population size, biologists often use qualitative information as an indicator of population trends.

Species Status and Population Trends

The trends of all data show a highly variable population that responds both positively and negatively to environmental parameters and varies significantly from year to year. It is likely that a combination of environmental factors is impacting the CLH population. The fluctuating abundance trend has continued throughout the duration of the qualitative sampling efforts and indicates CLH populations have at times been extremely low and at other times relatively high.

Species Status and Population Trends

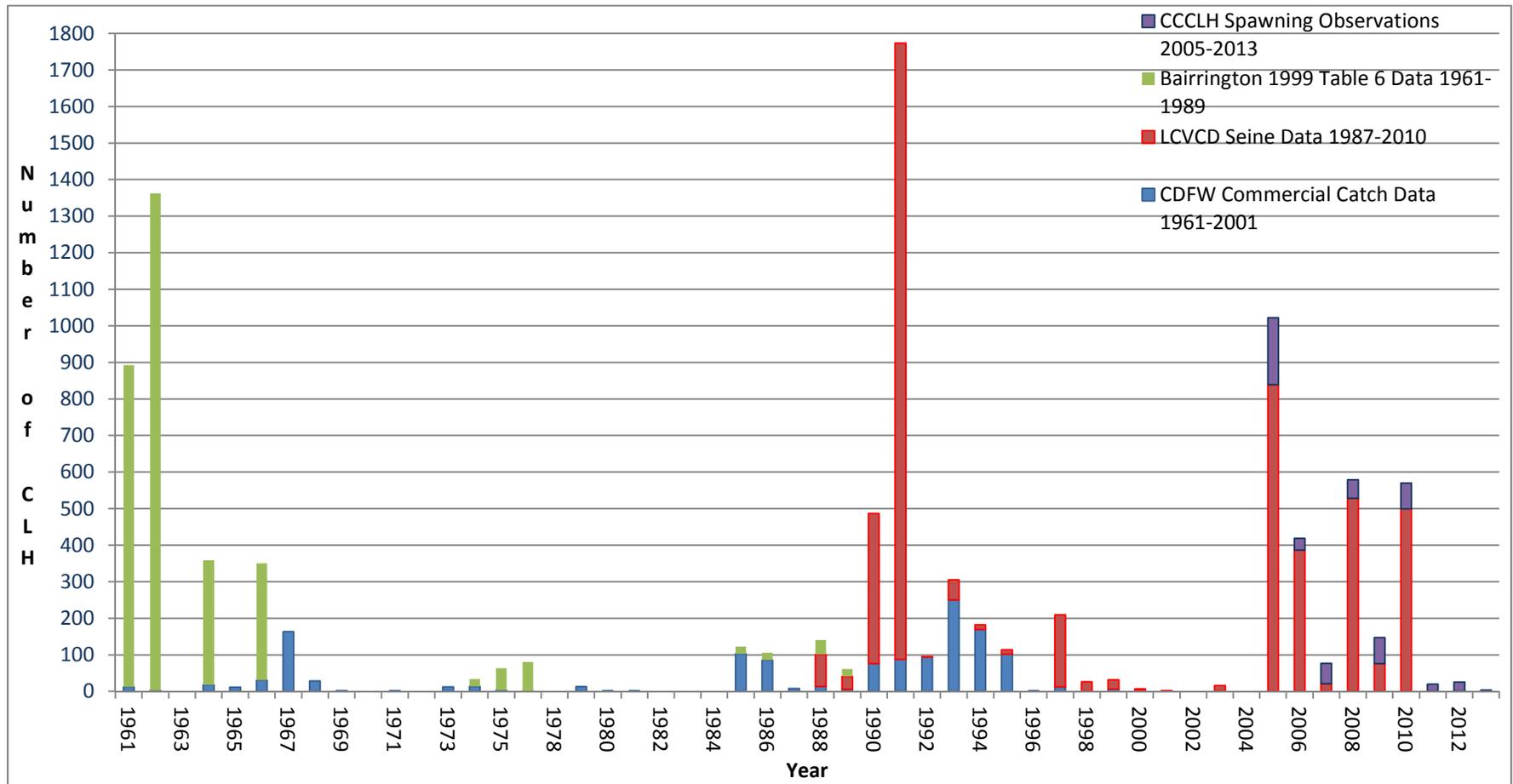


Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and one data extrapolation.

Species Status and Population Trends

In 2013 the Department conducted a mark-and-recapture study to gain a better understanding of the CLH spawning population in Cole and Kelsey creeks. Unfortunately, too few individuals were marked and recaptured to give a statistically valid population estimate (Ewing 2013). Electrofishing surveys in June 2012 identified thousands of young of year CLH in near shore habitats along the southwestern shoreline of Clear Lake (CDFG 2012). Volunteers with the CCCLH conducted direct observations of CLH in spawning tributaries of Clear Lake in 2013, and spawning observations identified less than 500 CLH present (CCCLH 2013). Of those fish, 300 to 400 CLH were found below the Kelsey Creek detention dam. No single day count totaled more than 70 fish in any spawning tributary in 2013 (CCCLH 2013).

CCCLH qualitative spawning observations between 2005 and 2013 indicated peak single day CLH spawning counts of 1,000 to 5,000 fish (CCCLH 2013), and daily observation averages ranged from 3.5 to 183.1 fish (Figure 2). However, these observations make no distinction between previously counted fish, and it may be more prudent to look at fixed location single day counts from this time period. Additionally, numbers of spawning fish moving at night and during high turbidity events cannot be accounted for by these observations. The highest number of CLH observations recorded was approximately 5,000 during 2005; concurring with beach seine data that demonstrate a higher than average number of CLH caught in 2005 as well (CCCLH 2013; LCVCD 2013). The increased number of CLH in 2005 is the likely reason for the increase in spawning observations between 2007 and 2009. Appendix A contains summary graphs and figures, prepared by CCCLH, for observations made between 2005 and 2013.

There is sufficient information from these spawning observations to suggest the number of spawning tributaries being used by CLH decreased in 2013 compared to the average from 2005 to 2012 (Figure 3) (CCCLH 2013). However, the data limitations do not allow for quantitation of observation time on each creek (survey effort) compared with the number of fish observed to aid in understanding the extent of use in each tributary. The years with reduced numbers of tributaries with spawning observations also coincide with dry years when stream flows were reduced. In dry years it is likely only tributary streams with larger watersheds maintain sufficient flow for spawning. Years with the highest number of tributaries being used for spawning coincide with years when stream flows were at or above normal for the spawning period. A comparison between Figure 2 and Figure 3 shows some correlation between the number of spawning tributaries and the abundance of CLH in observational and capture surveys indicating more recruitment in years with increased tributary occupancy. Appendix B contains figures depicting the decline in annual spawning runs in Clear Lake tributaries between 2005 and 2013 (CCCLH 2013). Historic accounts and habitat suitability predications suggest that CLH originally spawned, to some degree, in all the tributaries to Clear Lake (Robinson Rancheria Ecological Center (RREC) 2011). However, reports on Pomo geography speak of Pomo tribes in the area travelling to Kelsey Creek to capture CLH and even of war when a tribe tried to divert Kelsey Creek to gain control of the important CLH supply

Species Status and Population Trends

(Barrett 1906; Kniffen 1939). Based on these reports it is unclear to what extent CLH spawned in other tributaries to Clear Lake. It can be surmised the largest CLH spawning run occurred in Kelsey Creek during this period. Over the past eight years the number of occupied spawning tributaries has decreased from a high of 12 in 2006 to three in 2013 (CCCLH 2013). Currently, Adobe Creek seems to have the largest spawning run in the Clear Lake watershed while Kelsey and Cole creeks support smaller spawning runs. Based on historical accounts and current data the primary spawning tributary has shifted from Kelsey Creek to Adobe Creek (Kniffen 1939; CCCLH 2013).

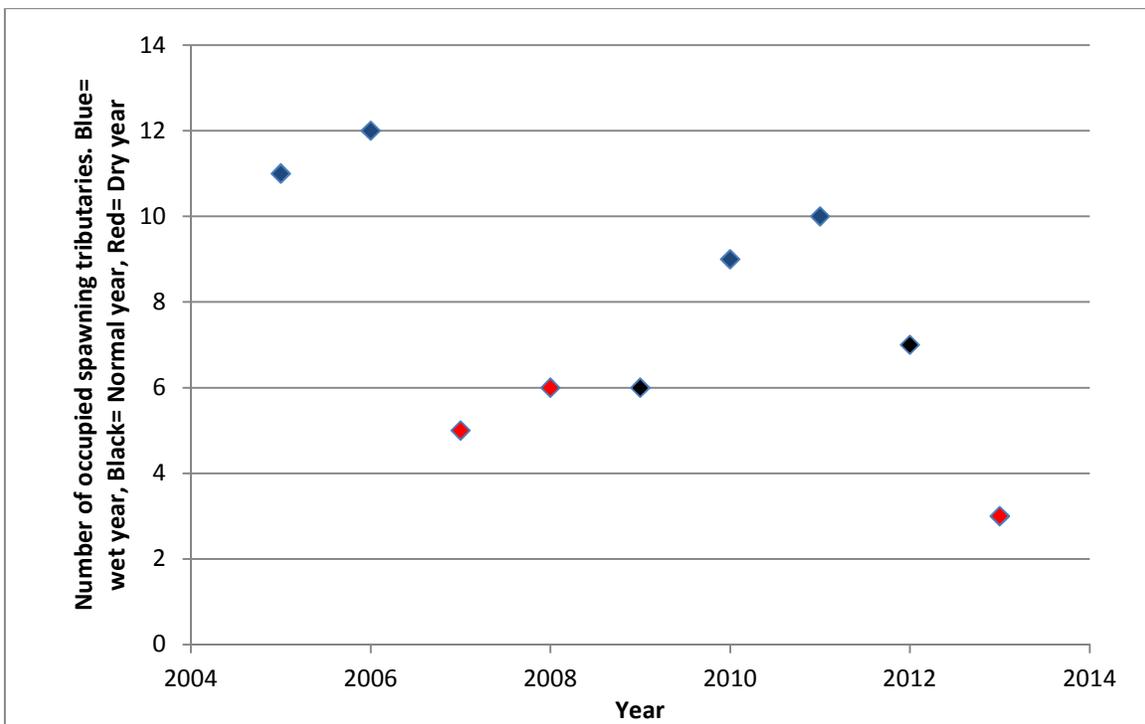


Figure 3. The number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013.

LCVCD has been collecting beach seine data at various sites around the lake for more than two decades. The sampling is designed to measure abundance of threadfin shad (*Dorosoma petenense*) and Mississippi silversides (*Menidia audens*) as part of a Clear Lake gnat (*Chaoborus astictopus*) surveillance program. Incidental captures of CLH are recorded during these surveys; however, the data collected are not appropriate for a statistically valid evaluation of CLH populations as the sampling was not designed for this purpose. Additionally, sample locations are in areas that contain open unvegetated beaches that are not preferred habitat for CLH. Although surveys were not conducted to assess CLH, capture data for these surveys are consistent with other data sources in

Species Status and Population Trends

demonstrating a population that has poor recruitment in many years interspersed with few years of high levels of recruitment (Figure 4) (LCVCD 2013). In most years less than 100 CLH are captured during the surveys (17 of 24 years). Four of the six years when more than 100 CLH were captured were between 2005 and 2010. The greatest numbers of CLH were captured in 1991, a year that was described by the Department as a boom for juvenile fish in the lake (Bairrington 1999). Commercial fisheries data from 1991 also indicate an increase in CLH numbers captured during operations; over 6,000 CLH were captured and released by commercial fishery operators between March and May of 1991 (CDFW Commercial Fisheries Data). Data from the early 1990s also indicate an increase in zooplankton and macroinvertebrate numbers and a decline in threadfin shad and Mississippi silverside abundance resulting in increased available forage for CLH (Eagles-Smith et al. 2008; Winder et al. 2010).

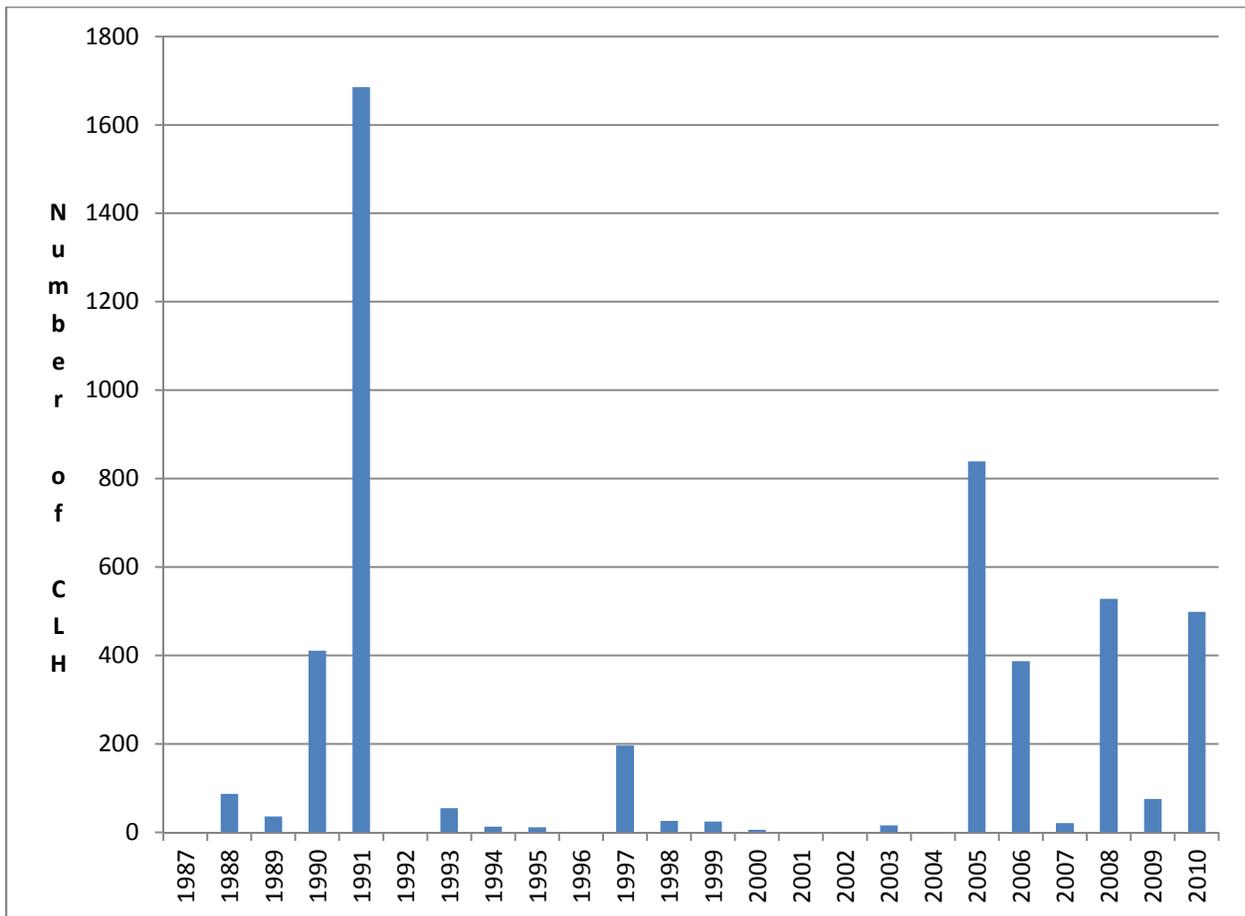


Figure 4. Summary of Clear Lake Hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010.

Species Status and Population Trends

The data available to the Department that cover the greatest timeframe come from commercial harvest records for Clear Lake. The data begin in 1961, continue through 2001, and provide estimates of CLH numbers captured incidentally during operations (Figure 5). Multiple times throughout the past 50 years the number of CLH captured has surpassed 10,000. There are also several years where CLH were almost or entirely absent from sample collections. These data suggest that CLH are able to sustain a population through multiple years, of either one or both, suppressed spawning and recruitment.

Species Status and Population Trends

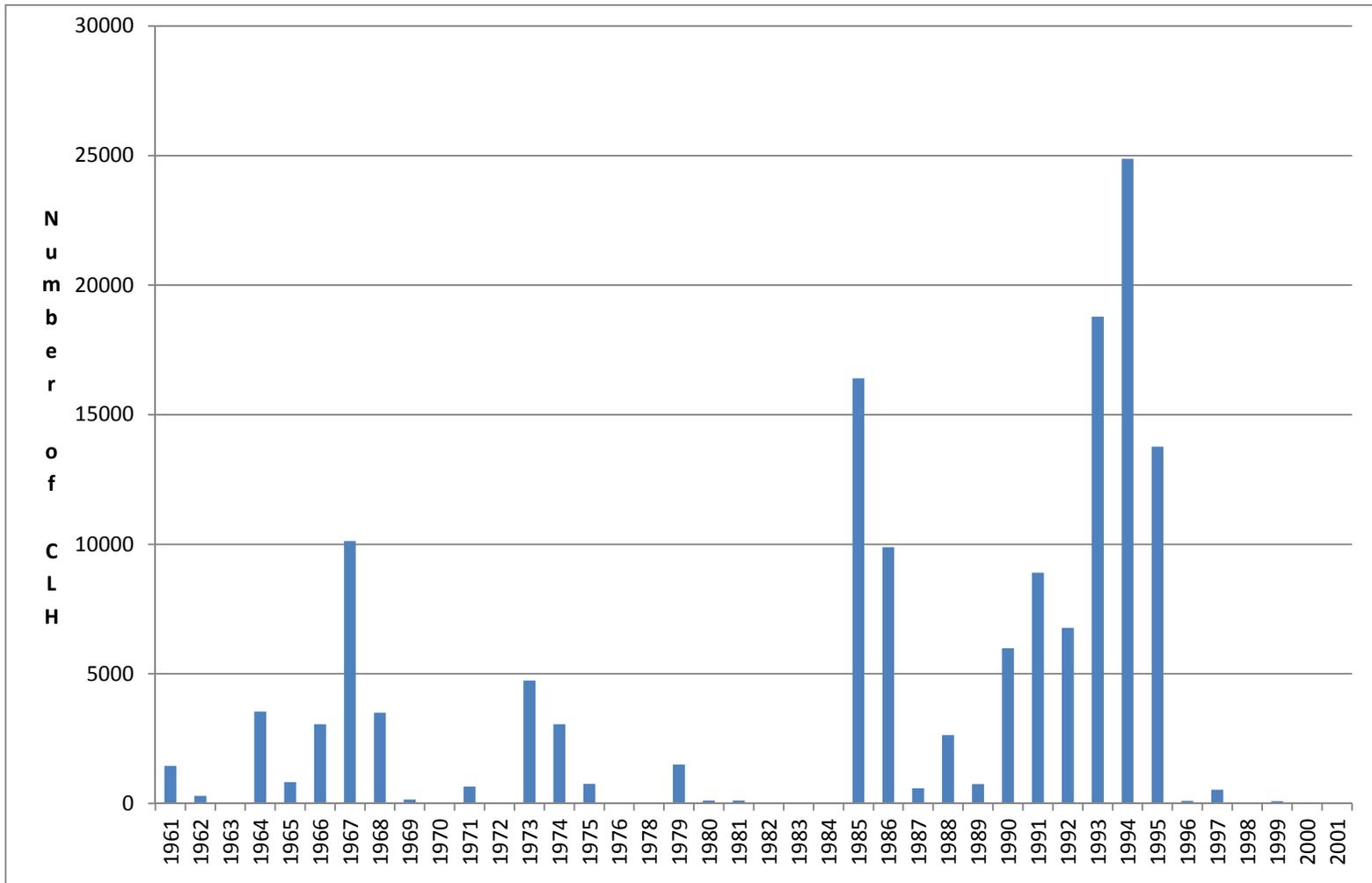


Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001.

Species Status and Population Trends

In the 1980s, the Department began various sampling at Clear Lake to assess fish assemblages, distribution, and occurrence in the lake. Electrofishing surveys found adult CLH occupying littoral habitat between April and July each year (Week 1982). The surveys were directed towards littoral zone use and provide no information on CLH outside of those months (Week 1982). An electrofishing survey was completed in April of 1987, and CLH was the most abundant fish sampled at locations around Rattlesnake Island and Clearlake Oaks subdivision; however, only a total of 52 CLH were captured during the survey (CDFG 1988). It must be noted that this sampling was on a very small scale, was targeting black crappie (*Pomoxis nigromaculatus*), and occurred in habitats where CLH would likely be found during this time period. Additional spring and fall electrofishing surveys between 1995 and 2006 found CLH to be the most abundant native fish, but the overall capture numbers were relatively low with a peak catch per unit effort (CPUE) of only 0.087 for juvenile fish in the fall of 2000 and 0.169 for adult fish in the spring of 1999. CPUE's were based on the number of fish caught per minute of electrofishing (Cox 2007). Electrofishing surveys conducted during late June 2007 reported low numbers of CLH recorded during the survey (Rowan 2008). The low numbers of CLH may be attributed to the sampling timeframe of late June. As noted in Cook et al. 1964, CLH were absent from littoral zone sampling following the start of summer. In an effort to reduce impacts to CLH while sampling, the Department's Clear Lake surveys between 2008 and 2012 were all confined to the timeframe of late June and July when CLH numbers are greatly reduced in the littoral zone.

As late as 1972, CLH and other non-game fish were described as comprising the bulk of the Clear Lake fishery (Puckett 1972). The Lake County Mosquito Abatement District conducted surveys between 1961 and 1963 examining the relationship between fish and midges. These surveys identified CLH as the third most abundant fish in the lake. The majority of CLH were captured in the littoral and profundal zones using gill nets. However, the limnetic zone was not sampled since midges do not occur in this area. A total of 1,229 fish was taken during these surveys (Cook et al. 1964).

Field notes from CDFG biologists in 1955 note CLH runs with large numbers in Kelsey Creek (CDFG 1955). Similar notes from 1956 indicate spawning CLH in Kelsey Creek as numbering in the hundreds and Seigler Creek containing 400 CLH for every 100 feet of stream above the Anderson Brothers ford (CDFG 1956). CLH were the second most abundant fish caught during various gill net surveys in the lake at that time (Lindquist et al. 1943). Surveys conducted between 1938 and 1941, for examination of fish and gnat interactions, described the runs of Clear Lake splittail (*Pogonichthys ciscoides*) and CLH as numbering in the tens of thousands (Lindquist et al. 1943). A photograph from 1890 depicts a spawning run so thick that fish formed a blanket across the creek (Figure 6). The photo likely shows a run of fish comprised of different Cyprinid species. Early stories from the area depict tales of fish so thick that streams were difficult to ford by horses and wagons, and residents shoveled spawning fish to bring home for hog feed (Rideout 1899). The volume of dead fish found during spawning runs on Clear Lake tributaries created a stench that was intolerable to lakeshore residents (Dill and

Species Status and Population Trends

Cordone 1997). Livingston Stone (1876), who lived on the lake in 1872 and 1873, stated “They ran up the streams in spring to spawn in countless numbers”. It is not entirely clear if spawning runs such as those depicted in Figure 6 occurred every year or fluctuated based on tributary flows, but it is likely they fluctuated in a similar fashion to what was observed during the past decade of CCCLH spawning surveys. Regardless, the body of evidence lends support for claims of CLH as common and the most abundant fish in Clear Lake during the late nineteenth and early twentieth centuries (Coleman 1930; Jordan and Gilbert 1894).

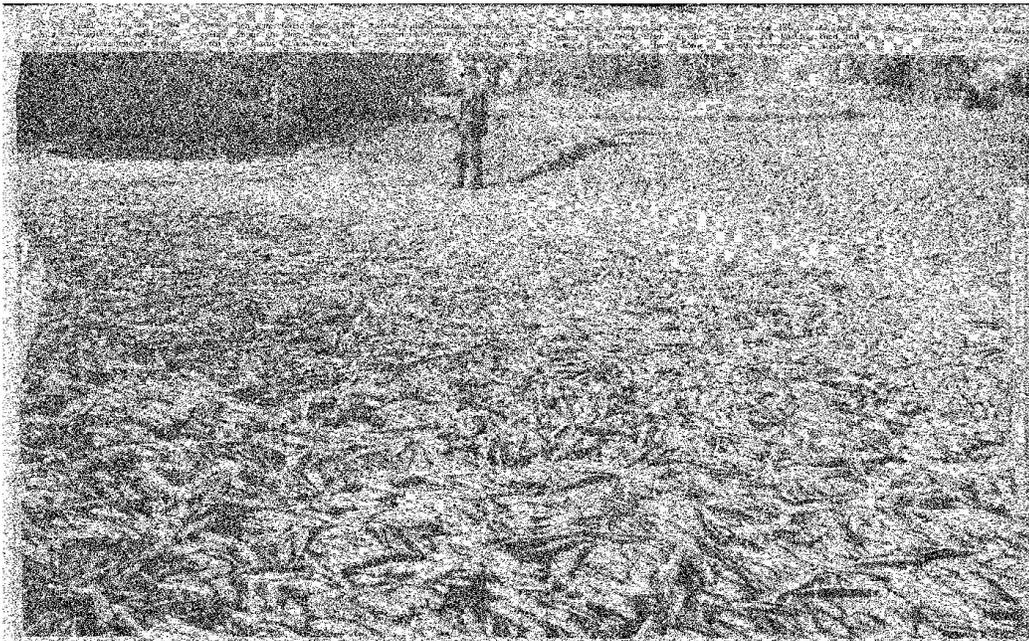


Figure 6. Photo from 1890s depicting spawning fish being stranded in Kelsey Creek.

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Present or Threatened Modification or Destruction of Habitat

Wetland Habitat Loss

Wetlands provide critical rearing habitat for juvenile fishes native to Clear Lake (Geary 1978; CDFG 2012). Wetlands are those areas near shore or adjacent to tributaries that are inundated with shallow water and contain emergent vegetation. Prior to the arrival of European settlers in the mid-1800s, Clear Lake was surrounded by large tracts of wetlands. Throughout the expansion of European settlement around the lake, the wetland habitat was drained and filled to provide urban and agricultural lands. Currently, the Clear Lake watershed contains over 16,000 acres of land dedicated to agricultural production, of which a portion comes from reclaimed wetlands (Lake County Department of Agriculture 2011; Forsgen Associates Inc. 2012). Comparisons of historical versus current wetland habitat reveal a loss of approximately 85%, from 9,000 acres in 1840 to 1,500 acres by 1977 (Week 1982; Bairrington 1999; Suchanek et al. 2002; Lake County Department of Public Works 2003; Giusti 2009; CEPA 2012). Loss of wetland habitat coupled with competition for existing habitat with introduced fishes has led to a decline in available rearing habitat for juvenile CLH (Week 1982).

Spawning Habitat Exclusion and Loss

Dams, Barriers, and Diversions

Cache Creek Dam was constructed at the outlet of Clear Lake in 1915, and Yolo County Flood Control and Water Conservation District (YCFCWCD) manipulates the lake water level several feet seasonally to allow irrigation diversion (CDWR 1975). Clear Lake is allowed to fluctuate on a yearly basis a maximum of 7.56 feet above a mean level plane referred to as the "Rumsey gage" (CDWR 1975). The fluctuations in water level at Clear Lake are not as extreme as traditional reservoirs that can fluctuate tens to hundreds of feet per year. In most years the lake is at its highest level between January and May and if full on May 1, water withdrawals may occur during the summer months. As a result of water withdrawals the lake is usually at its lowest level in October or November prior to the start of the rainy season (Figure 7) (County of Lake 2013). The effects of lake water manipulations on CLH populations have not been quantified but is likely less than those effects would be if Clear Lake was a traditional reservoir. However, manipulation of water levels in the Clear Lake watershed likely results in decreased water quality, a reduction in spawning and rearing habitat, and increased risk of predation (Converse et al. 1998; Wetzel 2001;

Factors Affecting the Ability to Survive and Reproduce

Gafny et al. 2006; Cott et al. 2008; Hudon et al 2009). All of these impacts can lead to the extinction of native species that evolved in lakes free of habitat modifications resulting from impoundment structures (Wetzel 2001). Impounded systems also tend to be dominated by non-native species (Moyle and Light 1996).

Factors Affecting the Ability to Survive and Reproduce

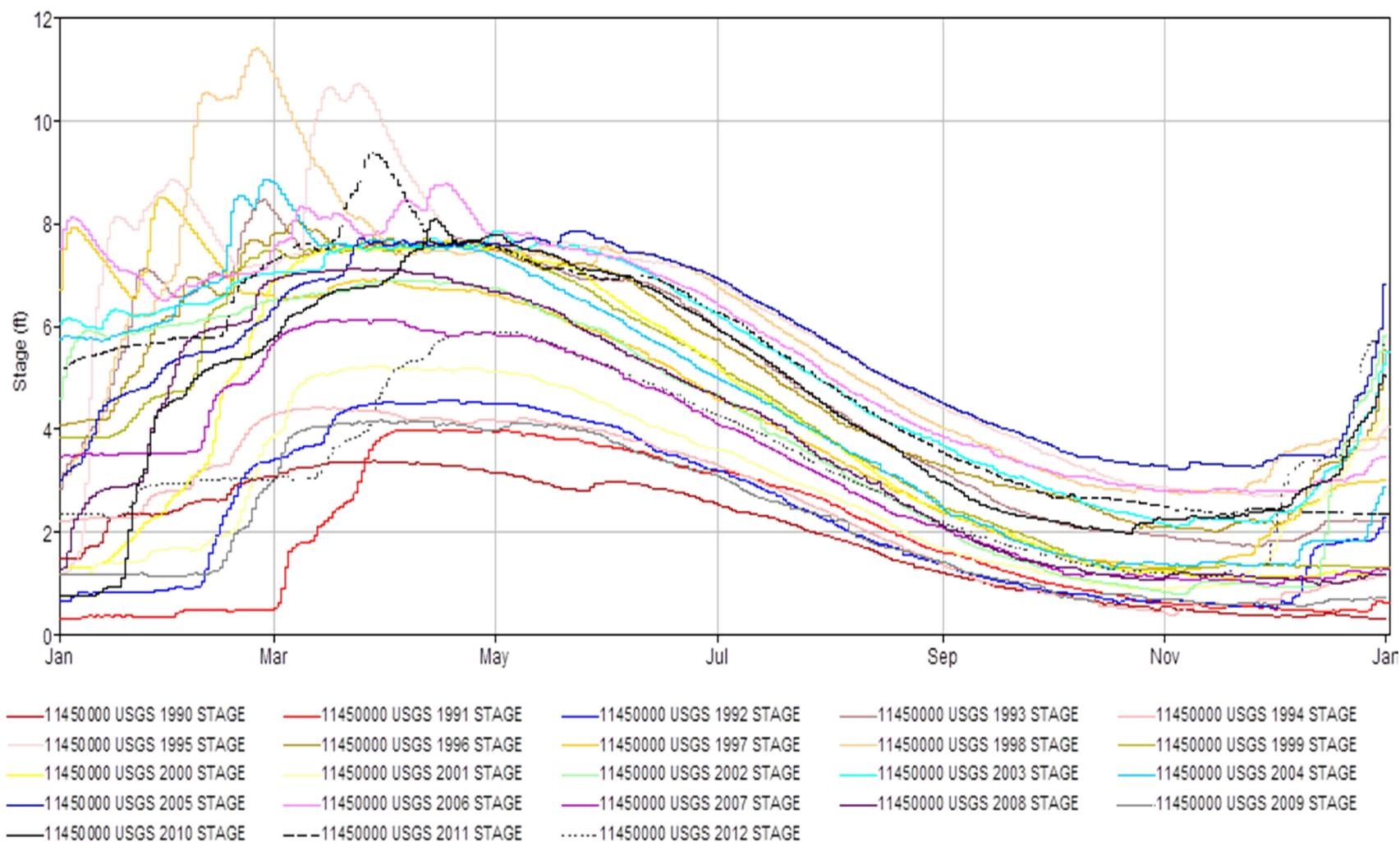


Figure 7. Clear Lake levels from 1990 to 2012 recorded at U.S. Geological Survey storage gage 11450000.

Factors Affecting the Ability to Survive and Reproduce

CLH spawn in low-gradient tributary streams to Clear Lake. All of the tributary streams to Clear Lake have been altered to various degrees by dams, barriers, and diversions. Dams, barriers, and diversions consist of manmade structures or habitat modifications that impede the passage of fish; these can be the result of flood control, construction, water diversions, vegetation removal, sedimentation, or any other modification to the existing habitat. Stream alterations can block migratory routes and impede passage necessary for adults to reach spawning areas and for larval fish to gain access to the lake. The result can be direct loss of spawning and rearing habitat, loss of nursery areas or loss of access to these areas, increases in predation, and decreased water quality (Murphy 1948 and 1951; Moyle 2002;). A limited biological survey was conducted in 2013 on the lower reaches of Adobe, Kelsey, Manning, Middle, and Scotts creeks. Results indicate all of the areas surveyed had low Index of Biological Integrity (IBI) scores and are either partially or not supportive of aquatic life (Mosley 2013). Examples of alterations to Clear Lake tributaries that have impacted CLH include agricultural irrigation pumps and diversions, aggregate mining activity, flood control structures, road crossings, bridge aprons, and off-highway vehicle (OHV) use (McGinnis and Ringelberg 2008).

It is clear that Adobe Creek, Highland Creek, Middle Creek, Clover Creek, and Kelsey Creek have experienced a reduction in fish spawning habitat and access to spawning habitat since the installation of dams and increased irrigation (Murphy 1951; Macedo 1994; McGinnis and Ringelberg 2006). In 2006, a barrier assessment was completed for Middle Creek and the Kelsey Creek fish ladder (McGinnis and Ringelberg 2006). The assessment found physical barriers associated with bridge aprons and weirs as well as habitat barriers from historical gravel operations that removed riparian vegetation, redistributed substrate, and altered flows (McGinnis and Ringelberg 2006). The Kelsey Creek fish ladder was found to be insufficient for passage of CLH as the jump heights and velocities found at the ladder were too great for CLH. Spawning observations by CCCLH from 2005 to 2013 witnessed fish stranded below barriers within the watershed (CCCLH 2013).

Many Clear Lake tributaries are no longer used for spawning or have reduced spawning runs as a result of artificial structures that continue to impede spawning migrations (Figure 8). While some operational and physical modifications to these structures have been implemented over the years, they continue to prevent spawning CLH from accessing spawning habitat, especially during dry years when spring flows are low.

In preparation of this report, the Department estimated the loss of CLH spawning and rearing habitat due to constructed barriers and impediments within the tributaries of Clear Lake (Figure 8). The barrier assessment determined the approximate locations of barriers and estimated miles of stream habitat as determined from the California Native Diversity Database, CDFW Geographic Information System, CDFW Fish Passage Assessment Database, California

Factors Affecting the Ability to Survive and Reproduce

geographic information system (GIS) street layer, and Google Earth Maps. Using that data, the Department estimated 180 stream miles were historically available to spawning CLH and that barriers have eliminated or reduced access to more than 92% of the historically available spawning habitat. Physical barriers, such as the footings of bridges, low water crossings, dams, pipes, culverts, and water diversions in Kelsey, Scotts, Middle, Clover, and other creeks interrupt or eliminate migration to spawning areas (McGinnis and Ringelberg 2008). Appendix C contains a list of several tributaries and some of their associated barriers.

Factors Affecting the Ability to Survive and Reproduce

Water is frequently diverted from Clear Lake tributaries, during the CLH spawning season, under riparian and water rights associated with land ownership in the watershed. These water diversions consist of direct diversion from surface water intake pumps and from shallow off-channel wells that capture underflow from adjacent channels. The primary purpose of water diversions from Clear Lake tributaries is for agricultural production, frost protection, various forms of irrigation, and domestic water supply. Water diversions for frost protection have been shown to temporarily reduce in-stream flow by as much as 95% (Deitch et al. 2009). Natural flow regimes are thought to favor the success of native fishes over non-native fishes (Marchetti and Moyle 2001). No studies on water diversions in tributaries have been completed and the impact on CLH spawning tributaries is poorly understood. A review of stream flow data recorded at U.S. Geological Survey station 11449500 (Figure 9), on Kelsey Creek, was conducted to determine if monthly average flows correlated with either increases or decreases in CLH observations or captures. There does not appear to be a strong correlation with increased flows February through April and increases in CLH observations or captures. The highest number of CLH were captured in 1990 and 1991, which were dry water years with lower than average flows during the spawning season. From 1993 to 1995 CLH captures continued to decline even though the flows were average to above average during the spawning season. The flows presented in Figure 9 are averages for each month and may not accurately display the variability of day-to-day flows on all Clear Lake tributaries and do not take into account water diversions downstream of the gaging station. In some tributaries, water diversion has contributed to early drying of stream reaches and desiccation of CLH eggs masses and newly hatched juveniles (Macedo, R., personal communication, November 25, 2013, unreferenced). Additionally, significant flow reductions can lead to increased water temperatures, reduced available aquatic habitat, altered or decreased biodiversity, increases in non-native species, and alterations to fish assemblages (Marchetti and Moyle 2001; Bunn and Arthington 2002; Bellucci et al. 2011).

The impacts of spawning habitat alterations to CLH may be inferred by the fate of another native Clear Lake fish that required tributaries for spawning; the Clear Lake splittail was last recorded in 1972 (Puckett 1972). The Clear Lake splittail formerly spawned later in the season than did CLH, and the drying up of tributaries contributed to its demise (Moyle 2002). Cook et al (1966) noted the Clear Lake splittail “underwent a drastic reduction in the 1940s” and feared it “may disappear if increased demands upon the water further limit reproductive success”. All stream spawners had “declined precipitously” by 1944 (Murphy 1951). Therefore, earlier drying of tributaries by both natural and anthropogenic processes likely impacts the CLH population.

Factors Affecting the Ability to Survive and Reproduce

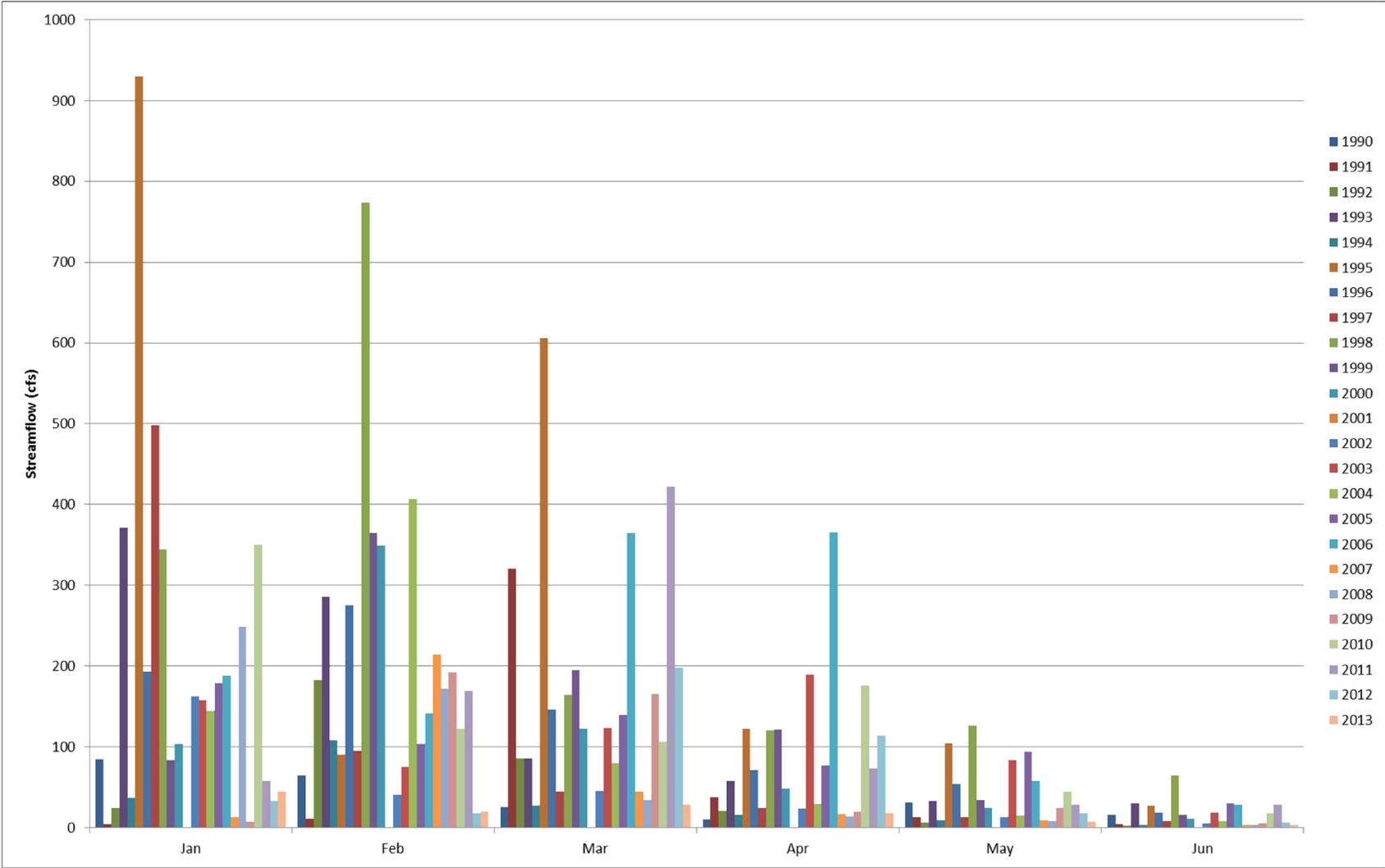


Figure 9. Average January through June flows on Kelsey Creek as recorded at USGS Station 11449500.

Factors Affecting the Ability to Survive and Reproduce

Dredging and Mining

Since the first European settlers arrived at Clear Lake and began gravel mining and dredging operations, there have been documented deleterious effects on the watershed (Suchanek et al. 2002). Field notes from CDFW personnel conducting stocking assessments document Kelsey Creek so loaded with silt from gravel operations that creek visibility was zero (CDFG 1955). Smaller scale mining and dredging in tributary streams has occurred since early settlement and has altered the amount and distribution of stream gravels (Thompson et al. 2013). In some tributaries, gravel extraction has resulted in the incising and channelization of the streams, streambed elevation levels have also downcut by as much as 15 feet (Suchanek et al. 2002; Eutenier, D. April 17, 2013 comment letter). After 1965 about one million metric tons of gravel product per year was removed from the watershed until the partial moratorium on aggregate mining in 1981 (Richerson et al. 1994). Gravel was removed from Clear Lake tributaries to provide road base for new roads created to accommodate the expanding population of the area (Suchanek et al. 2002). Currently, approximately 5,000 cubic yards of gravel are removed annually from Scotts Creek and 58 acres in the Clear Lake watershed are used for quarries, strip mines, and gravel pits (Forsgren Associates Inc. 2012).

Many areas along the tributaries to Clear Lake were channelized in response to frequent flooding during the late winter and early spring (Maclanahan et al. 1972; U.S. Army Corps of Engineers 1974). As a result of gravel extraction and channelization, some areas were covered with riprap or confined by levees to prevent further erosion and flooding. Erosion problems have contributed to sediment entering Clear Lake and providing increased phosphorous loads that impair water quality (Richerson et al. 1994). Gravel extraction results in channelization, down cutting of the stream banks, decreases in suitable spawning habitat, increasing flow velocities and amount of coarse material that passes through the system (Brown et al. 1998).

Water Quality Impacts

The Clear Lake watershed has seen a significant increase in the amount of contaminants entering the lake over the past 75 years (Richerson et al. 1994). An increase in agriculture, mining, and a shift to an urban environment, has resulted in adverse water quality impacts in the lake (Mioni et al. 2011; California Environmental Protection Agency [CEPA] 2012).

Sediment

Erosion from construction, dredging, mining, agriculture, OHV use, grazing, and urbanization has resulted in increased sediment loads to the Clear Lake watershed (Forsgren Associates Inc. 2012). Increased sediment loads transport nutrients, particularly phosphorous, into Clear Lake. Increased sediment loads also reduce

Factors Affecting the Ability to Survive and Reproduce

spawning habitat quality by increasing substrate “embeddedness” (Mosley 2013). During the late 1990s and early 2000s soil erosion and sedimentation became an increasing problem as existing agricultural lands were converted to vineyards (Forsgren Associates Inc. 2012). From 2002 to 2011 vineyard acreage in the Clear Lake watershed increased from approximately 5,500 acres to 8,000 acres (Lake County Department of Agriculture 2011).

Nutrients

Development and expansion of agriculture in the Clear Lake watershed during the late 1890s until present day reclaimed the lake’s natural wetland filtration system for agricultural use. An increase in agricultural production and a decrease in wetland filtration increased nutrient flows into Clear Lake. Wetland reclamation projects altered the transport of sediment and nutrients, particularly phosphorous, into Clear Lake, resulting in an increase in noxious cyanobacteria blooms that cover the lake in warmer months (Suchanek et al. 2002). As a result of continued water quality issues, Clear Lake was added to the Clean Water Act Section 303(d) list of impaired water bodies in 1988 (CEPA 2010 and 2012). In recent years, noxious cyanobacteria blooms have at a minimum remained constant and may have increased (CEPA 2012).

Cyanobacteria

Cyanobacteria blooms have occurred at Clear Lake since the mid-1900s. Studies indicate an increase in phosphorous was the driver behind water quality impairments and noxious cyanobacteria blooms (Horne 1975; Richerson et al. 1994; CEPA 2012). The blooms originally consisted primarily of *Microcystis*, but in recent years the blooms have been attributed to both *Microcystis* and *Lyngbya*. These taxa represent both non-nitrogen fixing (*Microcystis*) and nitrogen fixing (*Lyngbya*) cyanobacteria and raise concerns that both phosphorous and nitrogen entering the lake that need to be controlled (Mioni et al. 2011; CEPA 2012). Cyanobacteria blooms have the ability to both directly and indirectly impact CLH by direct interference with the growth of *Daphnia*, a limnetic organism that is a food source for adult CLH, and interference with food web efficiency. No studies have been conducted at Clear Lake to quantify the impact of cyanobacteria blooms on the ecosystem, but studies conducted at other water bodies with varying degrees of cyanobacteria blooms provide information on their impacts to the aquatic environment. Cyanobacteria blooms reduce the amount of light penetration in the water column and cause a reduction in producers that are unable to reposition themselves to gain more light (Havens 2008). Primary producers such as epiphyton, benthic algae, and rooted vascular plants have a reduced ability to function in the ecosystem as a result of cyanobacteria blooms. As the cyanobacteria alter the nutrient cycle of the lake they replace the producers in space and mass. The expanding cyanobacteria begin to deplete CO₂ from the water body, which increases

Factors Affecting the Ability to Survive and Reproduce

pH and reduces growth of other producers (Havens 2008). The decreased CO₂ and increased pH can create surface scums and result in mortality of fishes, including CLH. In the summer of 1969, a large fish die off, due to heavy cyanobacteria growth and low oxygen levels, was reported at Clear Lake. An estimated 170,000 fish died, consisting primarily of carp, CLH, and blackfish (CDFG News Release 1969). Sub-lethal and lethal effects of toxins released during cyanobacteria blooms are also seen in fish and their associated food web (Havens 2008).

On September 19, 2007, the U.S. Environmental Protection Agency (EPA) approved a control program as a nutrient Total Maximum Daily Load (TMDL) for Clear Lake with the goal of reducing point and non-point source phosphorous entering the lake (CEPA 2012). Sources for phosphorous entering the lake include agricultural and urban runoff, timber harvest, road maintenance, construction, gravel mining, dredging, and fire. Other potential sources of phosphorus from home fertilizers, marijuana culture, sewer, and septic systems cannot be quantified.

Pesticides and Herbicides

To allow for increased yields on agricultural land and to prevent nuisance insect species around the lake, pesticides became commonplace during the early and mid-1900s. Between 1949 and 1957, an important food source of juvenile CLH, the Clear Lake gnat, was targeted with the pesticide dichlorodiphenyldichloroethane (DDD). During these years it is estimated that 99% of the gnat larvae in the lake were killed. Concentrations of DDD were magnitudes higher in invertebrates, fish, and birds than in the surrounding water in which they were found (Lindquist and Roth 1950; Rudd 1964). Sampling conducted during the late 1950s identified CLH, as well as other fish species, contaminated with DDD (Hunt and Bischoff 1960). Contamination levels ranged from 5.27 to 115 parts per million for edible flesh of sampled fishes (Hunt and Bischoff 1960). CLH were at the lower level of DDD (10.9 to 28.1 parts per million for edible flesh content) contamination than other Clear Lake fishes (Hunt and Bischoff 1960). The application of DDD in the Clear Lake watershed resulted in the first major ecological disaster related to the use of pesticides at the lake and the first records of bioaccumulation in the wildlife of the lake (Suchanek et al. 2002).

Following the resurgence of gnat populations in response to growing resistance to DDD, two additional measures were taken to reduce the gnat population. Gnat eggs were targeted with a petroleum product (Richfield Larvicide), and adult gnats were targeted at roosting locations with malathion (Suchanek et al. 2002). Additional applications of methyl parathion were also made in 1962 (Suchanek et al. 2002). Clear Lake gnats are still present at the lake, but populations are significantly reduced from historical levels. The likely cause of the reduced population of gnats is introduced fishes, primarily Mississippi silversides (Suchanek et al. 2002). In 2010 and 2012 Clear Lake gnat populations reached levels not observed in decades.

Factors Affecting the Ability to Survive and Reproduce

These gnat population booms appeared to coincide with years of low population levels of Mississippi silversides (Scott, J. 2013 personal communication, Aug 1, 2013, unreferenced). Qualitative sampling data on CLH do not allow for a direct comparison of CLH numbers in years with increases in the gnat population.

In recent years, two herbicides, Komeen™ (copper sulfate) and SONAR™ (fluridone), have been used to manage the *Hydrilla verticillata* infestation of the lake. Applied concentrations of Komeen do not kill fish directly; however, the impacts to macroinvertebrates may indirectly impact CLH populations (Bairrington 1999). These herbicides also pose a threat to non-target vascular aquatic plants, such as tules and submerged vegetation, which juvenile CLH require for habitat. As noted previously, there has already been a significant reduction in wetland habitat around the lake, and any additional reductions would further limit the amount of habitat available for CLH. Initial studies indicate a reduction in tule habitat following Sonar applications (Bairrington 1999). Environmental monitoring of eradication activities in 1996 and 1997 found that invertebrate species declined within the treatment area but rebounded quickly following the toxicity decay of the herbicide (Bairrington 1999). Post-treatment electrofishing surveys noted an increase in the number and abundance of fish species.

Mercury

Mining operations within the watershed contributed to sulphur and mercury contamination in Clear Lake. The Sulphur Bank Mercury Mine began operations in 1865 and ended in 1957 (Osleger et al. 2008; Giusti 2009). Originally the mine focused on extracting sulfur, but as operations continued into the late 1920s and the sulfur was found to be contaminated with mercury sulfide, operations switched to extracting mercury from the large-scale open-pit mine (Giusti 2009). As a result of contamination, the mine was classified as an EPA Superfund Site in 1990 (Suchanek et al. 1993). The mine is thought to have contaminated the lake with both mercury and arsenic (Suchanek et al. 1993). Studies have found the mercury concentrations in sediment to be high (over 400 ppm) in the vicinity of the mine, decreasing as distance from the mine increases (Suchanek et al. 2002). The mine continues to produce low pH acid mine drainage that delivers sulfate to the lake. Over the past decade, the EPA has taken several actions to remediate contamination from the mine. These include erosion control measures, removal of contaminated soil, storm water diversion, and well capping (U.S. EPA 2012).

During the 1970s, elevated concentrations of mercury were found in the fish of the lake (Curtis 1977). High levels of mercury accumulation can lead to significant impacts to the reproductive success of fishes and can result in reduced brain function, altered size and function of gonads and reduced gamete production (Sandheinrich and Miller 2006; Crump and Trudeau 2009). In 2003, a mercury TMDL was developed for Clear Lake to reduce methylmercury in fish by reducing

Factors Affecting the Ability to Survive and Reproduce

overall mercury loads to Clear Lake (CEPA 2010). The level of mercury found in CLH was 0.19 ug/g, and all other fish were between 0.06 and 0.32 ug/g (CEPA 2002), which resulted in health advisories on their consumption, but are below acute toxicity thresholds (Harnly et al. 1997). Mercury levels are close to the effect thresholds for reproduction and growth for fathead minnow (0.32-0.62 ug/g) and rainbow trout (National Oceanic and Atmospheric Administration [NOAA] 2011). Concentrations with no effect on rainbow trout growth and development are 0.02-0.09 ug/g (NOAA 2011). Lacking specific studies on CLH, based on effect levels for fathead minnows and rainbow trout, it is possible that CLH may be experiencing sub-lethal chronic and reproductive effects from mercury contamination.

Overexploitation

Commercial Harvest

Commercial fish harvest at Clear Lake occurred from the early 1900s through 2007. However, catch records are only available for a portion of the harvest period. Harvested fish were distributed to fish markets in California for sale for human consumption and animal feed. Prior to 1941, the majority of commercial operations centered on harvesting catfish (*Ictalurus* or *Ameiurus* spp.) from the lake. Although exact numbers are unavailable, it is likely that large numbers of catfish were taken during this period (Bairrington 1999). In 1942 commercial harvest of catfish was banned at Clear Lake. Beginning in the 1930s commercial harvest focused on Sacramento blackfish (*Orthodon microlepidotus*), a native species, and common carp (*Cyprinus carpio*), a non-native species. From 1932-1962 the annual average catch rate was 295,000 pounds for the commercial fishery (Bairrington 1999). A ratio of 1.33:1 for blackfish to carp was the average during commercial fishing operations (Bairrington 1999). In 1976 the only recorded capture and sale of CLH for commercial purposes was submitted to the Department, a total of 1,550 pounds was reported captured and sold at market that year (CDFW Commercial Fisheries Data). This is the only instance in the records of CLH being captured for commercial sale, primarily due to lack of interest and low sale price for the species. By 1960 commercial fishing operators were required to count and release all bycatch from commercial operations. CLH were found in large numbers some years and were recorded and returned to the lake when captured (Figure 5; CDFW Commercial Fisheries Data). The Department has received no commercial permit applications for operations on Clear Lake over the past several years. The lack of permit applications indicates that at this time commercial fishing operations at Clear Lake have ceased (CDFW Commercial Fishing Permit Data).

Factors Affecting the Ability to Survive and Reproduce

Cultural Harvest

Clear Lake hitch are culturally significant to several Pomo tribes that inhabit the Clear Lake watershed. Two Pomo tribes fought a war over Kelsey Creek and its important CLH supply (Barrett 1906; Kniffen 1939). Historically, large runs of CLH provided a staple food source for the local tribes (RREC 2011). During spawning runs, CLH were captured by constructing a series of dams in the creeks from which the fish were then scooped with baskets. The fish were cured to provide a food source throughout the year (Kniffen 1939). Historical accounts from tribal members speak of CLH being easy to find as they spawned in large numbers in the tributaries to the lake (Scotts Valley Band of Pomo Indians historical accounts 2013). There are no estimates of the number of CLH that were taken for cultural harvest during any specific timeframe. However, an account from a tribal member indicates that a single family would take a couple thousand fish during the spawning run (Big Valley Environmental Protection Agency 2013). Tribal accounts indicate the harvest of CLH continued until the decline in spawning runs in the mid-1980s (Big Valley Environmental Protection Agency 2013). Prior to designation of CLH as a candidate species for listing, regulations in the Clear Lake watershed allowed for the harvest of CLH in spawning tributaries by hand or hand-held dip net. In 2013 the Department issued to three tribes CESA Memoranda of Understanding, pursuant to Fish and Game Code, section 2081, subdivision (a), to collect CLH for scientific research and public education (Kratville, D. personal communication, October 7, 2013, unreferenced).

Predation and Competition

Non-native fish introductions into Clear Lake date back as far as the late 1800s (Dill and Cordone 1997). Prior to the introduction of non-native fish species, between 12 and 14 native fish species occupied Clear Lake (Bairrington 1999; Moyle 2002; Thompson et al. 2013). Currently, approximately ten native species and 20 non-native species inhabit the lake (Bairrington 1999; Thompson et al. 2013). Over the past 100 years two native species, thicketail chub (*Gila crassicauda*) and Clear Lake splittail, have gone extinct from the lake and another, Sacramento perch (*Archoplites interruptus*), has not been captured in sampling efforts since 1996 (Bairrington 1999; CDFW Commercial Fisheries Data; Thompson et al. 2013). The majority of non-native species introductions have been conducted by the Department and various local agencies and angling groups in an effort to increase sport fish opportunities. Introductions of fish at Clear Lake have been warmwater sport fish (largemouth and Florida bass (*Micropterus spp.*), sunfish (*Lepomis spp.*), catfish, etc.) or forage species for piscivorous sport fish. The Department has not stocked fish in Clear Lake in the past decade. Four fish species have been introduced without authorization from the Department (Dill and Cordone 1997; Rowan J. personal communication, October 10, 2013, unreferenced). Mississippi silverside, threadfin

Factors Affecting the Ability to Survive and Reproduce

shad, smallmouth bass (*Micropterus dolomieu*), and pumpkinseed (*Lepomis gibbosus*) were introduced to provide forage for other game fishes, provide Clear Lake gnat control, or as part of a new sport fishery (Anderson et al. 1986; Dill and Cordone 1997; Bairrington 1999). Smallmouth bass and pumpkin seed never established sustainable populations in the lake. Non-native game fishes comprise nearly 100% of the sport catch from the lake. Incidental captures of native species occur infrequently and are rarely recorded during creel and tournament surveys (Rowan J. personal communication, October 10, 2013, unreferenced).

Non-native fish introductions can have significant impacts on native fish species. Mississippi silverside and threadfin shad are thought to compete directly with CLH for food resources (Geary and Moyle 1980; Anderson et al. 1986; Bairrington 1999). A comparison of Mississippi silverside and threadfin shad abundance from graphs in Eagles-Smith et al. (2008) and population trends for CLH (Figure 2) indicate a possible connection between abundances of these species. From 1990 to 2002 a similar pattern exists in increased CLH captures and observations during years of decreased Mississippi silverside and threadfin shad abundance. All three species are limnetic foragers that rely on macroinvertebrates for food. During years with decreased populations of Mississippi silverside and threadfin shad limnetic zooplankton numbers increase in stomach analysis of fishes indicating an increase in their availability to limnetic foragers (Eagles-Smith et al. 2008). Years with declines in threadfin shad and Mississippi silverside are thought to coincide with increases in CLH numbers, and years with decreased threadfin shad and Mississippi silverside result in increased young of year recruitment for other native and non-native species (Eagles-Smith et al. 2008; LCVCD 2013; Rowan J. personal communication, October 10, 2013, unreferenced). Eagles-Smith et al. (2008) found that zooplankton populations declined precipitously as threadfin shad populations increased, causing other common plankton-feeding fishes (juvenile largemouth bass and bluegill, Mississippi silverside) to switch to benthic feeding. Clear Lake hitch, being more specialized for zooplankton feeding and not being able to switch to benthic feeding, may have been strongly affected by the threadfin shad boom-and-bust population cycles in the lake (Eagles-Smith et al (2008).

Competition for juvenile rearing habitat and food has likely increased with the reduction in wetland habitat and increase in non-native fish species. Rearing habitat is essential for CLH recruitment to any year class. A reduction in recruitment leads to a decrease in spawning adults the following years. A species with highly fluctuating population trends, such as CLH, is particularly vulnerable to population level impacts in years with reduced recruitment. Piscivorous fish species such as largemouth bass (*Micropterus salmoides*) and Florida bass (*Micropterus floridae*) prey directly on both juvenile and adult CLH. Although no comprehensive diet studies have been done, incidental data indicate that CLH are found in the stomachs of piscivorous species in the lake (Moyle et al. in progress). Omnivorous species such as bullhead catfish (*Ameiurus* spp.) are known to prey on various life stages of native fishes. It is suggested that the introduction of bullhead catfish to Clear Lake may have played a role in the decline of native fish

Factors Affecting the Ability to Survive and Reproduce

species (Dill and Cordone 1997). The introduction of white catfish (*Ameiurus catus*) was described, by Captain J.D. Dondero of the Division of Fish and Game, as having solved the problem of large spawning runs of fish dying in tributaries to Clear Lake and that the population of nongame fish diminished following their introduction (Dill and Cordone 1997). Jordan and Gilbert (1894) also describe catfish as being destructive to the spawn of other species. The rates at which CLH are consumed in relation to other prey species and the amount of CLH consumed are unknown.

Disease and Parasites

Disease outbreaks in fishes have been known to occur at Clear Lake. The outbreaks are primarily koi herpes virus (KHV) and impact introduced carp and goldfish. Native minnows, including CLH, show no effects from KHV. Fish fungi (*Saprolegnia* spp.) have been observed on fishes captured in Clear Lake and results from physical injury or infection. CLH are susceptible to fish fungi but it is not readily observed in captured fish. All fish in Clear Lake are susceptible to anchor worms (*Lernaea* spp.) and heavy infestations can lead to mortality. No CLH with heavy anchor worm infestations have been observed during CDFW fishery surveys at Clear Lake (Rowan J. personal communication, October 10, 2013, unreferenced). The Big Valley Rancheria Band of Pomo Indians has documented light loads of anchor worms occurring on CLH (Big Valley Rancheria 2012 and 2013).

Other Natural Occurrences or Human Related Activities

Climate Change

It is likely that native fishes in California will be vulnerable to physical and chemical changes as a result of climate change (Moyle et al. 2012). Research has shown that the annual mean temperature in North America has increased between 1955 and 2005 and is predicted to continue increasing in the future (Field et al. 1999; Hayhoe et al. 2004); however, it varies across North America, is more pronounced in spring and winter, and has affected daily minimum temperatures more than daily maximum temperatures (Field et al. 2007). In general, climate change models for California indicate an increase in overall temperature, decreased and warmer rainfall, and an increase in overall water temperatures (California Climate Change Center [CCCC] 2012). Cold storms are expected to decrease, giving way to warmer storms that create earlier run-off and less water storage capabilities (Field et al. 1999; Hayhoe et al. 2004; CCCC 2012). Climate change in the Clear Lake watershed is likely to cause changes to the interannual variability in rainfall. The change in rainfall variability would likely increase the occurrence of drought and flood years (Clear Lake Integrated Watershed Management Plan [CLIWMP] 2010). Expected climate

Factors Affecting the Ability to Survive and Reproduce

change impacts to California and the Clear Lake watershed will be significant during annual CLH spawning cycles. CLH require winter and spring storms that provide suitable spawning flows in the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff will likely significantly impact the ability of CLH to successfully spawn. Anthropogenic driven climate change in the Clear Lake watershed could result in the loss of spawning habitat, reduced access to spawning habitat, stranding of spawning and juvenile fish, and egg desiccation.

A report on the projected effects of climate on California freshwater fishes, prepared for the California Energy Commission's California Climate Change Center, determined CLH to be critically vulnerable to impacts from climate change (Moyle et al. 2013). The report evaluated criteria such as population size, population trends, range, lifespan, and vulnerability to stochastic events to identify the degree of vulnerability of each fish species. The Intergovernmental Panel on Climate Change has stated that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change (Kundzewicz et al. 2007). Freshwater lake species are more susceptible to extirpation because they are unable to emigrate should habitat changes occur (CA Natural Resources Agency 2009).

Recreational Activities

The natural resources of the Clear Lake watershed are a tremendous recreational resource for residents and visitors to Lake County. As the largest freshwater lake wholly in California, with opportunities for multiple aquatic recreational activities, the lake receives many thousands of visitors a year. According to 2008 data acquired from Lake County quagga mussel (*Dreissena rostriformis*) inspection sticker application forms; there were 11,230 boats that visited the lake that year. Jet skis and pleasure boats accounted for 41% of the boating activity at the lake (CLIWMP 2010).

Permanent structures, associated with boat docks, boat ramps, and swimming beaches, have reduced littoral zone habitat around the lake. These structures require clearing of littoral zone habitat to maintain access for recreational boaters and swimmers. It is estimated that there are over 600 private boat docks and boat ramps on the lake shoreline. In addition to reducing littoral zone habitat these structures provide additional habitat for non-native sport fish, such as largemouth bass, that prey on CLH.

Recreational and tournament angling generate a significant amount of the activity in the Clear Lake aquatic environment. In 2008, 18% of all boats entering the lake identified their recreational activity as angling (CLIWMP 2010). In a single year creel

Factors Affecting the Ability to Survive and Reproduce

survey conducted in 1988 by the Department, CLH comprised two percent of the recreational sport catch (Macedo 1991).

The number of angling tournaments, primarily targeting largemouth bass, has increased over the last three decades in response to Clear Lake's reputation as a premiere sport fishery. Between 2001 and 2008 the number of permitted angling tournaments increased from 98 to 208 per year (Rowan J. personal communication, October 10, 2013, unreferenced). Since 2008 the number of permitted tournaments has decreased each year proportional to what has been observed throughout the rest of California. In 2013 there were 132 permitted bass tournaments at Clear Lake (Rowan J. personal communication, Feb 13, 2014, unreferenced). It is believed that recreational and tournament anglers' capture CLH incidentally while angling. The impact to CLH from the increase in angling tournaments is unknown, but is likely negligible because tournament anglers do not target CLH and bycatch would be an inadvertent snagging on an artificial lure, a rare occurrence.

REGULATORY AND LISTING STATUS

Federal

On September 25, 2012 the Center for Biological Diversity petitioned the U.S. Fish and Wildlife Service (USFWS) to list CLH as endangered or threatened under the federal Endangered Species Act (ESA). As of the publication of this Status Review report there has been no action taken on the petition by USFWS.

The U.S. Forest Service (USFS) lists CLH as a sensitive species. USFS sensitive species are those plant and animal species identified by a regional forester that are not listed or proposed for listing under the federal ESA for which population viability is a concern.

State

The Department designated CLH as a Species of Special Concern (SSC) in 1994. A SSC is a species, subspecies, or distinct population of an animal native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria:

- Is extirpated from the State or, in the case of birds, in its primary seasonal or breeding role;
- Is listed as Federally, but not State, threatened or endangered;
- Is experiencing, or formerly experienced, serious (nonscyclical) population declines or range restrictions (not reversed) that, if continued or resumed, could qualify it for State threatened or endangered status;
- Has naturally small populations exhibiting high susceptibility to risk from any factor(s) that if realized, could lead to declines that would qualify it for State threatened or endangered status.

The intent of designating a species as a SSC is to:

- Focus attention on animals at conservation risk by the Department, other State, local and Federal government entities, regulators, land managers, planners, consulting biologists, and others;
- Stimulate research on poorly known species;
- Achieve conservation and recovery of these animals before they meet California Endangered Species Act criteria for listing as threatened or endangered.

Regulatory and Listing Status

There are no provisions in the Fish and Game Code that specifically prohibit take of CLH or protect its habitat.

Other Rankings

The American Fisheries Society ranks CLH as vulnerable, meaning the taxon is in imminent danger of becoming threatened throughout all or a significant portion of its range (Jelks et al. 2011).

EXISTING MANAGEMENT EFFORTS

Resource Management Plans

An increase in resource management efforts throughout the Clear Lake watershed has been of benefit to CLH, and several plans and strategies are in place to assist in reducing the threats to CLH.

The CLIWMP (2010) provides details of past and current resource management within the Clear Lake watershed. The plan seeks to identify opportunities to improve and protect the health and function of the watershed and identifies specific implementation actions to improve and protect watershed resources. Recommended actions are prioritized on a timeline. As funding allows, implementation of these actions will be undertaken by various non-governmental organizations (NGO) and local, state, tribal, and federal agencies that share an interest in promoting the health and function of the watershed. Multiple action items listed in the plan would benefit CLH and its habitat. Several tributaries to Clear Lake have completed Watershed Assessment plans as well. These include Kelsey Creek Watershed Assessment (2010), Middle Creek Watershed Assessment (2010), and Scotts Creek Watershed Assessment (2010). These plans were all completed by Lake County Water Resources Division for West and East Lake Resource Conservation Districts.

With adoption of the TMDL for Clear Lake, several projects are in process or have been completed to reduce the amount of phosphorous entering the lake. Specifically, the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project seeks to reduce the amount of phosphorous entering the lake by 40% (CEPA 2012). Lake County and the California Department of Transportation have implemented several best management practices (BMPs) for managing storm water runoff to reduce the amount of phosphorous and other contaminants that enter the lake. Both the USFS and Bureau of Land Management (BLM) have undertaken projects to reduce nutrients entering the lake as a result of off-highway vehicles and other land uses. BLM, in coordination with Scotts Valley Band of Pomo Indians, received a grant to implement the Eightmile Valley Sediment Reduction and Habitat Enhancement Project Design. Controlling sediment from Eightmile Valley is crucial to controlling the amount of nutrients entering the lake. Many of these projects are still in design or early implementation and it will be several years before changes in nutrient loads within the lake can be observed and studied.

The adverse effects from an increase in sedimentation as a result of conversion of various types of agricultural land to vineyard resulted in the formation of the Erosion Prevention and Education Committee (EPEC). The EPEC was a group of county agencies and private entities that provide educational outreach regarding erosion control and water quality protection. However, the group has not convened a meeting

Existing Management Efforts

or completed any actions for several years. The Lake County Grading Ordinance was approved in 2007 and requires grading permits and Erosion Control and Sediment Detention Plans for projects with increased probability of resulting in increased sedimentation (Forsgren Associates, Inc. 2012).

Concerns over the reduction in habitat quality resulting from gravel mining prompted Lake County to adopt an Aggregate Resources Management Plan in 1994. The plan called for a moratorium on gravel mining in several tributaries to Clear Lake. The implementation of gravel mining regulations has resulted in reduced in-stream and bank erosion and increased riparian habitat along the creeks (CEPA 2008).

To prevent further destruction of wetland habitat along the lake shoreline, in 2000 and 2003 amendments, Lake County adopted Section 23-15 of the Clear Lake Shoreline Ordinance prohibiting the destruction of woody species and tules. In addition to the ordinance, there is a no net-loss requirement for commercial, resort, and public properties that wish to clear areas of shoreline (CLIWMP 2010).

RREC produced an Adaptive Management Plan (AMP) for the Clear Lake Hitch, *Lavinia exilicauda chi* (RREC 2011). The AMP describes the current status of CLH habitat and impediments to habitat recovery. The habitat assessments are included in a management plan that identifies action items, issues of uncertainty, stakeholder involvement, sustainability, and AMP amendment procedures. The RREC is currently in the process of revising the AMP.

The Department has created or approved two Conceptual Area Protection Plans (CAPP) for the Clear Lake Watershed. The creation of a CAPP for an area allows the Department, as well as local, federal, and NGOs, to apply for land acquisition funding from the Wildlife Conservation Board. The first, the Clear Lake CAPP, was approved in 2002 and addresses land acquisition needs in the area of Middle Creek. The plan focuses on protecting wetland and riparian habitat for the benefit of natural resources. The second CAPP, Big Valley Wetlands, is currently in development and should be approved in 2014. The Big Valley Wetlands CAPP focuses on land acquisitions in the western portion of the Clear Lake watershed for the purpose of protecting wetland and riparian habitat. Both CAPP's will benefit CLH in the protection of riparian and wetland habitat critical for spawning and rearing CLH. Land acquisitions that seek to protect and restore existing CLH habitat should create a stable environment for CLH populations.

The Department published a Clear Lake Fishery Management Plan in 1999 (Bairrington 1999). The plan provides a review of past and present biological information for Clear Lake. The primary focus of the plan is to maintain fishery resources of the lake and enhance recreational fishing opportunities. The plan identifies areas of controversy between various stakeholder groups in the watershed, stating that "adapting to the biological and social settings at Clear Lake involves a variety of compromises between these groups and the non-angling groups who wish to ensure the well-being of Clear Lake's native fish species." The plan identifies the decline in native fish species at

Existing Management Efforts

Clear Lake as being detrimental both socially and biologically. No specific guidelines are given for addressing impacts to native species, but restoration of spawning habitat and natural flow regimes are discussed as critical for native species survival.

Monitoring and Research

In 2013 the Department attempted to conduct a status assessment of the CLH population present in Cole and Kelsey creeks. Sampling produced too few fish to facilitate a statistically valid mark and recapture study. As a result, a population estimate was not completed. The Department has proposed additional funding in 2014 to begin a multi-year mark-recapture study to determine a statistically valid population estimate or index of CLH.

The CCCLH has been conducting annual spawning observations since 2005. A simple protocol is followed that identifies a time, observer, and number of CLH observed to be documented. Volunteers have put in hundreds of hours monitoring CLH spawning runs during this time period. Although not quantitative, the surveys provide a glimpse into the number of spawning CLH and how successful spawning is in a particular season. Results of these surveys are included in Appendices A and B and summarized in Section 4.1 and 4.2 above.

Habitat Restoration Projects

In recent years, local, state, and federal agencies have begun implementing actions to aid in the protection and restoration of Clear Lake wetland habitat. The Middle Creek Flood Damage Reduction and Ecosystem Restoration Project will restore up to 1,400 acres of wetland habitat around Middle Creek and Rodman Slough, essentially doubling the amount of existing wetland habitat in the watershed (CLIWMP 2010).

Impacts of Existing Management Efforts

To date, existing management efforts have focused on CLH habitat restoration. Wetland restoration projects that would significantly benefit CLH have been proposed. These projects have been or will be implemented through the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project and the two CAPPs that cover portions of the watershed. Wetland restoration is expected to aid in increasing spawning success and juvenile recruitment into the population. Increased wetland acreage would enhance filtration of tributary waters resulting in decreased amounts of nutrients entering the lake and an increase in the water table. The increased water table will help maintain surface flow in tributaries, resulting in suitable spawning habitat

Existing Management Efforts

being maintained throughout the spawning season. The Clear Lake Shoreline Ordinance has resulted in a “no net loss” of shoreline wetland habitat around the lake since its enactment. However, because these wetland restoration projects are either recent or yet to be implemented, a thorough assessment of direct and indirect impacts to CLH populations cannot be included in this Status Review report.

Establishment of TMDLs for mercury and nutrients has led to a reduction in inputs and an increase in monitoring efforts in the Clear Lake watershed. Past and future steps by the federal government will reduce mercury contamination resulting from the Sulphur Bank Mercury Mine. Most of the identified initial actions for cleanup have been implemented. The focus will now be on two long-term projects to address waste pile and lake sediment cleanup, which should result in significant reductions in mercury contamination in the watershed. Nutrient loads entering Clear Lake have been addressed by several measures including wetland restoration, BMPs for storm water runoff, and erosion control measures. Many of these projects are in the early stages of implementation, and a thorough assessment of impacts to CLH is yet to be completed. Reduced mercury and nutrient loads in Clear Lake will result in a benefit to CLH.

Scientific Determinations Regarding the Status of
Clear Lake Hitch in California

**SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE
HITCH IN CALIFORNIA**

CESA directs the Department to prepare this report regarding the status of CLH based upon the best scientific information available to the Department. CESA's implementing regulations identify key factors that are relevant to the Department's analyses.

Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1 (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and Game Code provide key guidance to the Department's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease." (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067).

The preceding sections of this Status Review report describe the best scientific information available to the Department, with respect to the key factors identified in the regulations.

Present or Threatened Modification or Destruction of Habitat

Beginning with the arrival of European settlers in the mid-1800s, alterations to habitats in the watershed have directly impacted the ability of CLH to survive. Habitats necessary for both spawning and rearing have been reduced or severely decreased in suitability in the past century resulting in an observable decrease in the overall abundance of CLH and its habitat. Spawning tributaries have been physically altered by a combination of dams, diversions, and mining operations that have altered the course and timing of spring flows and the amount and quality of spawning habitat available for CLH. Dams create barriers to CLH passage that reduce the amount of available spawning habitat while altering the natural flow regime of tributaries. Water diversions on tributaries have resulted in decreased flows during critical spawning migrations for CLH. Loss of eggs, juvenile, and adult fish due to desiccation and stranding from water diversions are likely a significant impact on CLH populations. Gravel mining removed large amounts of spawning substrate during peak operations in the mid-1900s.

Scientific Determinations Regarding the Status of Clear Lake Hitch in California

Spawning substrate has been restored slowly after gravel mining was discontinued in the majority of the watershed. Water quality impacts to the watershed have resulted in Clear Lake being listed as an impaired water body and led to the establishment of TMDLs for both mercury and nutrients for the lake. It is unclear to what extent the water quality impacts are affecting CLH populations. The Department considers modification and destruction of habitat a significant threat to the continued existence of CLH.

Overexploitation

Harvest of CLH has occurred by both Native American tribes and commercial fishery operators at Clear Lake. Historic accounts from tribal members indicate that significant amounts of CLH were harvested during spawning runs. In recent years, the amount of harvest by the Pomo has been minimal, and the CLH are primarily used for educational and cultural reasons. Since the early 1990s commercial fishery operations have been required to return all CLH captured to the lake. Prior to that, CLH had not been regularly harvested for sale. It is likely that incidental catch during commercial harvest operations resulted in mortality of some CLH. However, there is no information indicating that overexploitation threatens the continued existence of CLH.

Predation

Direct predation of CLH by fish, birds, and mammals is known to occur in occupied habitats within the watershed. Spawning runs are vulnerable to predation from birds and mammals as fish migrate upstream and become stranded at various locations. Stranding occurs both naturally and as a result of habitat modifications described above. Non-native fishes prey directly on different life stages of CLH and represent an introduced impact to the population. CLH have been found during stomach content analyses of largemouth bass. Incidental observations indicate that largemouth bass may target CLH as the CLH stage at the entrance to ascend spawning tributaries in early spring. Other introduced fishes, such as bullhead catfish, also prey on CLH. A detailed diet study on selected introduced fishes is necessary to determine the extent of predation from introduced fishes. There is evidence suggesting that predation by introduced fishes threatens the continued existence of CLH.

Competition

The extent of impacts on CLH from competition with other aquatic species is poorly understood. Studies conducted on diet analysis of CLH indicate that there is competition between CLH and other macroinvertebrate consuming fish species, primarily Mississippi silversides and threadfin shad. Observations by Department

Scientific Determinations Regarding the Status of Clear Lake Hitch in California

biologists and others indicate that CLH populations fluctuate on alternating cycles with Mississippi silverside and threadfin shad populations with CLH being more abundant in years with decreased Mississippi silverside and threadfin shad abundance. CLH directly compete with other native and non-native fishes for juvenile rearing habitat. Many fishes in Clear Lake utilize near shore wetland habitat as juveniles and adults. With the decrease in wetland habitat over the past century, there is increased competition for the remaining habitat. Although no formal studies have been completed, it is likely that competition for resources threatens the continued existence of CLH.

Disease

There are no known diseases that are significant threats to the continued existence of CLH.

Other Natural Occurrences or Human-related Activities

If climate change models are accurate, potential impacts to California and the Clear Lake watershed will be significant during annual CLH spawning cycles. CLH require winter and spring storms that provide suitable spawning flows in the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff could significantly impact the ability of CLH to successfully spawn. A report on the projected effects of climate on California freshwater fishes determined CLH to be critically vulnerable to impacts from climate change. Climate change is considered a threat to the continued existence of the species.

Numerous recreational activities take place in Clear Lake each year. The majority of recreational activities pose no significant threat to the survival of CLH. It is believed that recreational and tournament anglers' capture CLH incidentally, however the occurrence is considered rare. The significance of impacts to CLH from angling is unknown, but likely do not threaten the continued existence of CLH.

Summary of Key Findings

SUMMARY OF KEY FINDINGS

At present time, the species can be found in portions of its historic habitat and qualitative surveys indicate a variable interannual population. Based on qualitative surveys efforts to date a population estimate or index of CLH is not attainable. Without a current population or index for CLH it is necessary to estimate impacts not based on a set baseline but rather against trends seen in abundance and distribution in sampling efforts over the past half century.

It is imperative for the Department and the conservation community to study and monitor the population of CLH over the next decade. A review of the scientific determinations regarding the status of CLH indicates there are significant threats to the continued existence of the species, particularly related to historical and ongoing habitat modification, predation from introduced species, competition, and climate change. Many of these threats are currently or in the near future being addressed by existing management efforts. Monitoring impacts from existing management efforts will be imperative to assessing the future status of CLH.

Recommendation for Petitioned Action

RECOMMENDATION FOR PETITIONED ACTION

CESA directs the Department to prepare this report regarding the status of CLH in California based upon the best scientific information available. CESA also directs the Department based on its analysis to indicate in the status report whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). The Department includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science.

Based on the criteria described above, the scientific information available to the Department indicates that CLH, while not presently threatened with extinction, are likely to become an endangered species in the foreseeable future, absent the special protections and management efforts required by CESA. The Department recommends that the petitioned action to list CLH as a threatened species is warranted.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an endangered or threatened species, unauthorized “take” of CLH will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier, CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any person violating the take prohibition would be punishable under State law. The Fish and Game Code provides the Department with related authority to authorize “take” under certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) As authorized through an incidental take permit, however, impacts of the taking on CLH caused by the activity must be minimized and fully mitigated according to State standards.

Additional protection of CLH following listing would also occur with required public agency environmental review under CEQA and its federal counter-part, the National Environmental Policy Act (NEPA). CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and threatened special status species. Under CEQA’s “substantive mandate,” for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate and the Department’s regulatory jurisdiction generally, the Department expects related CEQA and NEPA review will likely result in increased information regarding the status of CLH in California as a result of, among other things, updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, the Department expects project-specific required avoidance, minimization, and mitigation measures will also benefit the species. While both CEQA and NEPA would require analysis of potential impacts to CLH regardless of their listing status under CESA, the acts contain specific requirements for analyzing and mitigating impacts to listed species. In common practice, potential impacts to listed species are examined more closely in CEQA and NEPA documents than potential impacts to unlisted species. State listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, is also expected to benefit the species in terms of related impacts for individual projects that might otherwise occur absent listing.

If CLH is listed under CESA, it may increase the likelihood that State and federal land and resource management agencies will allocate funds towards protection and recovery actions. However, funding for species recovery and management is limited, and there is a growing list of threatened and endangered species.

MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES

Current data on CLH suffer from being largely anecdotal and qualitative in nature. Studies designed to provide quantitative data on CLH populations and the factors that affect the ability of CLH to survive and reproduce are necessary for species management. The following list of management recommendations were generated by Department staff with considerations from local agencies, non-profits, and interested parties.

- Derive a statistically valid population estimate or index allowing assessment of impacts to the overall population and provide a baseline to maintain a sustainable population level.
 - Conduct a thorough assessment of barriers to fish movement on primary spawning streams and provide recommendations for restoration actions on substantial barriers.
 - Complete a detailed analysis of spawning habitat on primary spawning streams and provide recommendations for restoration actions.
 - Implement identified restoration activities to increase available spawning and rearing habitat for CLH.
 - Conduct a review of reservoir operations at Highland Springs, Adobe Creek, and Kelsey Creek detention dams to assess water release operations that may be impacting CLH, development and implementation of guidelines for minimizing impacts.
 - Conduct an in stream flow analysis of primary spawning tributaries to determine impacts of water diversions on stream flows, particularly during spawning season.
 - Coordinate with landowners, stakeholders, and permitting agencies on developing strategies for reducing in stream diversions during spawning season.
 - Determine the value of wetland habitat in the watershed pertaining to survivorship of juvenile CLH and make appropriate recommendations on restoration or modification.
 - Analyze food web interactions of CLH and non-native fish to determine potential impacts to CLH.
 - Conduct a diet analysis of selected introduced fish species to determine the extent of their impact on CLH.
 - Conduct creel surveys to gain a better understanding of CLH capture rates during both recreational and tournament angling.
 - Develop a comprehensive monitoring program that assesses both native and non-native fish populations and their distribution in the watershed.
 - Identify habitats within the watershed that may be suitable for CLH translocations.
 - Coordinate the above research and restoration efforts with interested stakeholders in the watershed.
- Develop an outreach program to provide updates to stakeholders on recovery and management efforts.

Public Responses

PUBLIC RESPONSE

Comments were invited in response to the current petition in a Department press release dated April 16, 2013. Four of the comment letters received provided the Department with data for the Status Review report or recommendations on how to improve habitat for CLH. Four comment letters provided support for the listing as threatened under CESA and six comment letters were either against the listing as threatened under CESA or were against actions to improve conditions for CLH by removing other sport fish from the lake. Comments received are included in Appendix D.

Peer Review

PEER REVIEW

Independent fishery experts were invited to review the Status Review report prior to submission to the Fish and Game Commission. The letters of invitation and all comments received are included in Appendix E.

Acknowledgements

ACKNOWLEDGEMENTS

The Department would like to thank Dr. Camm Swift, Gregory Giusti, Dr. Jerry J. Smith, Dr. Peter B. Moyle, and Thomas Taylor for providing peer review for this Status Review report.

LITERATURE CITED

- Aguilar, A. and J. Jones. 2009. Nuclear and Mitochondrial Diversification in two Native California Minnows: Insights into Taxonomic Identity and Regional Phylogeography. *Molecular Phylogenetics and Evolution* 51 (2): 373-381.
- Anderson, N.L., D.L. Woodward and A.E. Colwell. 1986. Pestiferous dipterans and two recently introduced aquatic species at Clear Lake. *Proceedings of the California Mosquito Vector Control Association*. 54:163-167.
- Anderson, N.L., 1989. Letter to Rick Macedo containing notes and data from LCVCD sampling efforts.
- Avise, J.C. and F.J. Ayala. 1976. Genetic differentiation in speciose versus depauperate phylads: Evidence from the California minnows. *Evolution* 30:46-58.
- Barrett, S.A., 1906. The Ethno-Geography of the Pomo and Neighboring Indians. *University of California Publications in American Archeology and Ethnology*. Vol 6 No. 1.
- Bairrington, P., 1999. CDFG Clear Lake Fishery Management Plan.
- Bellucci, C. J., Becker, M., & Beauchene, M. (2011). Characteristics of macroinvertebrate and fish communities from 30 least disturbed small streams in Connecticut. *Northeastern Naturalist*, 18(4), 411-444.
- Big Valley EPA, 2013. Hitch interview notes with families of Big Valley Rancheria and Elem Indian Colony.
- Big Valley Rancheria, 2012. Hitch *Lavinia exilicauda* Chi Hopkirk ecology and water quality studies in Big Valley sub-basin creeks in 2012.
- Big Valley Rancheria, 2013. Big Valley sub-basin creek water quality, quantity, and Hitch *Lavinia exilicauda* Chi Hopkirk ecology program Spring, 2013.
- Brown, A.V., M.M. Little, and K.B. Brown, 1998. Impacts of gravel mining on gravel bed streams. *Transactions of the American Fisheries Society*. 127:979-994.
- Bunn, S.E., and A.H. Arthington, 2002. Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol. 30:4. Pp 492-507.
- California Climate Change Center, 2012. Our Changing Climate 2012 Vulnerability and Adaptation to the Increasing Risks from Climate Change in California.
- California Department of Fish and Game, 1955-1956. Field notes on Kelsey and Seigler Creeks.

Literature Cited

California Department of Fish and Game, 1961-2001. Commercial Catch data for Clear Lake

California Department of Fish and Game, 1969. News Release on Fish Dieoffs at Clear Lake.

California Department of Fish and Game, 1988. Clear Lake Electrofishing Survey, April 2, 1987 Memorandum.

California Department of Fish and Game, 2012. Electrofishing data, Memorandum in progress.

California Department of Fish and Wildlife, 2013. Report to the Fish and Game Commission Evaluation of the Petition from the Center for Biological Diversity to List Clear Lake Hitch (*Lavinia exilicauda chi*) as a Threatened Species under the California Endangered Species Act.

California Department of Fish and Wildlife, 2013. Commercial Fisheries Data from catch records.

California Department of Fish and Wildlife, 2013. Commercial Operators permit applications.

California Department of Fish and Wildlife, April 24, 2013. Press Release – CDFW Seeks Public Comment and Data Regarding Clear Lake Hitch.

California Department of Water Resources. 1975. Clear Lake Water Quality Data.

California Natural Resources Agency, 2009. California Climate Adaptation Strategy Discussion Draft.

California Environmental Protection Agency RWQCBCVR, 2002. Clear Lake TMDL for Mercury Staff Report.

California Environmental Protection Agency RWQCBCVR, 2008, Monitoring and Implementation Plan Clear Lake Mercury and Nutrient TMDL's.

California Environmental Protection Agency RWQCBCVR, 2010. Clear Lake Mercury Total Maximum Daily Load Update.

California Environmental Protection Agency RWQCBCVR, 2012. Clear Lake Nutrient Total Maximum Daily Load Control Program 5-year Update.

California Regulatory Notice Register, 2012. No. 41-Z. p.1501

California Regulatory Notice Register, 2013. No. 12-Z. p.488

Literature Cited

- Center for Biological Diversity, 2012. Petition to List Clear Lake Hitch (*Lavinia exilicauda chi*) as Threatened under the California Endangered Species Act. 58 pp.
- Chi Council for the Clear Lake Hitch (CCCLH). 2013. Hitch spawning survey results, 2005-2013. Available at <http://lakelive.info/chicouncil/>
- Clear Lake Integrated Watershed Management Plan, February 2010. Prepared for West Lake and East Lake Resource Conservation Districts.
- Coleman, G.A. 1930. A biological survey of Clear Lake, Lake County. *Calif. Fish and Game* 16: 221-227.
- Converse, Y.A., C.P. Hawkins and R. A. Valdez, 1998. Habitat Relationships of Subadult Humpback Chub in the Colorado River Through Grand Canyon: Spatial Variability and Implications of Flow Regulation. *REGULATED RIVERS: RESEARCH & MANAGEMENT* 14: 267-284
- Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1964. The impact of the fishery on the midges of Clear Lake, Lake County, CA, *Annals of the Entomological Society of America*, Vol. 57, pp. 701-707.
- Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1966. Status of the Native Fishes of Clear Lake, Lake County, California. *Wasmann Journal of Biology*, 24: 141-160.
- Cott, P. A., Sibley, P. K., Somers, W. M., Lilly, M. R., & Gordon, A. M. (2008). A REVIEW OF WATER LEVEL FLUCTUATIONS ON AQUATIC BIOTA WITH AN EMPHASIS ON FISHES IN ICE-COVERED LAKES1. *Journal of the American Water Resources Association*, 44(2), 343-359.
- County of Lake Water Resources, 2013. Memo on Historical Water Levels of Clear Lake.
- Cox, B., 2007. CDFG Clear Lake Fishery Surveys Summary Report.
- Curtis T.C. 1977. Pesticide Laboratory report. California Department of Fish and Game, E.P. No. P-133. 3pp.
- Crump, KL and VL Trudeau, 2009. Mercury-induced reproductive impairment in fish. *Environmental Toxicology and Chemistry*. 28(5):895-907.
- Deitch, M.J., G.M. Kondolf, and A.M. Merenlender. 2009. Hydrologic impacts of smallscale instream diversions for frost and heat protection in the California wine country. *River Research and Applications*, Volume 25, Issue 2, pages 118-134.
- Dill, W. A., and A. J. Cordone. 1997. Fish Bulletin 178. History and Status of Introduced Fishes in California 1871-1996. California. Fish and Game. 414 pp.

Literature Cited

- Eagles-Smith, C.A., T.H. Suchanek, A.E. Colwell, N.L. Anderson, and P.B. Moyle. 2008. Changes in fish diets and food web mercury bioaccumulation induced by an invasive planktivorous fish. *Ecological Applications* 18(Supplement): A213–A226.
- Ewing, B., 2013. Summary of the Clear Lake Hitch Population Estimate for Cole and Kelsey Creeks, Lake County.
- Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller, 1999. *Confronting Climate Change in California: Ecological Impacts on the Golden State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of America, Washington, DC.
- Field, C.B., L.D. Mortsch,, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running and M.J. Scott, 2007: North America. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 617-652.
- Forsgren Associates Inc, 2012. Clear Lake Watershed Sanitary Survey 2012 Update Final.
- Franson, S. 2013. Summary of Spring 20-13 Field Monitoring with Locations chosen for observing egg and larval development of Clear Lake Hitch (*Lavinia exilicauda chi*).
- Gafny, S., A. Gasith, and M. Goren 2006. Effect of water level fluctuation on shore spawning of *Mirogrex terraesanctae* (Steinitz), (Cyprinidae) in Lake Kinneret, Israel *Journal of Fish Biology* vol 41:6 pages 863-871
- Geary, R.E. 1978. Life history of the Clear Lake hitch (*Lavinia exilicauda chi*). Unpublished Master's Thesis, University of California, Davis. 27 pp.
- Geary, R.E. and P.B. Moyle. 1980. Aspects of the ecology of the hitch, *Lavinia exilicauda* (Cyprinidae), a persistent native cyprinid in Clear Lake, California. *Southwest. Nat.* 25:385-390.
- Giusti, G. 2009. Human Influences to Clear Lake, California A 20th Century History.
- Harnly, M., S. Seidel, P. Rojas, R. Fornes, P. Flessel, D. Smith, R. Kreutzer, and L. Goldman. 1996. Biological monitoring for mercury within a community with soil and fish contamination. *Environmental Health Perspectives*, Vol. 105:4, 424-429.
- Havens, K.E. 2008. Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs. Chapter 33: Cyanobacteria blooms: effects on aquatic ecosystems.
- Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S.

Literature Cited

Kalkstein, J. Lenihan, C.K.Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. *Proceedings of the National Academy of Science* 101:12422-12427.

Hopkirk, J.D. 1973. Endemism in fishes of the Clear Lake region of central California. *University of California Publications in Zoology* 96: 160 pp.

Horne, A.J. 1975. The Effects of Copper, Major and Minor Nutrient Element Additions, and Lake Water Movements on Blue-Green Algal Bloom Development in Clear Lake.

Hudon, C., Armellin, A., Gagnon, P., & Patoine, A. (2010). Variations in water temperatures and levels in the St. Lawrence river (Quebec, Canada) and potential implications for three common fish species. *Hydrobiologia*, 647(1), 145-161.

Hunt, E.G. and A.I. Bischoff. 1960. Inimical effects on wildlife of periodic DDD applications to Clear Lake. *California Fish and Game* 46:91-106.

Jelks, H L., Stephen J. Walsh, Noel M. Burkhead, Salvador Contreras-Balderas, Edmundo

Diaz-Pardo, Dean A. Hendrickson, John Lyons, Nicholas E. Mandrak, Frank McCormick, Joseph S. Nelson, Steven P. Platania, Brady A. Porter, Claude B. Renaud, Juan Jacobo Schmitter-Soto, Eric B. Taylor & Melvin L. Warren Jr. (2008): Conservation Status of Imperiled North American Freshwater and Diadromous Fishes, *Fisheries*, 33:8, 372-407.

Jordan, D.S., and C.H. Gilbert. 1894. List of Fishes Inhabiting Clear Lake, California. *Bulletin of the United States Fish Commission*, Vol. XIV.

Kelsey Creek Watershed Assessment, February 2010. Prepared for East Lake and West Lake Resource Conservation Districts.

Kimsey, J.B. and L.O. Fisk. 1960. Keys to the freshwater and anadromous fishes of California. *Calif. Fish Game* 46:453-79.

Kniffen, F.B. 1939. Pomo Geography. *University of California Publications in American Archaeology and Ethnology*. Vol. 36 No. 6 pp. 353-400.

Kratville, D. October 7, 2013. Email correspondence on CESA MOU's issued for CLH.

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate*

Literature Cited

- Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.
- Lake County Department of Agriculture, 2011. Crop Report
- Lake County Department of Public Works Water Resources Division, 2003. Clear Lake Wetlands Geographic Information Systems Data User Manual.
- Lake County Vector Control District, 2013. Copy of verified Beach Seine 1987-2010 CL Hitch with notes.
- Lindquist, A.W., C.D. Deonier, and J.E. Hanley. 1943. The relationship of fish to the Clear Lake gnat, in Clear Lake, California. *Calif. Fish Game* 29:196-202.
- Lindquist, A.W. and A.R. Roth. 1950. Effect of dichlorodiphenyl dichloroethane on larva of the Clear Lake gnat in California. *Journal of Economic Entomology* 43:328-332.
- Macclanahan, J., E. W. Danley, H. F. Dewitt, and W. Wolber. 1972[app]. Flood control project maintenance and repair, 1971 inspection report. California Department of Water Resources Bulletin 149-71.
- Macedo, R., 1991. Creel Survey at Clear Lake, California March – June, 1988. CDFG Administrative Report No. 91-3.
- Macedo, R. 1994. Swimming Upstream Without a Hitch. *Outdoor California*: January/February 1994.
- Marchetti, M.P. and P.B. Moyle, 2001. Effects of flow regime on fish assemblages in a regulated California stream. *Ecological Applications*. 11(2). Pp. 530-539.
- McGinnis, D. and E. Ringelberg. 2006. Lake County Fish Barrier Assessment. Technical Memo.
- Middle Creek Watershed Assessment, February 2010. Prepared for West Lake Resource Conservation District.
- Miller, R.R. 1945. A new cyprinid fish from Southern Arizona, and Sonora, Mexico, with description of a new subgenus of *Gila* and a review of related species. *Copeia* 1945:104-110.
- Miller, R.R. 1963. Synonymy, characters and variation of *Gila crassicauda*, a rare California minnow, with an account of its hybridization with *Lavinia exilicauda*. *California Fish and Game* 49 (1): 20-29.
- Mioni, C., R. Kudela, and D. Baxter. 2011. Harmful cyanobacteria blooms and their toxins in Clear Lake and the Sacramento-San Joaquin delta (California). Central Valley Regional Water Quality Control Board: 10-058-150.

Literature Cited

- Mosley, D. 2013. Biological and Physical Habitat Assessment Report. Prepared for Habematolel Pomo of Upper Lake.
- Moyle, P.B. and M. Massingill. 1981. Hybridization between hitch, *Lavinia exilicauda*, and Sacramento blackfish, *Orthodon microlepidotus*, in San Luis Reservoir, California. California Fish Game 67:196-198.
- Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California, 2nd edition.
- Moyle, P.B. and T. Light, 1996. Fish Invasions in California: Do Abiotic Factors Determine Success? Ecology 77:1666-1670.
- Moyle, P. B. 2002. Inland Fishes of California. Berkeley: University of California Press.
- Moyle PB, Kiernan JD, Crain PK, Quiñones RM (2013) Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A Systematic Assessment Approach. PLoS ONE 8(5): e63883. doi:10.1371/journal.pone.0063883.
- Moyle P.B., J.V Katz, and R.M. Quinones. In review. Fish Species of Special Concern for California. Prepared for California Department of Fish and Game, Sacramento
- Murphy, G.I. 1948. Notes on the biology of the Sacramento hitch (*Lavinia e. exilicauda*) of Clear Lake, Lake County, California. Calif. Fish Game 34:101-110.
- Murphy, G.I. 1951. The fishery of Clear Lake, Lake County, California. *Calif. Fish and Game* 37: 439-484.
- National Oceanic and Atmospheric Administration, 2011. Table 2. Toxicity associated with mercury in tissues (ug/g) wet weight.
- Nicola, S.J. 1974. The life history of the hitch, *Lavinia exilicauda* Baird and Girard, in Beardsley Reservoir, California. Inland Fish. Admin. Rep. 74-6:1-16.
- Osleger, D.A., R.A. Zierenberg, T.H. Suchanek, J.S. Stoner, S. Morgan, and D.P. Adam. 2008. Clear Lake sediments: anthropogenic changes in physical sedimentology and magnetic response. Ecological Applications 18 (Supplement): A239-A256.
- Puckett, L., 1972. CDFG Memorandum-Fisheries Survey Clear Lake, Lake County.
- Richerson P.J., T.H. Suchanek, and S.J. Why. 1994. The Causes and Control of Algal Blooms in Clear Lake, Clean Lakes Diagnostic/Feasibility Study for Clear Lake, California. Prepared for USEPA Region IX.
- Ridout, W.L. 1899. A Fish Jam on Kelsey Creek. *Overland Monthly and Out West Magazine*. Volume 34, Issue 202. p. 333.

Literature Cited

Robinson Rancheria Environmental Center (RREC). 2011. Draft Adaptive Management Plan for the Clear Lake Hitch, *Lavinia exilicauda chi*. Available at <http://www.robinsonrancheria.org/environmental/water.htm>.

Rowan, J., 2008. CDFG Clear Lake, Lake County Memorandum.

Rudd, R.L. 1964. *Pesticides and the Living Landscape*. University of Wisconsin Press, Madison, WI.

Sandheinrich, MB. And KM Miller, 2006. Effects of dietary methylmercury on reproductive behavior of fathead minnows (*Pimephales promelas*). *Environmental Toxicology and Chemistry*. 25(11):3053-3057.

Scotts Creek Watershed Assessment, February 2010. Prepared for West Lake Conservation District.

Scotts Valley Band of Pomo Indians, 2013. Historical accounts provided to CDFW by Steve Elliott and Wanda Quitiquit.

State of California Fish and Game Commission, March 11, 2013. California Fish and Game Commission Notice of Findings

State of California Fish and Game Commission, October 2, 2012. California Fish and Game Commission Notice of Receipt of Petition

Suchanek, T.H., P.J. Richerson, L.A. Woodward, D.G. Slotton, L.J. Holts and C.E. Woodmansee. 1993. Ecological Assessment of the Sulphur Bank Mercury Mine Superfund Site, Clear Lake, California: A Survey and Evaluation of Mercury In: Sediment, Water, Plankton, Periphyton, Benthic Invertebrates and Fishes Within the Aquatic Ecosystem of Clear Lake, California. Phase 1- Preliminary Lake Study Report. Prepared for EPA-Region IX, Superfund Program. 113 pp., plus 2 attachments.

Suchanek, T.H., P.J. Richerson, D.C. Nelson, C.A. Eagles-Smith, D.W. Anderson, J.J. Cech, Jr., G. Schladow, R. Zierenberg, J.F. Mount, S.C. McHatton, D.G. Slotton, L.B. Webber, A.L. Bern and B.J. Swisher. 2002. Evaluating and managing a multiply-stressed ecosystem at Clear Lake, California: A holistic ecosystem approach. "Managing For Healthy Ecosystems: Case Studies," CRC/Lewis Press. pp. 1233-1265.

Swift, C. 1965. Early development of the hitch, *Lavinia exilicauda*, of Clear Lake, California. Calif. Fish Game 51:74-80.

Thompson, L.C., G.A. Giusti, K.L. Weber, and R.F. Keiffer. 2013. The native and introduced fishes of Clear Lake: a review of the past to assist with decisions of the future. California Fish and Game 99(1):7-41.

Literature Cited

U.S. Army Corps of Engineers. 1974[app]. Flood plain information: Big Valley streams (Manning, Adobe, Kelsey, and Cole Creeks), Kelseyville, California. Department of the Army, Sacramento District, Corps of Engineers, Sacramento, California, USA.

U.S. Environmental Protection Agency, 2012. Sulphur Bank Mercury Mine News Release – EPA to Begin Construction of Test Covers in Clear Lake.

Week, L., 1982. Habitat Selectivity of Littoral Zone Fishes at Clear Lake, CDFG California. Administrative Report No. 82-7.

Wetzel, R.G., 2001. Limnology lake and River Ecosystems, 3rd ed. Pg. 834.

Winder, M., J. Reuter and G. Schladow, 2010. Clear Lake Report: Clear Lake Historical Data Analysis.

Literature Cited

This page left blank intentionally

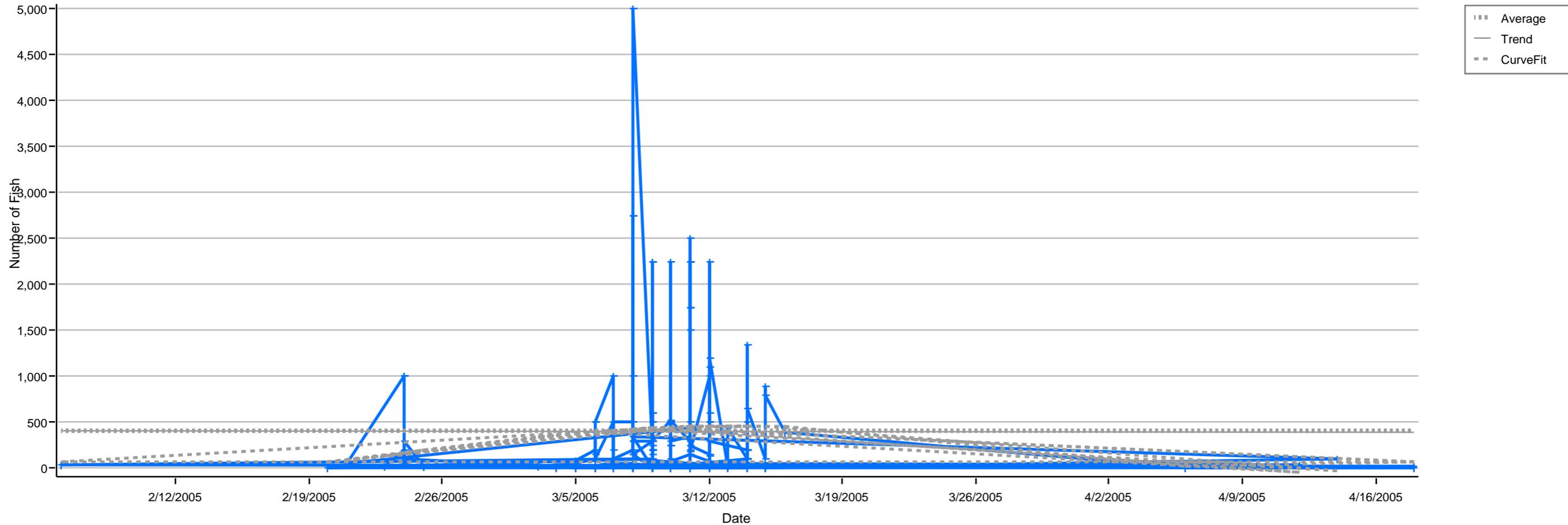
Appendix A

Appendix A. Summary graphs of spawning observations between 2005 and 2013

Appendix A

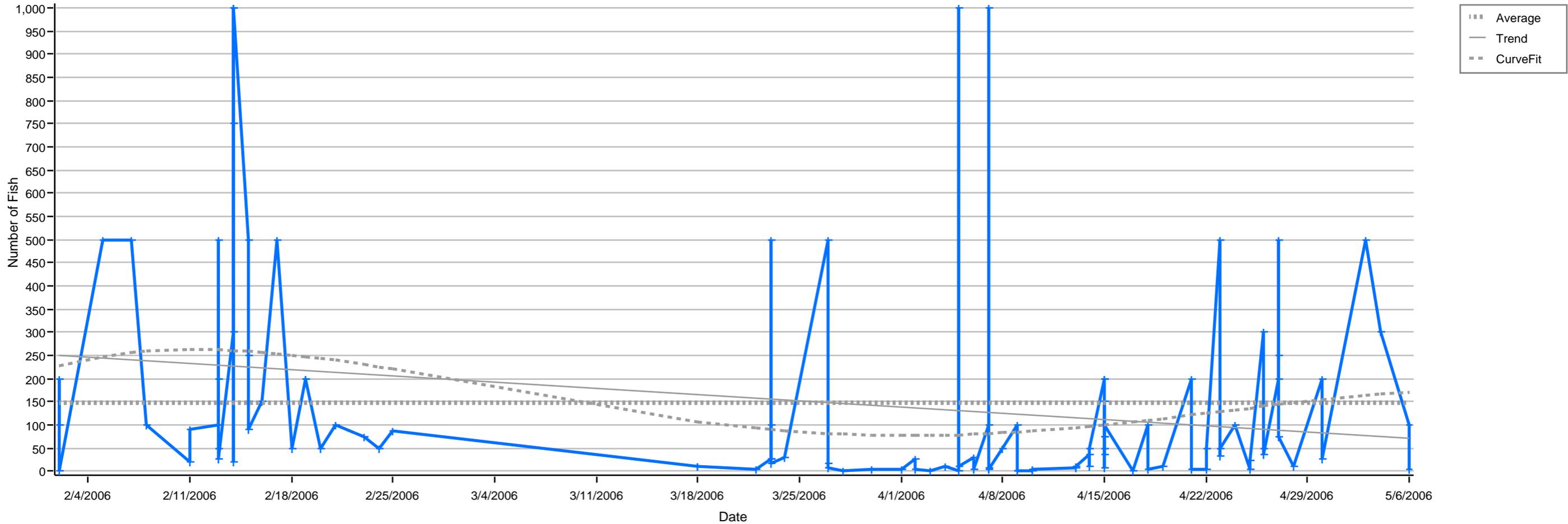
This page left blank intentionally

2005 Chi Observations



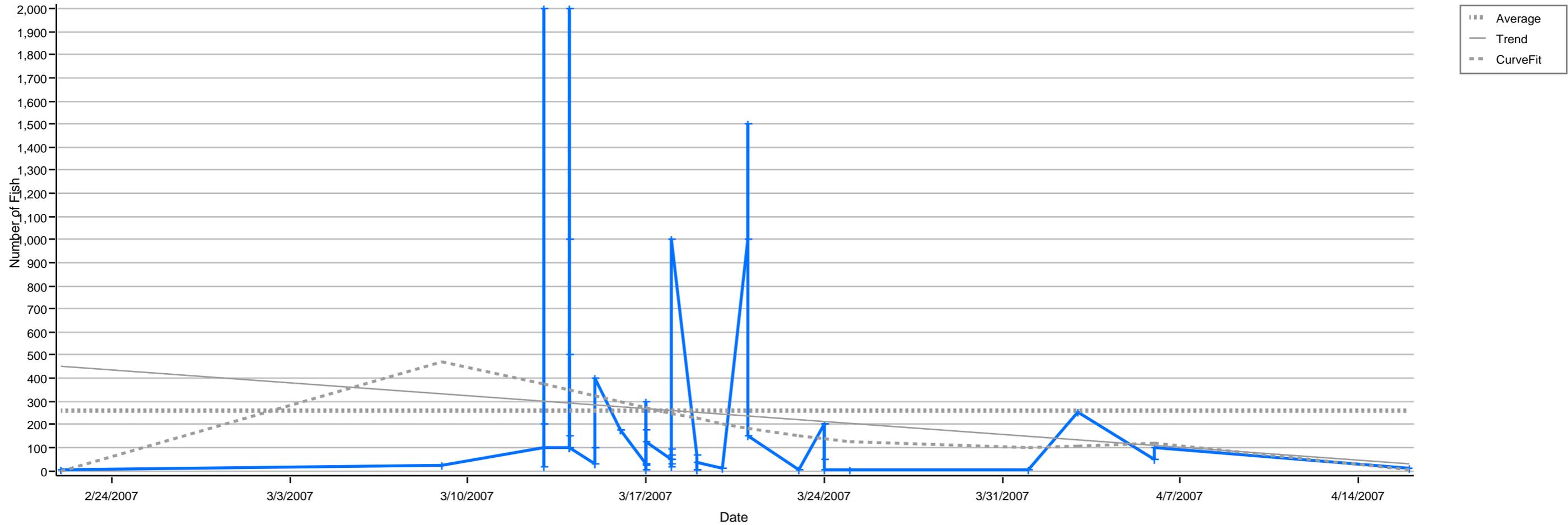
Only observed in 12 streams.

2006 Chi Observations



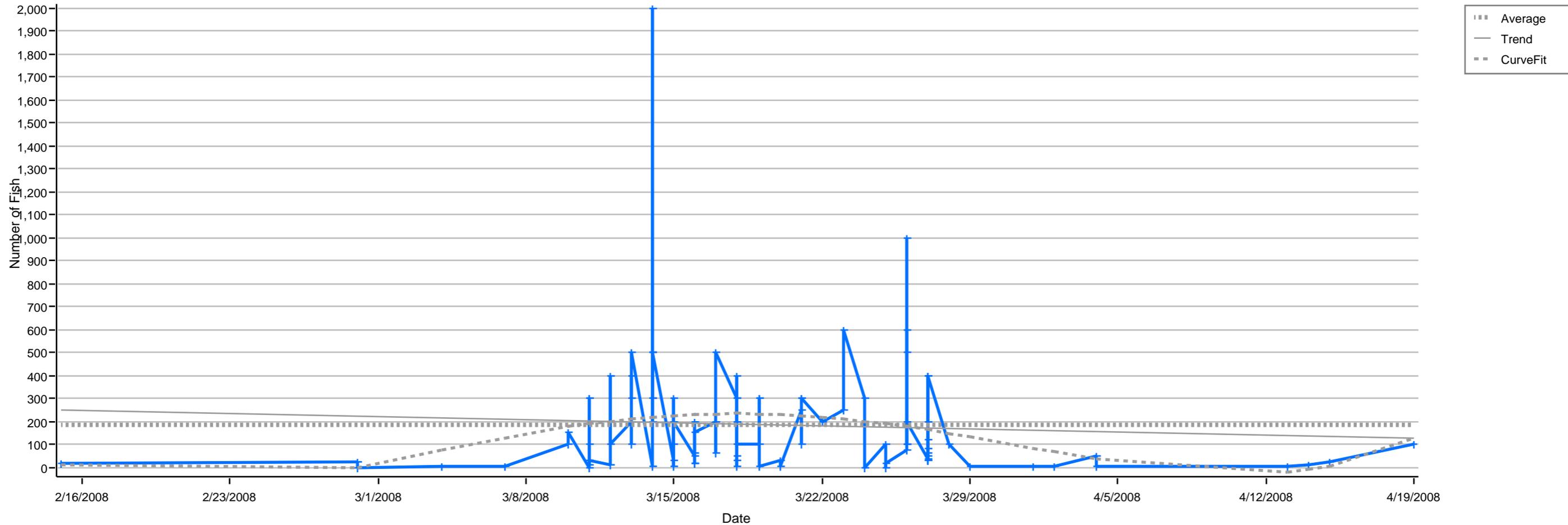
Only observed in 11 streams.

2007 Chi Observations



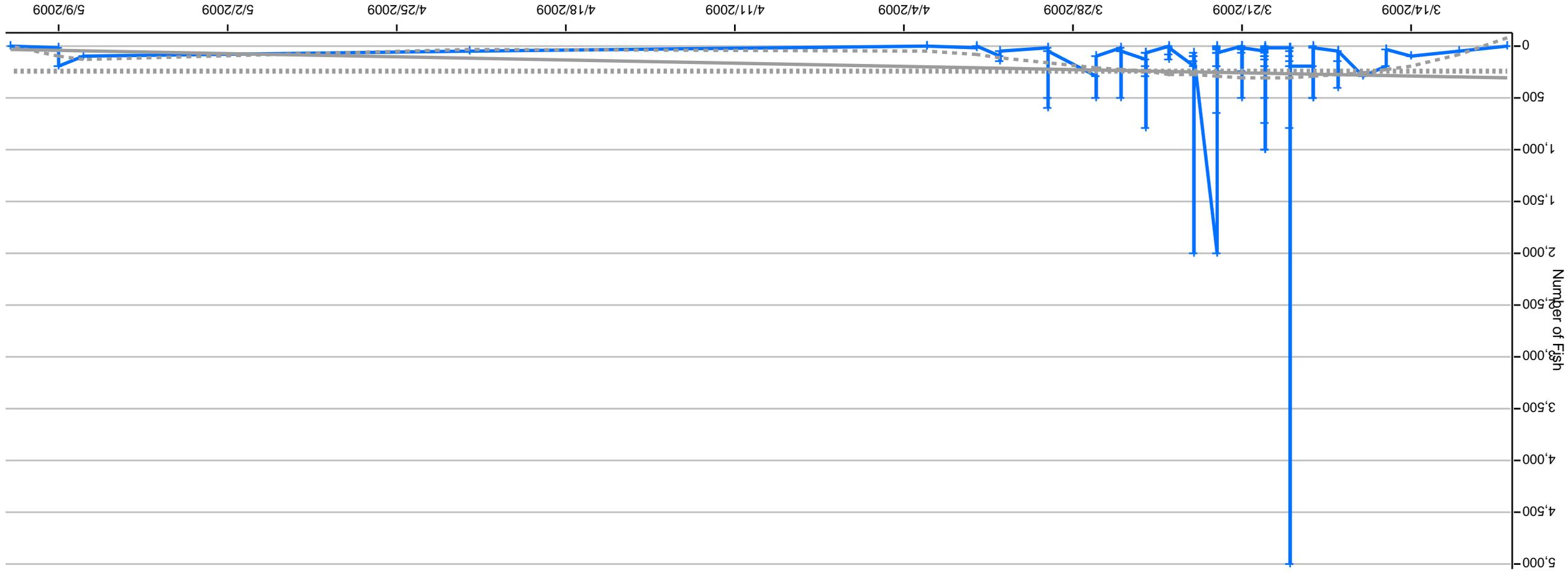
Only observed in five streams.

2008 Chi Observations



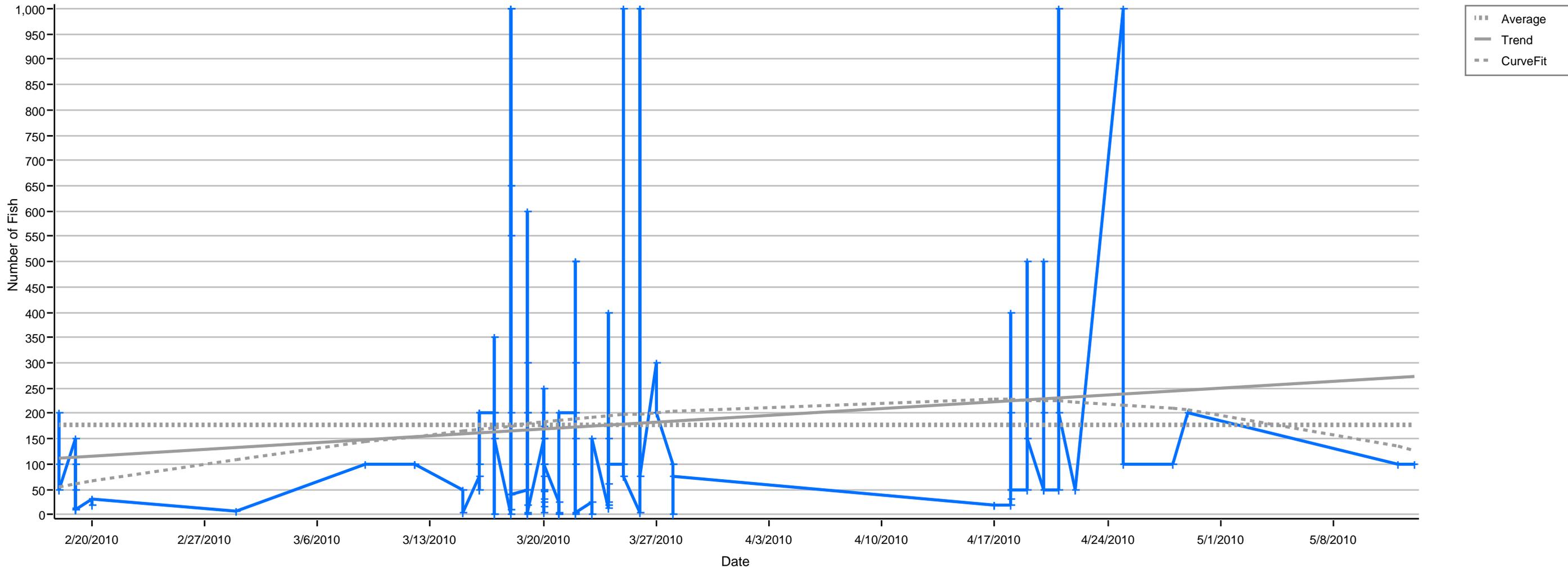
Only observed in six streams.

2009 Chi Observations

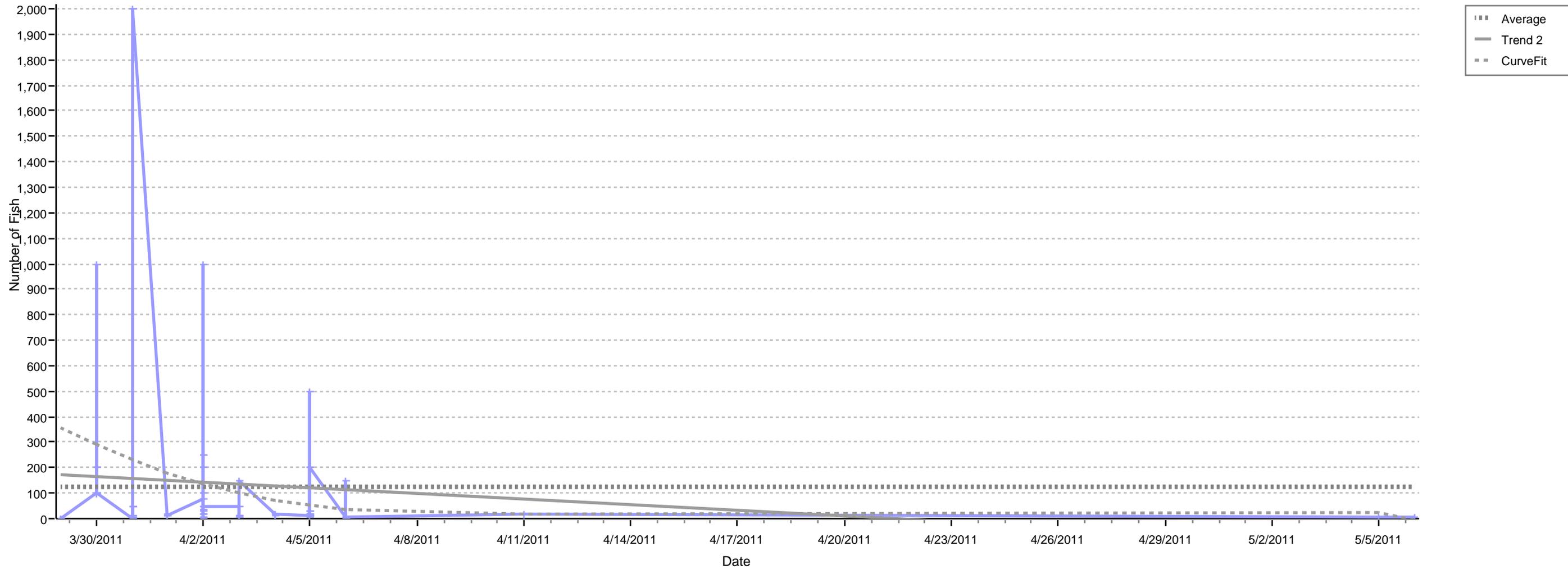


Only observed in seven streams.

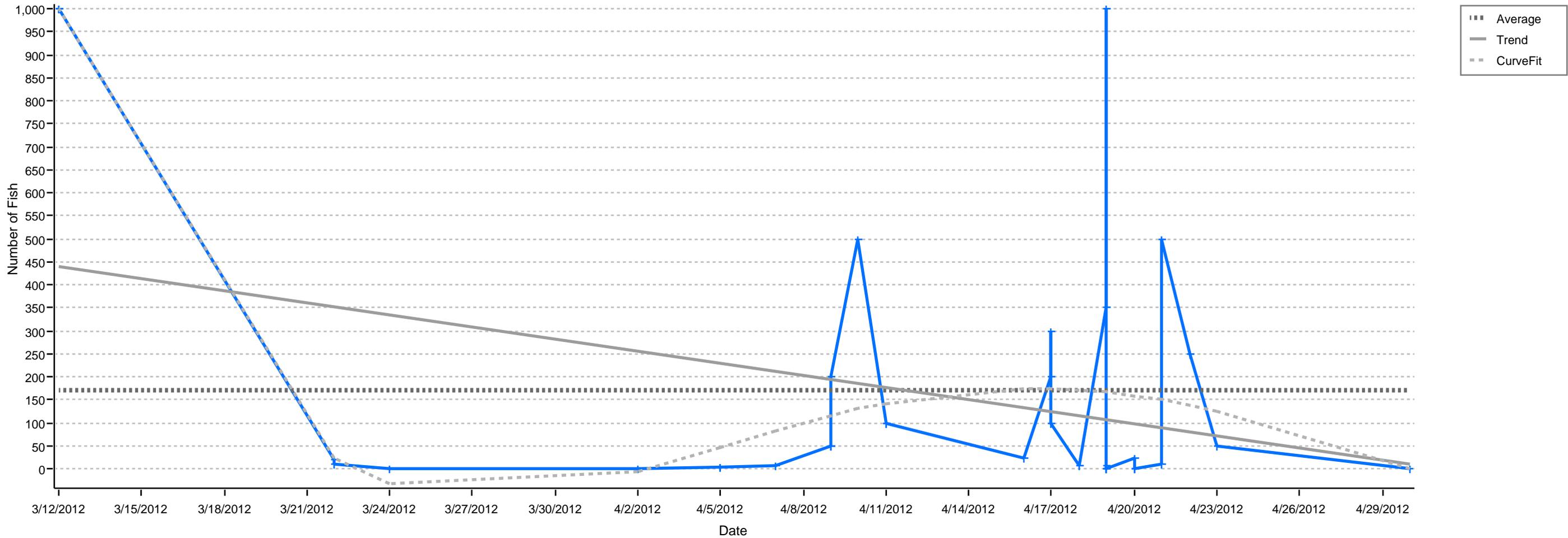
2010 Chi Observations



2011 Chi Observations

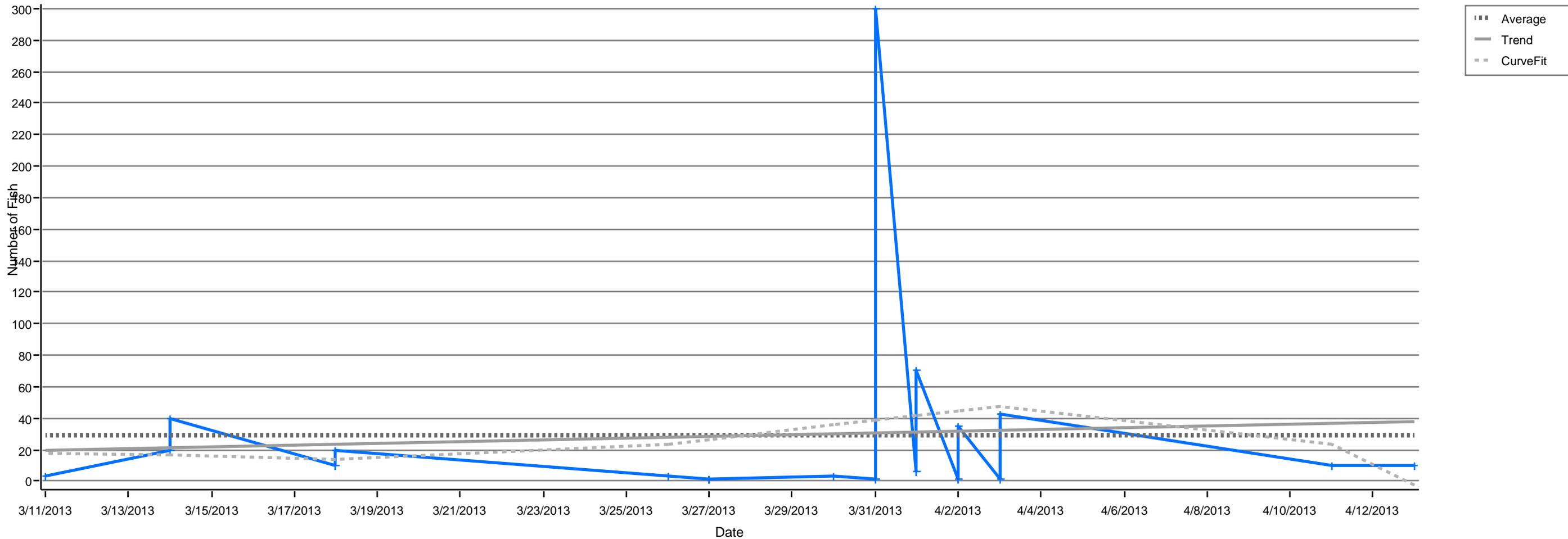


2012 Chi Observations



Only observed in eight streams.

2013 Chi Observations



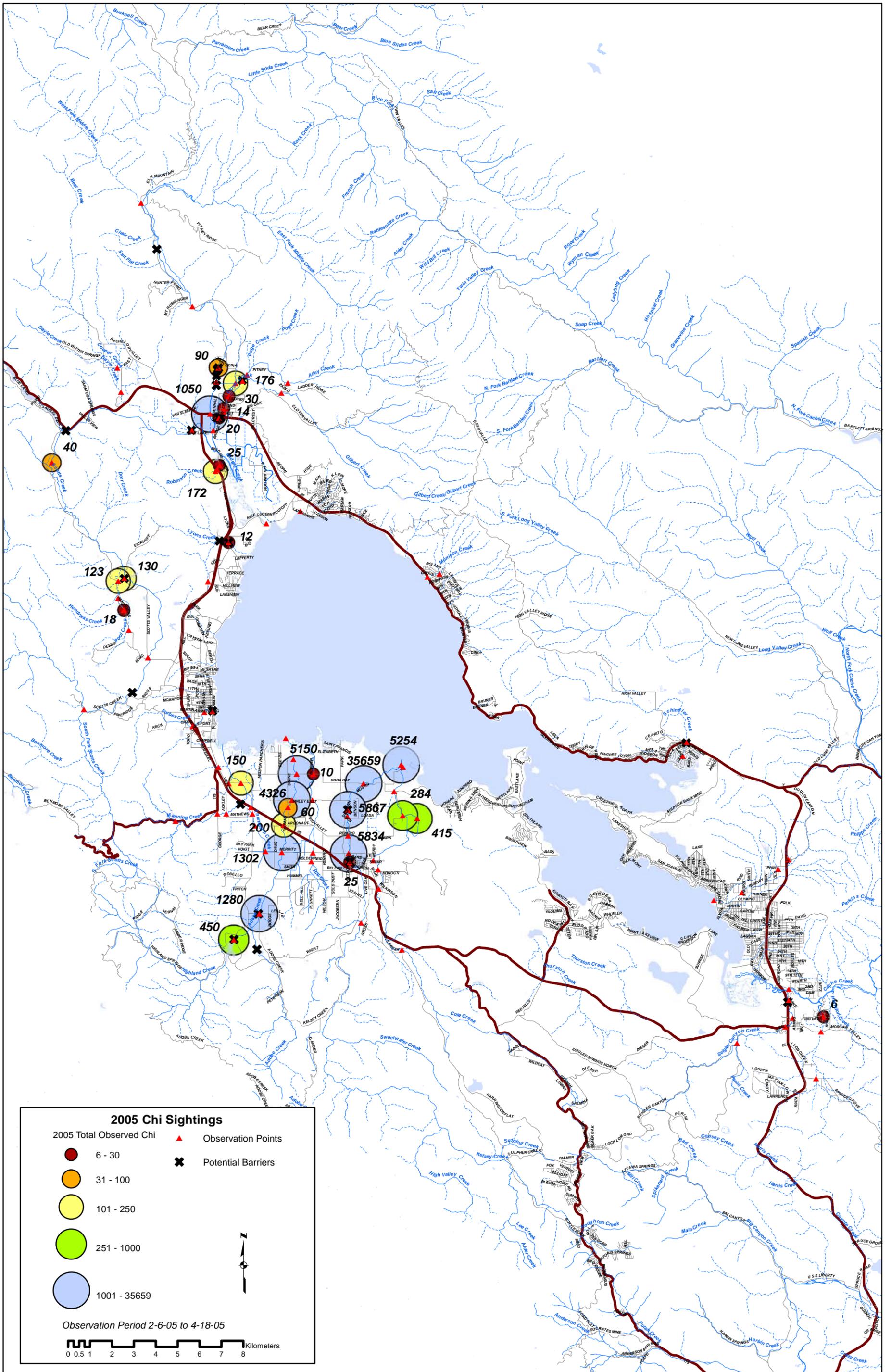
Only observed in four streams.

Appendix B

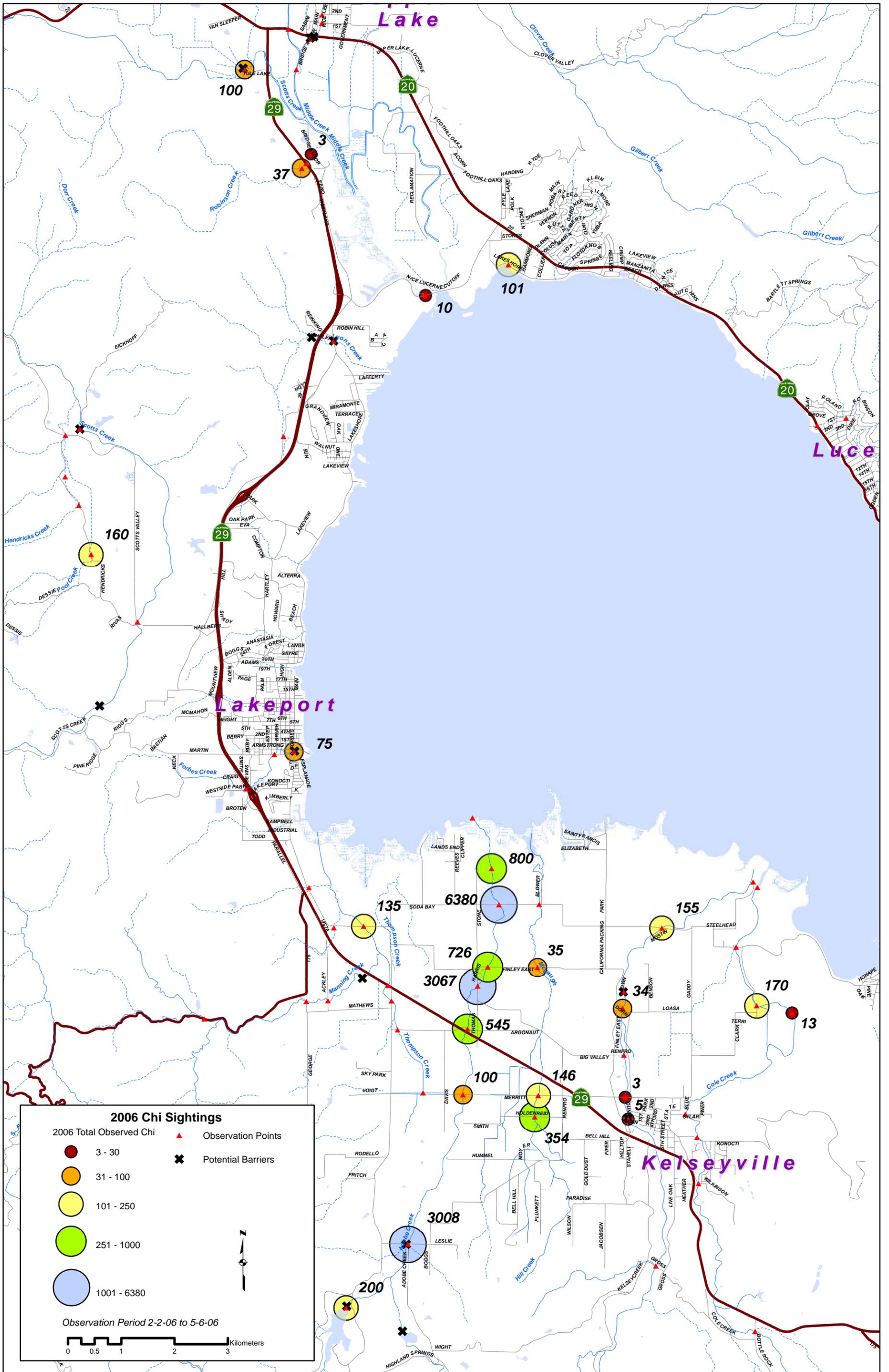
Appendix B. Figures depicting CLH observations on spawning tributaries

Appendix B

This page left blank intentionally



90, 1050, 176, 30, 14, 20, 25, 172, 12, 123, 130, 18, 150, 5150, 35659, 5254, 4326, 10, 284, 60, 5867, 200, 5834, 415, 1302, 25, 1280, 450, 6



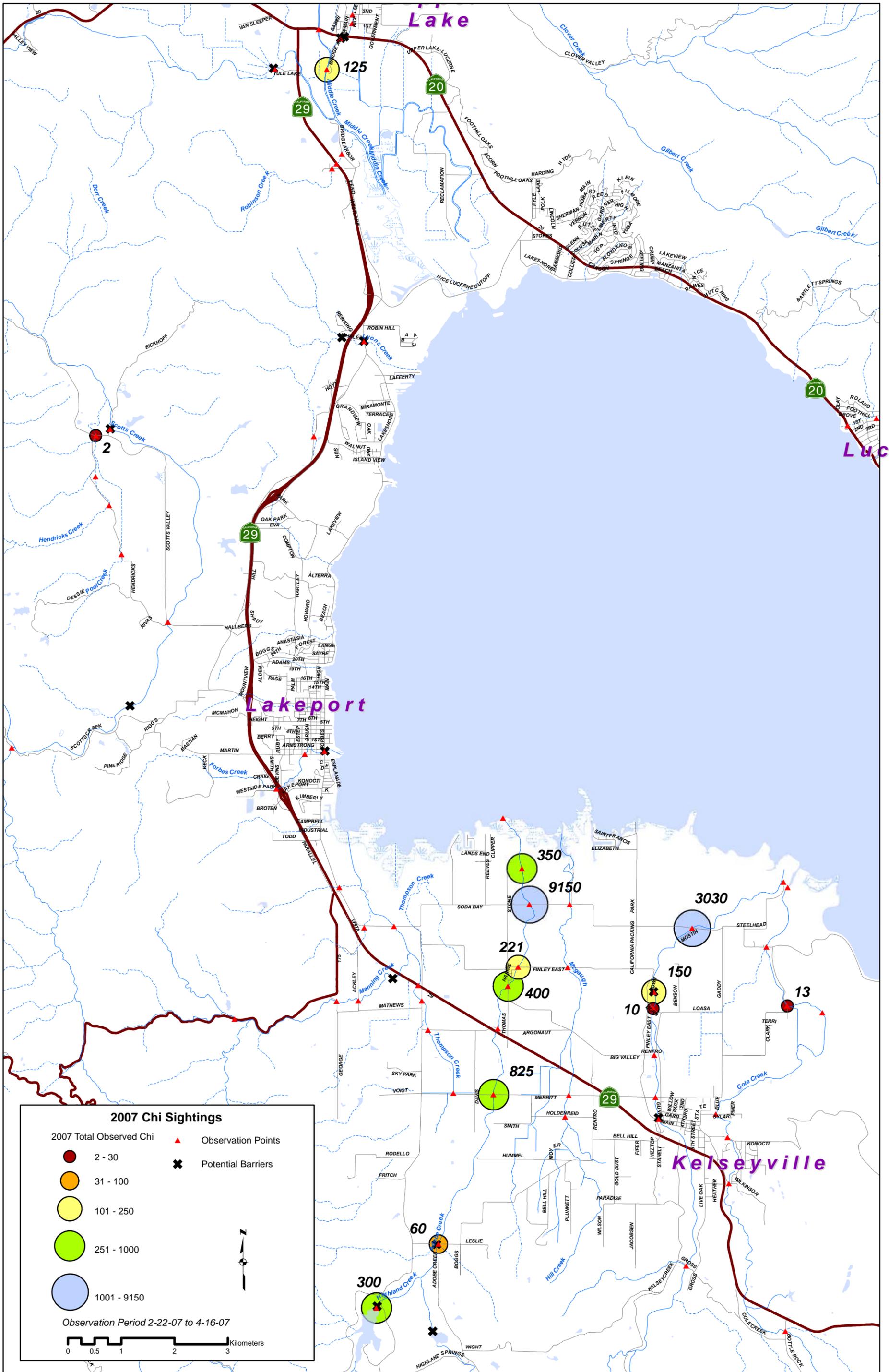
2006 Chi Sightings

- | | |
|-------------------------|----------------------|
| 2006 Total Observed Chi | ▲ Observation Points |
| ● 3 - 30 | ✘ Potential Barriers |
| ● 31 - 100 | |
| ● 101 - 250 | |
| ● 251 - 1000 | |
| ● 1001 - 6380 | |

Observation Period 2-2-06 to 5-6-06

0 0.5 1 2 3 Kilometers



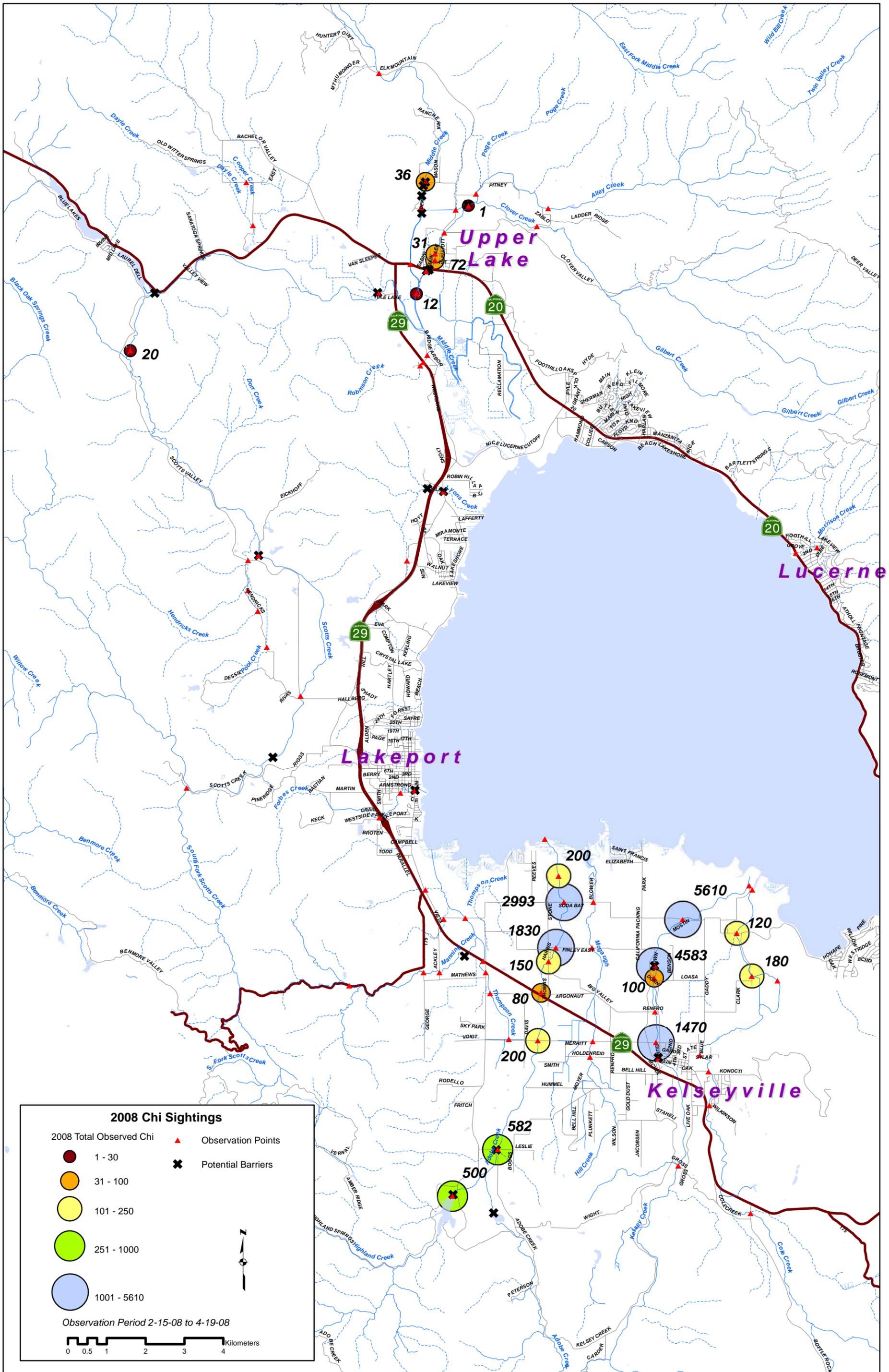


2007 Chi Sightings

- | | |
|-------------------------|----------------------|
| 2007 Total Observed Chi | ▲ Observation Points |
| ● 2 - 30 | ✘ Potential Barriers |
| ● 31 - 100 | |
| ● 101 - 250 | |
| ● 251 - 1000 | |
| ● 1001 - 9150 | |

Observation Period 2-22-07 to 4-16-07





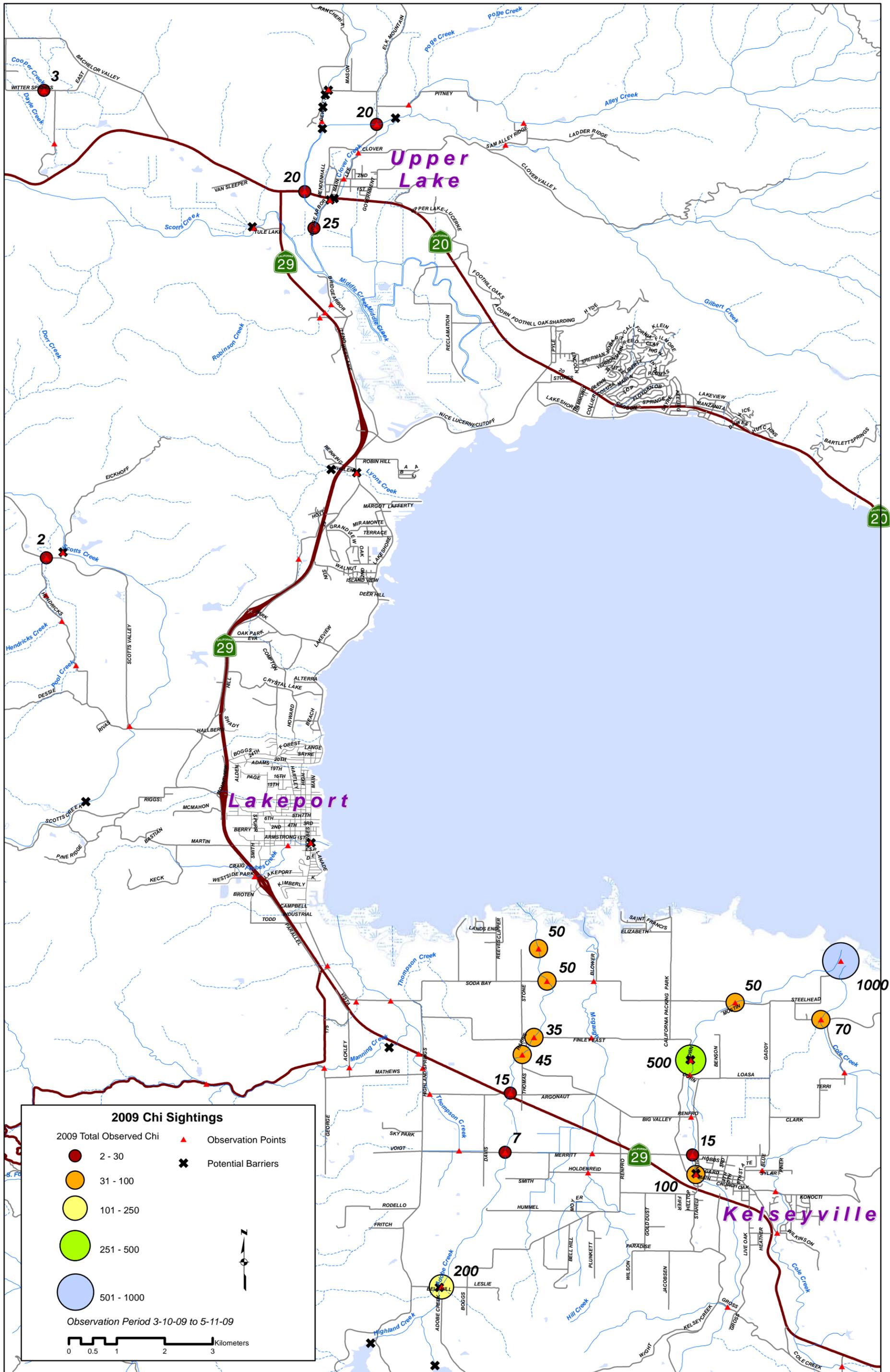
2008 Chi Sightings

- 2008 Total Observed Chi
- 1 - 30
 - 31 - 100
 - 101 - 250
 - 251 - 1000
 - 1001 - 5610

- ▲ Observation Points
- ✕ Potential Barriers

Observation Period 2-15-08 to 4-19-08





Upper Lake

Lakeport

Kelseyville

20

20

25

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

29

20

3

2

2

2

2

2

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

20

50

50

35

45

15

7

200

200

200

200

200

200

50

50

35

45

15

7

200

200

200

200

200

200

50

50

35

45

15

7

200

200

200

200

200

200

50

50

35

45

15

7

200

200

200

200

200

200

50

50

35

45

15

7

200

200

200

200

200

200

1000

70

15

15

100

15

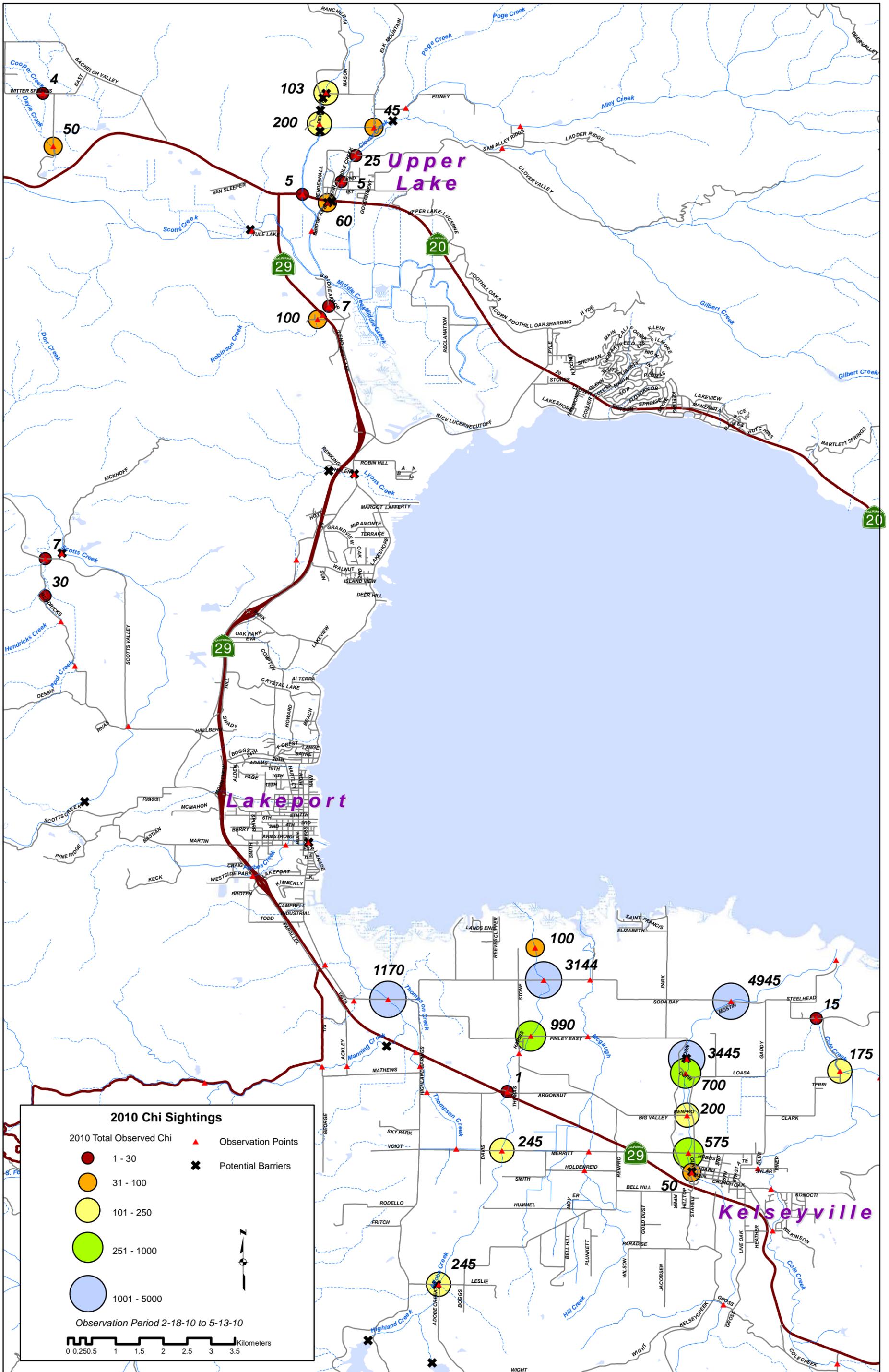
15

15

15

15

15



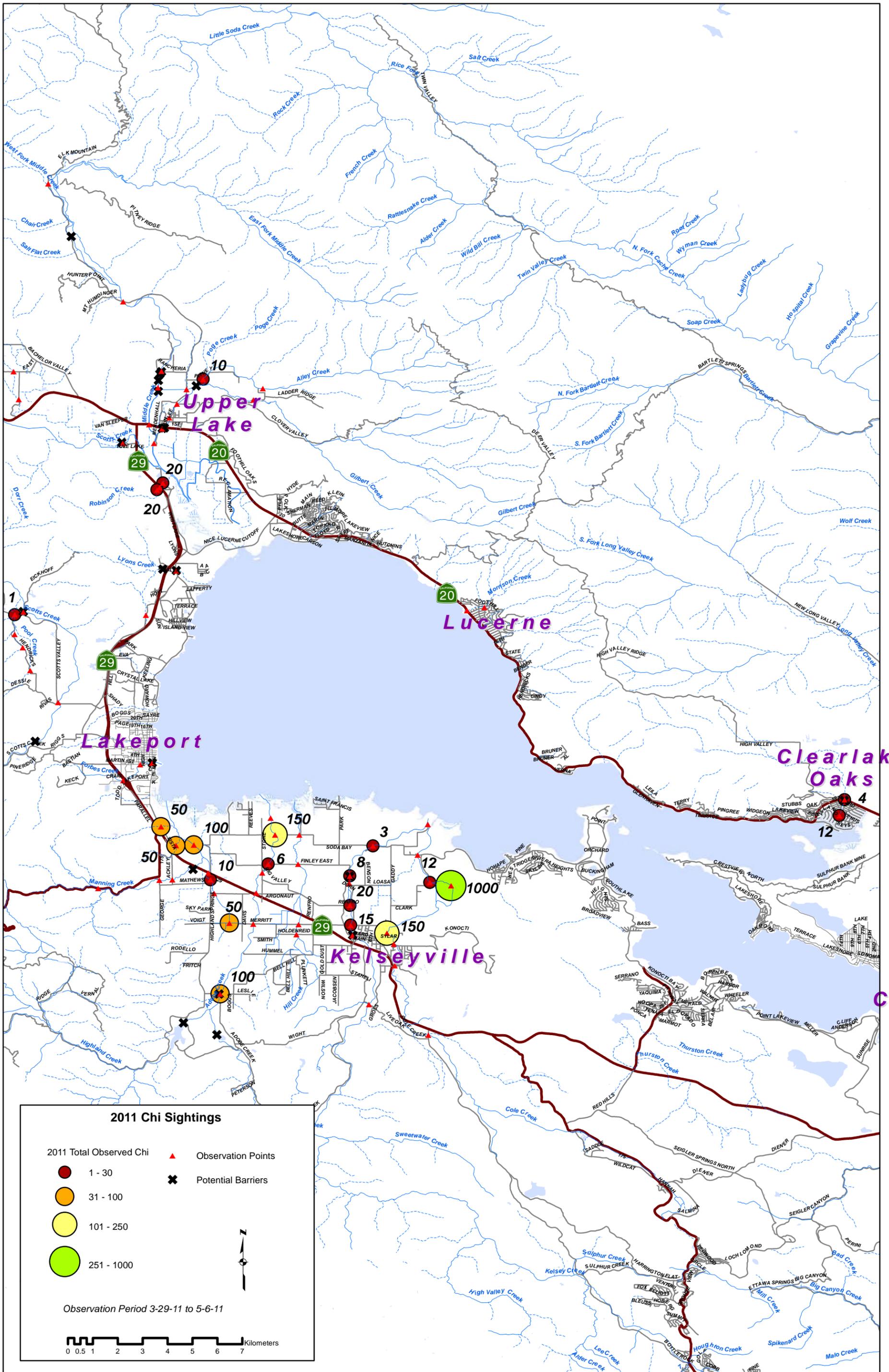
2010 Chi Sightings

- | | |
|-------------------------|----------------------|
| 2010 Total Observed Chi | ▲ Observation Points |
| ● 1 - 30 | ✕ Potential Barriers |
| ● 31 - 100 | |
| ● 101 - 250 | |
| ● 251 - 1000 | |
| ● 1001 - 5000 | |

Observation Period 2-18-10 to 5-13-10

0 0.250.5 1 1.5 2 2.5 3 3.5 Kilometers



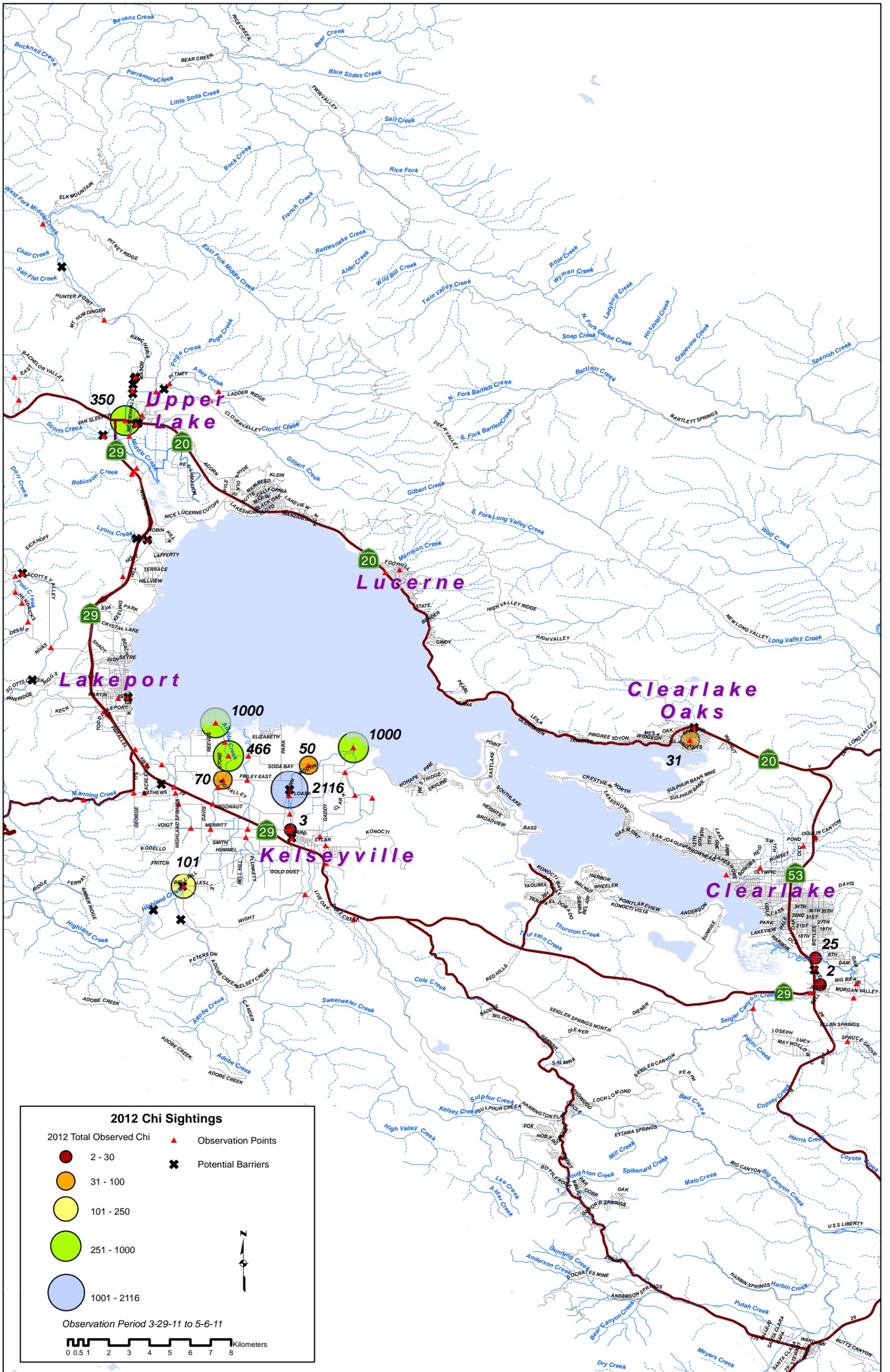


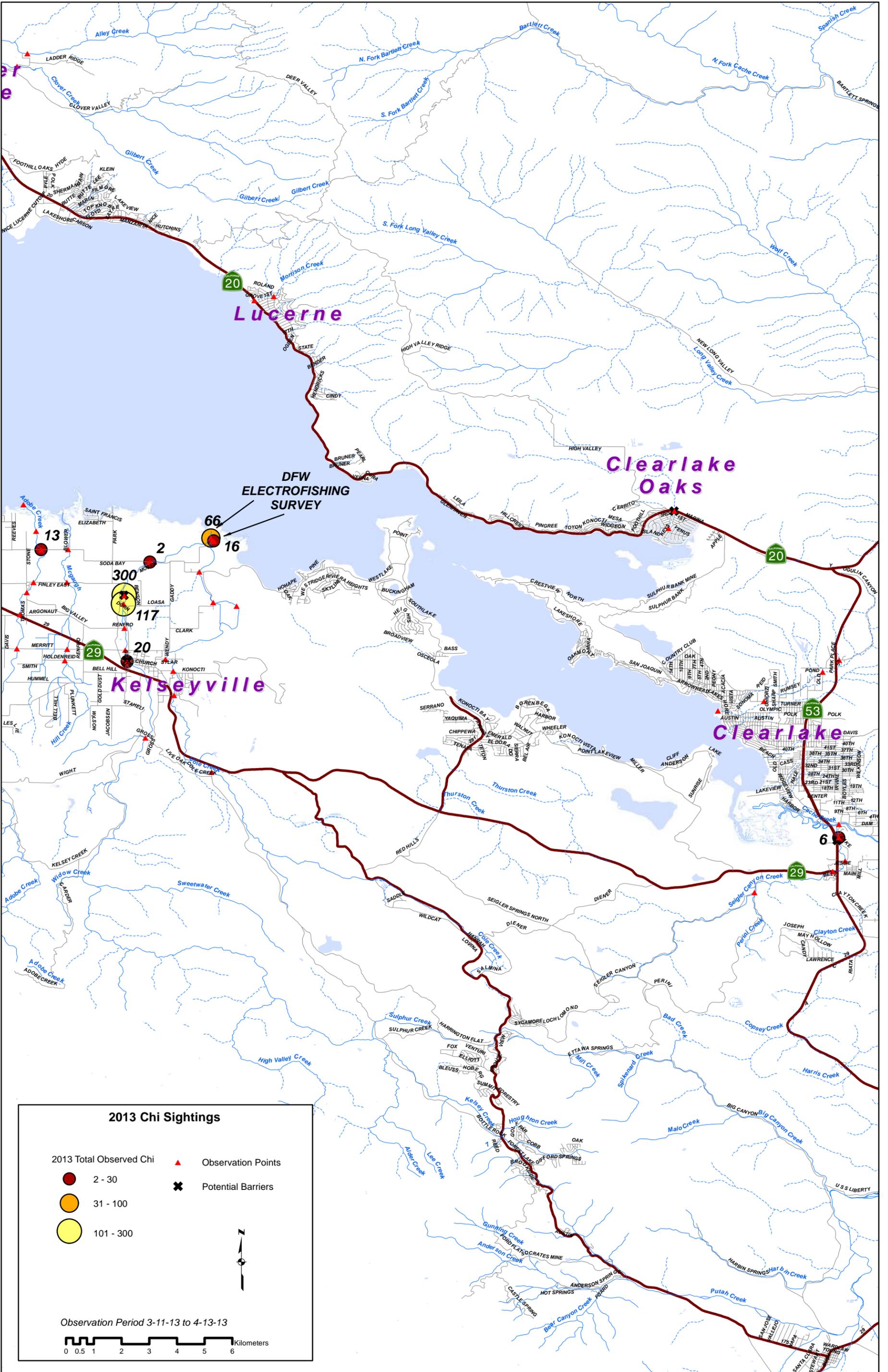
2011 Chi Sightings

- | | |
|-------------------------|----------------------|
| 2011 Total Observed Chi | ▲ Observation Points |
| ● 1 - 30 | ✘ Potential Barriers |
| ● 31 - 100 | |
| ● 101 - 250 | |
| ● 251 - 1000 | |

Observation Period 3-29-11 to 5-6-11







Appendix C

Appendix C. Description of barriers associated with CLH spawning tributaries

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

Adobe Creek: There is a flood control dam on Adobe Creek above Bell Hill Road that is impassable to hitch. There are two culverts on Adobe Creek that are mitigation barriers to spawning hitch when the water flows and velocity are not too great, but these culverts block hitch migration.

Alley Creek: Alley Creek has been channeled and diverted into Clover Creek. Alley Creek historically supported hitch runs. During some time and under certain conditions migrating hitch can access Alley Creek via the Clover channel bypass, but not when the diversion has silt or sand obstructing it.

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 usually becomes a complete barrier when filled with gravel and sediment.

Forbes Creek: Forbes Creek has a concrete storm water diversion structure that impedes and at times blocks hitch passage.

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 barrier to the passage of hitch (Peter Windrem, personnel communication, 2012). The structure has a fish ladder which is nonfunctional 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 impede 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.

Appendix C

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

Manning Creek: A dam upstream of known hitch spawning areas in the lower reaches of Manning Creek may prevent hitch from spawning further upstream.

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 at the Decker Bridge is a total barrier to the passage of hitch. As water levels have been lower, a barrier at the lower end of Tule lake is problematic for fish passage to Tule lake 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 prevents 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 completely blocks hitch access to that creek, once a major spawning tributary.

Appendix D

Appendix D. Comments from affected and interested parties on the petitioned action

Appendix D

This page left blank intentionally

Thomas, Kevin@Wildlife

From: Roberta Alba <rbtaalba@gmail.com>
Sent: Friday, May 31, 2013 1:16 PM
To: Clear Lake Hitch
Subject: CLEARLAKE HITCH

To Whom It May Concern at CDFW: What a shock to hear that the #3 rated bass lake in the United States could be wiped out by something most people consider a trash fish. It is hard to imagine that the hitch is so valuable and sacred to a certain Indian tribe. Subsidize them. If the hitch population and propagation is low, obviously there are many factors. To solely blame and remove bass would be a gross misunderstanding of the food chain and predation. If you remove bass, you MUST remove eagles, ospreys, otters, minks, seagulls, pelicans, mergansers, crappie, bluegill, catfish, carp, grebes, herons, egrets, turtles, bullfrogs and even mallard ducks, which I have seen eating clouds of fry. All of the above eat the hitch or the eggs. Let's not forget that the last two years have seen below-average rainfall to feed the spawning creeks. Also, have any studies been done to see what is being FLUSHED out of orchards/vineyards and off the streets by runoff? Various chemicals might be the real culprit, as well as the spraying of aquatic weeds. Economically, shutting down fishing at Clear Lake would surely be a disaster for an already depressed county. We spend over \$8,000 a year between Lakeport and Glenhaven. We could easily stay in the Bay Area and fish the local reservoirs and the delta, but we choose Clear Lake. Clearly, there will be a domino effect curtailing fishing, especially bass fishing. Just think how the casinos, motels, resorts, grocery stores, gas stations, bait shops, and other local merchants will lose. Even the State Park will lose a lot of revenue. Please do not let a special interest group torpedo the incomes and lives of so many people who really enjoy the lake. Clear Lake is a treasure which should be shared by all and preserved as such. Sincerely, Ted and Roberta Alba 2808 Euclid Avenue, Richmond, CA 94804



May 29, 2013

California Department of Fish and Wildlife
North Central Region
Attn: Kevin Thomas
1701 Nimbus Road
Rancho Cordova, CA 95670
Kevin.thomas@wildlife.ca.gov
CLH@wildlife.ca.gov

California Fish and Game Commission
Sonke Mastrup, Executive Director
P.O. Box 944209
Sacramento, CA 94244-2090
fgc@fgc.ca.gov

Re: Comments on Status of Clear Lake Hitch

The Center for Biological Diversity submits the following comments on the status of Clear Lake hitch (*Lavinia exilicauda chi*).

We have enclosed the 2013 spawning survey results from the Chi Council for the Clear lake Hitch (see <http://lakelive.info/chicouncil/2013results.html>), which indicate that the Clear Lake hitch spawning run was almost nonexistent this spring. Despite more than 275 observational surveys conducted in 14 former hitch spawning streams, during the entirety of the 2013 hitch spawning season from February 9 through April 22, spawning hitch were found in only three streams.

More disturbingly, the numbers of hitch observed were the lowest since regular surveys began in 2005. Only one school of spawning hitch of any biological significance was observed in the entire Clear Lake basin: 300-400 hitch seen in Kelsey Creek in late March. Kelsey Creek had been the stronghold for spawning Clear Lake hitch, with more than 10,000 fish observed as recently as 2010. In Adobe Creek, which has been the other Clear Lake tributary with recent successful hitch reproduction, the hitch run was almost nonexistent in 2013, with only 53 fish seen on three occasions. Adobe Creek had 2,000 spawning hitch as recently as 2011. Six hitch were also observed in Seigler Creek in 2013. A DFW electrofishing survey also found small numbers of hitch (only 13 fish) at the mouth of Cole Creek on two occasions in March of 2013, but there is no evidence that hitch spawned in Cole Creek in 2013.

In short, the entirety of the spawning population of Clear Lake hitch has collapsed during the dry spring of 2013 to a critically low level which indicates that Clear Lake hitch are in imminent danger of going extinct in the immediate future without swift management and restoration efforts. **Accordingly, we urge the Department and Commission to promptly list the Clear Lake hitch as endangered, on an emergency basis.**

A July 2012 white paper by researchers at the University of California, Davis for the California Energy Commission's California Climate Change Center systematically evaluated climate change impacts on freshwater fishes in California.¹ A copy of that report is attached. Clear Lake hitch were found to be "critically vulnerable" to climate change. The researchers, including California native fish expert Dr. Peter Moyle, designate the conservation status of the Clear Lake hitch as endangered, based on climate change vulnerability scores, standards of the International Union for the Conservation of Nature, and conservation status information from Moyle et al. (2011).²

Sincerely,

Jeff Miller
Center for Biological Diversity
351 California Street, Suite 600
San Francisco, CA 94104
E-mail: jmiller@biologicaldiversity.org
Phone: (510) 499-9185

¹ Moyle, Peter B., Joseph D. Kiernan, Patrick K. Crain, and Rebecca M. Quiñones (University of California, Davis). 2012. ***Projected Effects of Future Climates on Freshwater Fishes of California***. California Energy Commission. Publication number: CEC - 500 - 2012 - 028.

² Moyle, P. B., J. V. E. Katz, and R. M. Quiñones. 2011. "Rapid decline of California's native inland fishes: A status assessment." *Biological Conservation* **144**: 2414–2423.

Chi Council for the Clear Lake Hitch

P. O. Box 1081, Kelseyville, CA 95451

www.lakelive.info/chicouncil

June 14, 2013

Via Email to clh@wildlife.ca.gov & U.S. mail

Mr. Kevin Thomas, Environmental Scientist
California Department of Fish & Wildlife
1701 Nimbus Road, Suite A
Rancho Cordova, CA 95670

Re: Clear Lake Hitch

Dear Mr. Thomas:

The Chi Council for the Clear Lake Hitch was formed in 2004 as a Coordinate Resource Management and Planning Project (CRMP) in Lake County, California. The Council was formed with the assistance of the Eastlake & Westlake Conservation Districts to facilitate coordinated activities between public agencies, tribes, private landowners and other interest groups interested in the welfare of the Clear Lake Hitch. The goal of the Council is to maintain a viable hitch population and a properly functioning habitat. The specific goals are to:

- Study, protect, restore, and maintain the watershed ecosystem leading to a restored population of Clear Lake Hitch
- Study and recognize the “lake effect” on the hitch population by the introduction of non-native fish, the condition of the shoreline habitat, the effects of pollutants in the water column, and aquatic conditions in general
- Study the fish population during migratory runs

Among its various activities, the Council sponsors a program to monitor the annual spawning migration of the hitch up the tributaries to Clear Lake. Specifically, the Council organizes volunteers and others to monitor streams to determine each year:

- When the spawning migration begins and ends
- In which streams the hitch spawn
- The sizes of the schools of hitch observed

Monitors are asked to make observations from specific locations on streams, principally from bridges. They post their observations on tally sheets with the following information:

Mr. Kevin Thomas, Environmental Scientist

June 14, 2013

Page 2

- The date of the observation
- The time of day
- The name of the stream
- The location, typically the name of the road on which the bridge is located
- The total number of hitch seen and, if no hitch are seen, that fact is entered
- Any other observations of interest, in particular hitch predators or water quality

The tally sheets are sent to the secretary of the Chi Council who enters the information onto a spreadsheet that is then posted to the Council's website at www.lakelive.info/chicouncil.

Accompanying this letter is a chart for each year from 2005 through 2013, derived from the data contained in those spreadsheets, that:

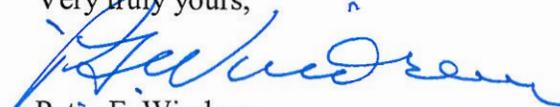
- Lists the names of the principal tributaries to Clear Lake
- Identifies the time periods during which monitoring of a stream occurred
- Identifies the time periods in which hitch were observed in each stream
- Identifies the time periods during which no monitoring occurred
- Contains notes on the significant characteristics of the migration

From these reports, the following conclusions may be drawn:

- The number of streams where significant numbers, i.e., thousands, of hitch spawn has declined since 2005.
- Most spawning now occurs in Adobe and Kelsey Creeks and, to a lesser extent, Cole Creek.
- Hitch spawning in Middle Creek and Scotts Creek and their tributaries, Clover Creek and Hendricks Creek, has declined to where no significant numbers of hitch spawn in those major tributaries to Clear Lake.
- The overall population of hitch has declined as fewer streams are populated with spawning fish.

We hope you find this information useful. If you have questions, please do not hesitate to contact us.

Very truly yours,



Peter F. Windrem
Chair of the Chi Council

Enclosures

Chi Council for the Clear Lake Hitch

Summary report on spawning migrations of the

Clear Lake Hitch

2005 - 2013

Prepared for Kevin Thomas, Environmental Ecologist
California Department of Fish & Wildlife

June 14, 2013

2005 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(33 observers recorded 380 observations)

	FEB					MARCH					APRIL					MAY				
	1-5	6-10	11-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	
CREEK																				
Cole																				
Kelsey																				
McGaugh																				
Hill																				
Adobe																				
Manning																				
Thompson																				
Forbes																				
Robinson																				
Scotts																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Byps																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

Periods of time during which observations were made with no fish observed.

Periods of time during which hitch were observed in varying numbers.

Period of time during which no monitoring was conducted.

Kelsey Creek has large schools of 2000+; Adobe Creek 1000+; Middle Creek 400+. Schools of less than 100 fish were typically seen in other streams. Too few observations were made on Scotts or Hendricks creeks to draw any conclusions. The early February siting on Scotts Creek was probably not hitch, but Sacramento suckers begin to spawn earlier than hitch. Heavy rain and stream flows stopped the migration in late February. The migration ended around March 16th. A few small schools were sited in mid-April.

2006 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(28 observers recorded 501 observations)

	FEB					MARCH					APRIL					MAY				
	1-5	6-10	11-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	
CREEK																				
Cole																				
Kelsey																				
McGaugh																				
Hill																				
Adobe																				
Manning																				
Thompson																				
Forbes																				
Robinson																				
Scotts																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Bypas																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

Periods of time during which observations were made with no fish observed.

Periods of time during which hitch were observed in varying numbers.

Periods of time during which no monitoring was conducted.

Adobe has hitch spawning for 3 months interspersed with heavy rainfall and high flows at the end of February and first 3 weeks of March. Kelsey has only 3 schools reported on April 23, 24 & 27 of 34, 100 & 50 fish only. No fish are observed in Middle and Clover Creeks; Scotts valley has only 1 unconfirmed sighting. Schindler and Seigler Canyon have no fish.

2007 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL
(22 observers recorded 279 observations)

	FEB					MARCH					APRIL					MAY			
	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	16-20
CREEK																			
Cole	Wavy			Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Kelsey	Wavy			Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
McGaugh																			
Adobe	Wavy			Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Manning																			
Thompson		Wavy																	
Robinson				Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Scotts				Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Cooper																			
Hendricks					Wavy														
Pool																			
Middle				Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Clover				Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Clover Bypas																			
Alley																			
Schindler	Wavy			Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy	Wavy
Copsey																			
Siegler Cyn	Wavy																		

KEY & COMMENTS

Wavy	Periods of time during which observations were made with no fish observed.
Grey	Periods of time during which hitch were observed in varying numbers.
White	Period of time during which no monitoring was conducted.

Adobe Creek has very large runs with schools in excess of a thousand fish. Kelsey Creek has generally smaller schools numbering the hundreds. Cole Creek very few fish seen – the largest count is 11 fish. In no other tributary to Clear Lake are hitch observed.

2008 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(31 observers recorded 405 observations)

	FEB					MARCH					APRIL					MAY			
	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	16-20
CREEK																			
Cole																			
Kelsey																			
McGaugh																			
Adobe																			
Manning																			
Thompson																			
Robinson																			
Scotts																			
Cooper																			
Hendricks																			
Pool																			
Middle																			
Clover																			
Clover Byps																			
Alley																			
Schindler																			
Copsey																			
Siegler Cyn																			

KEY & COMMENTS

Periods of time during which observations were made with no fish observed.

Periods of time during which hitch were observed in varying numbers.

Period of time during which no monitoring was conducted.

Adobe, Kelsey & Cole creeks had substantial runs. Adobe reported schools of 500+; Kelsey reported schools of 500+; Cole Creek had schools of 300+. No other creek reported hitch in any significant number. The largest schools in Middle Creek and Clover Creek were 30 fish. Monitoring of Scotts & Hendricks creeks revealed no fish.

2009 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL
(21 observers recorded 361 observations)

	FEB					MARCH					APRIL					MAY			
	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	16-20
CREEK																			
Cole																			
Kelsey																			
McGaugh																			
Adobe																			
Manning																			
Thompson																			
Robinson																			
Scotts																			
Cooper																			
Hendricks																			
Pool																			
Middle																			
Clover																			
Clover Byps																			
Alley																			
Schindler																			
Copsey																			
Siegler Cyn																			

KEY & COMMENTS

Periods of time during which observations were made with no fish observed.

Periods of time during which hitch were observed in varying numbers.

Kelsey Creek had large schools of 1000+ fish seen; Adobe had schools of 800+ fish. Middle Creek had a single confirmed sighting of 20 fish. Hendricks Creek, a major tributary to Scotts Creek, had no sightings. If there are fish in Scotts Creek, they migrate into Hendricks. From the lack of fish in Hendricks, one may conclude there were no hitch in Scotts Creek.

2010 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(46 observers recorded 468 observations)

	FEB					MARCH					APRIL					MAY				
	10-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	
CREEK																				
Cole																				
Kelsey																				
Adobe																				
Manning																				
Thompson																				
Robinson																				
Scotts																				
Cooper																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Bypas																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

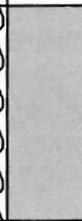
	Periods of time during which observations were made with no fish observed.
	Periods of time during which hitch were observed in varying numbers.
	Period of time during which no monitoring was conducted.
	The spawning season stretched in Adobe Creek from mid-February to mid-May. Periodic high water flows interrupted the spawning. As noted in earlier years, Adobe Creek is the most consistent and largest spawning creek followed by Kelsey Creek. No large runs were reported for Middle, Clover or Scotts Creek; any reported sightings were less than 100 fish and there were very few of those. Some fish were observed in small tributaries on the west side of Clear Lake, e.g. in a ditch at the intersection of Hiway 175 and South Main Street.

2011 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(34 observers recorded 329 observations)

CREEK	FEB				MARCH				APRIL				MAY							
	10-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	
Cole																				
Kelsey																				
Adobe																				
Manning																				
Thompson																				
Robinson																				
Scotts																				
Cooper																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Bypas																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

	Periods of time during which observations were made with no fish observed.
	Periods of time during which hitch were observed in varying numbers.
	Period of time during which no monitoring was conducted.

The spawning run was compressed and late because of high flows from heavy rains throughout March. Turbid conditions prior to recorded sightings may have obscured presence of migrating fish. Predators were observed, e.g., osprey, mergansers, herons, fishing in Adobe Creek a week before the hitch could be seen because of turbid water. The largest schools were in Adobe Creek (2,000+) and Cole Creek where over 1,000 were trapped in a flood basin by receding water. Thompson Creek had fish because the high water flows allowed rare passage over a low water crossing barrier on Manning Creek. Kelsey Creek had very few fish; nothing like prior years. Hitch were reported in Schindler Creek on April 4th (13 fish) & 5th (12 fish) for the first time since 2005.

2012 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(26 observers recorded 216 observations)

	FEB					MARCH					APRIL					MAY				
	10-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	
CREEK																				
Cole																				
Kelsey																				
Adobe																				
Manning																				
Thompson																				
Robinson																				
Scotts																				
Cooper																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Byps																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

	Periods of time during which observations were made with no fish observed.
	Periods of time during which hitch were observed in varying numbers.
	Period of time during which no monitoring was conducted.

The hitch run did not begin until April. The stream flows in February and March were very low. A school of 1000+ hitch was seen off the mouth of Adobe Creek on April 12th. The largest school seen in Adobe Creek was 250 fish seen on April 22nd during a tribal fish tagging operation. Most fish were seen in Kelsey Creek below the detention structure. One school of 350 fish was seen in Middle Creek on April 19th and 1 fish in Clover Creek the same day. No other fish were seen in Middle Creek and none were seen in Scotts Creek or its principal tributary, Hendricks Creek.

2013 SPRING HITCH MONITORING IN CREEKS BY CHI COUNCIL

(12 observers recorded 175 observations)

	FEB			MARCH					APRIL				MAY							
	10-15	16-20	21-25	26-28	1-5	5-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	5-10	11-15	
CREEK																				
Cole																				
Kelsey																				
Adobe																				
Manning																				
Thompson																				
Robinson																				
Scotts																				
Cooper																				
Hendricks																				
Pool																				
Middle																				
Clover																				
Clover Byps																				
Alley																				
Schindler																				
Copsey																				
Siegler Cyn																				

KEY & COMMENTS

 Periods of time during which observations were made with no fish observed.

 Periods of time during which hitch were observed in varying numbers.

 Period of time during which no monitoring was conducted.

There was effectively no hitch run this year. The stream flows were extremely low because a lack of rainfall beginning in early January 2013. Less than 2000 hitch were seen in Kelsey Creek and less than 200 in Adobe Creek. Six hitch were reported in Seigler Canyon Creek on April 1st; there was no other sighting in that creek. No hitch were observed in any other stream. CA Department of Fish & Wildlife conducted electrofishing tests at the mouths of Kelsey Creek and Cold Creek. Small numbers of hitch were detected.

Thomas, Kevin@Wildlife

From: Sunny Franson <sunny@pacific.net>
Sent: Wednesday, May 29, 2013 1:29 PM
To: Ewing, Ben@Wildlife; Thomas, Kevin@Wildlife
Subject: for review
Attachments: observations2013.pdf; ATT00001.txt; ATT00002.txt; ATT00003.txt; ATT00004.txt

Ben and Kevin,

Your deadline for sending material for review is coming up. Ben, I'm attaching a recap of the observations I did this spring. You probably already know my thoughts - habitat loss is primary, I think.

Just FYI, a diver told one of us, Meyo Marrufo, at Robinson a few years back that he's been diving in Clear Lake for decades and has never seen a hitch in the lake proper. A fisherman with decades of experience told me the same thing.

Something bothering me is that creeks seems to be drying up earlier and earlier, water flows downhill, and it appears that water sold to Yolo might be released April-June. I'm not knowledgeable about specifics because I haven't done that research. I have a few notes on measurements we made for App.3 of the adaptive management plan - 2010 levels and flow: lowered levels, reduced-to-0 currents at Rodman (see draft plan, appendix 3, pg.15), and calculations for acre-feet lost by early summer. It's staggering. You expect to see juvenile fish in the creeks April-June.

Here are a few photos of Mendenhall, that used to be Middle Creek. Mendenhall runs more to the side of the Upper Lake basin. I lived next to it for many years; I was a piano teacher then. It was a creek that ran most of the year, lower in dry years and flooded in rainy years. Now it's dry except for runoff, and even that dries quickly. If memory serves this began about the mid-80's.

I don't know why this is happening, and the answer could be something completely unexpected. However if people are involved I don't feel anybody has the right to kill a beautiful little creek like this. It belongs to everyone - hitch used to migrate in it, mallards raised clutches in it. It's sad.

Good luck with all that you are doing.
Kind regards,
Sunny







Thomas, Kevin@Wildlife

From: Sunny Franson <sunny@pacific.net>
Sent: Friday, March 29, 2013 11:06 AM
To: Thomas, Kevin@Wildlife; Ewing, Ben@Wildlife
Cc: Peter WIndrem
Subject: re: Clear Lake hitch

Hello Kevin and Ben,

Work that I know has been done within the last several years includes Chi Council counts, tagging by local Tribes, the Draft Hitch Adaptive Management Plan, the final report to the US FWS for Robinson's Tribal Wildlife grant, and the very small study I did last year. I sent your Department copies of the last 3 as they came out, so you already have work I've done and/or organized and written. I wish I had more to send.

I think hitch need critical habitat of flooded grasses and wetlands and when crowded, shallow gravel beds in creeks. Temperatures and timing for egg and larval development appear to be crucial. It appears to me that these Cyprinids have evolved to fill specific spatial and temporal niches in the basin for all phases of their life cycle. When prey items that they need become available would be an integral part of those niches. I found support in references listed, especially in the last 2.

In the Upper Lake basin I know of a creek that used to run most of the year round, and hitch used to use it to migrate to a large, marshy field where they spawned. Since about the mid-80's this creek is generally dry. It used to have water even before winter rains. Folks have told me similar stories about other places close by, but I don't know exact timelines for those. Several large pear orchards have been pulled over the last couple of decades. It's puzzling, you wonder about the aquifer, and you see habitat loss.

You have your work cut out for you. Sending many good wishes, and hoping that we can all move forward with this. Peter is right, being proactive is best.
Sunny

California Fish and Wildlife.

April 29, 2013

North Central Region-c/o Mr. Kevin Thomas

Rancho Cordova, CA

Dear Mr. Thomas:

I am submitting a comment letter regarding the Clear Lake hitch for your group's consideration. Listing this fish as endangered and possibly being almost extinct is the only way any protection will be given the species. As a native fish in the Clearlake Basin, this fish serves as the beginning of our food chain.

The hitch have to spawn in low water, undisturbed but running. This sort of condition can only occur if farmers and ranchers are not been drawing off excess water for frost protection or irrigation. That has been the great source of the problem, as more and more vineyards and ranches/farms move into the area. As people exploit the resources, they will go away if protections and rules are not put into place. Local farmers and ranchers have been seen running irrigation to the creeks to alter the flow in order to water their crops or keep them from freezing. Some of the local supposedly upstanding citizens (one a judge) have been seen doing this.

Please continue the effort to get this species listed. The millions that were once seen in the creeks are now dwindling down to a dozen or so, if we are lucky.

I appreciate you taking the time to read my letter. The hitch can only survive if they are given protection because people have been altering the environment. They are known as "chi" to the natives and were often clubbed because they were blocking up the creek flow; that is how numerous they once were. *We need to manage The remaining fish wisely.*

Sincerely,

Ellen Karnowski

Ellen Karnowski

5591 Konocti Terrace Drive

Kelseyville, CA 95451

707-591-6708

Thomas, Kevin@Wildlife

From: Paul Kolb <paulkolb@netzero.net>
Sent: Friday, June 14, 2013 10:07 PM
To: Clear Lake Hitch
Subject: Hitch Endangered Species Comments

I have owned property with 600 feet of frontage on Middle Creek for the past 33 years. For many years, the hitch would spawn so heavily that many would be pushed up onto the shores of Middle Creek because the creek was completely full and colored black with densely packed 1 lb, 12" long hitch. For the past ten years, very few, maybe 100-300 fish were all that appeared all spring. This year, I saw no adult hitch, and some, maybe 1,000, unidentified 1" baby fish that are not likely hitch. The hitch are almost gone from Middle and nearby Clover creeks.

The few Hitch that remain must be protected with all the force of the California and Federal Endangered Species Acts. The data from observations is obvious; drastic action is needed.

See all the studies done by U. C., DR. Moyle, Fish and Game, the Chi Council, and others.
TAKE ACTION NOW! SAVE THE HITCH!

Now, the Clover Creek channel thru downtown Upper Lake is completely overgrown with Himalayan Blackberry, and is impassable by any fish. This may be a result of the recent clearing of the channel for flood control, and the resulting quick recovery and domination by the blackberry. Himalayan blackberry is very usable and productive, but it overgrows and smothers native areas all over Lake County; a program should be started to try to remove it selectively.

For Clover Creek, it is an emergency now. I have been observing my part of Middle Creek for the past many years, and it appears to me that the Clover Creek strain of Hitch, which must pass thru the Middle Creek channel to get to Clover Creek, has always shown up under the First Street bridge, and there is no way they could get there now. I believe that the Clover Creek strain is still alive and stronger than the rest of the Hitch which continue up Middle Creek. I don't think that very many Hitch are still going up Middle Creek, so I believe it is very important to preserve and help the remaining Clover Creek strain.

Also, for the past 2 years, I haven't seen any adult Hitch, but have observed up to one hundred baby 1" fish in May which I believe are Hitch fry. Others have observed Hitch under the First Street bridge.

Please try to get the Clover Creek channel cleared; it's on private property, and may be difficult to clear.

I'm personally disgusted with our Board of Supervisors, voting unanimously to delay the Endangered Species listing; I'm glad that they were overruled. Their token actions to protect the Lake are ineffective, and they would let the Hitch and the whole lake die. My only hope is the program the Tribes are doing to captively breed the hitch; that WILL preserve them. I have transplanted hitch fry into a local private Upper Lake vernal pool a few years ago, and I hope they survive there too.

I intended to transplant some of the fry from either Kelsey or Adobe Creek into Highland Springs Reservoir also in hopes of them surviving after the others are extinct. The Chi Council should seek and encourage others to find private reservoirs for the strain from the creek nearest their reservoir. Three cheers for the Tribes "Hatch a Hitch" program!

PROTECT THE HITCH NOW!

Thank you.
Paul J. Kolb



Marc Hooper - President
David Rosenthal - 1st Vice President
Glenn Benjamin - 2nd Vice President
Claudia Street - Executive Director

February 26, 2013

California Fish and Game Commission
1416 Ninth Street, Room 1320
Sacramento, CA 95814

RE: Agenda Item #8 – Consideration of petition, department's report and comments received on whether listing Clear Lake Hitch as a threatened species may be warranted

Dear Commissioners,

The Lake County Farm Bureau (LCFB) represents over 550 family farms in Lake County. LCFB works closely with farmers to address issues of importance that pertain to the agricultural industry at the local, regional and state levels. As a voice for local agriculture, we respectfully submit the following position paper to the California Fish and Game Commission (Commission).

This letter is to provide comments to the "Petition to List the Clear Lake Hitch as Endangered or Threatened Under the Endangered Species Act" (Petition), prepared by the Center for Biological Diversity. LCFB supports the use of sound, peer-reviewed science in the development of any and all programs designed to protect our natural resources. Towards this end, we oppose the Petition as presented due to a lack of scientific data and inconsistencies in the general data found within the Petition. In addition, we acknowledge the significance of the Department's statement noting "the limited quantitative and qualitative information available regarding historical and current population numbers and information on the best scientific approach to enhance the existing population." It is our intent to provide additional information on the following points for consideration in the spirit of providing a more accurate assessment of current conditions, as well as supporting sound, peer-reviewed science.

A. Agriculture

Agriculture is presented as a major factor contributing to the reduced hitch population. In implicating agriculture, the petitioner fails to include current scientific evidence that documents significant advances to local agriculture practices that focus on conservation methods and sustainability programs. Such practices have been scientifically developed to minimize impacts to our natural resources and environment.

1. The use of organophosphates has decreased significantly over the past 25 years. Due to the establishment of a pheromone-based mating disruption program developed for the pear industry which replaces the prior dependency on organophosphates, increased government regulations and reduced pear acreages, the trend to reduce organophosphates is dramatic. From 1990 to 1992, pesticide use reports (PURs) report the annual average of organophosphate use was 46,771 pounds per year. The most recent 3 years of data, 2008 to 2010, document the annual average per year was only 651 pounds per year. This represents a 98.6% reduction in organophosphate applications during that period.

2. The Irrigated Lands Regulatory Program (Program) was initiated in 2003 to prevent agricultural runoff from impairing surface waters. Mandated and regulated by the Regional Water Quality Control (Board), monitoring results in Lake County have never exceeded pesticide limits set forth by the Board. In addition to claims made in the Petition regarding excessive nutrient loading, the Program is required to comply with appropriate TMDL monitoring protocol for nutrients. To date, no exceedances for nutrients have occurred. This data completely negates references in the Petition to pesticides found "in surface waters in many areas".

3. According to PURs, in the 1990's Lake County averaged approximately 1,014,832 pounds of pesticides used each year. In the 2000's this average dropped dramatically to 662,629 pounds per year, resulting in a 35% drop in total pounds of pesticides used. Again, this reduction is a direct result of widespread adoption of proven conservation methods and sustainability programs. In addition, the use of Integrated Pest Management Practices (IPM) has been effective in a reduction in pesticide use. IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

4. According to Natural Resources Conservation Service (NRCS), in 2012 approximately 1,000 acres of irrigation efficiency projects were implemented. These projects are developed to reduce the amount of water used during irrigation as well as reducing the amount of water runoff associated with irrigation. Numbers are not available for producers who have implemented such practices on their own.

5. According to NRCS, in 2012 approximately 1,000 acres of soil quality projects were implemented. These projects include the use of cover crops which have proven to reduce the amount of water runoff associated with irrigation or storm events. Numbers are not available for producers who have implemented such practices on their own.

6. According to NRCS, additional projects include installation of bird/bat/owl boxes to increase wildlife habitat; work with UCCE to install water monitoring sensors in pears and walnuts to increase irrigation efficiency, reduce the amount of water used in irrigation and reduce the amount of water runoff associated with irrigation; fencing to protect riparian areas; development of off-stream water storage capacity; planting of native hedgerows to increase pollinator habitat; establishment of cover crops to reduce erosion; establishment of conservation cover to provide natural insectaries; farm road improvements to reduce erosion; implementation of soil and tissue testing to better manage the amount and timing of nutrients; and the use of IPM to better manage the applications of pesticides. Numbers are not available for producers who have implemented such practices on their own.

B. Water

On the following points regarding water, the Petition lacks virtually any scientific evidence and is embellished with conjecture intended to advance the petitioner's cause.

1. There is no scientific evidence to support that "some of the tributary streams that used to run perennially now flow only after heavy rains".

2. The statement "Aquifers in the Clear Lake Basin are lower than they were even 25 years ago" is inconsistent with the scientific data that the County of Lake has collected over that period. In fact, scientific evidence documented in the CASGEM Monitoring Plan actually shows no significant changes in groundwater levels.

3. The statement by 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...Farmers do not seem to be inclined to use groundwater from wells..., but

instead preferred to pump water from creeks” lacks evidence, is defamatory and does not have any place or purpose in this Petition. According to information from the Lake County Water Resources Department, 83% of irrigation in Lake County is attributed to groundwater usage. An overall trend supports a decline in water used for irrigation as the conversion continues from pear orchards that require more irrigation to winegrapes that use considerably less irrigation.

C. Hitch Populations

The use of unscientific surveys fails to document a significant decrease in hitch populations and spawning activities since 2005.

1. While the petition estimates the spawning hitch population in the early 2000's to have dwindled to only a few thousand fish, using citizen science methodology, Chi Council surveys as late as 2010 showed 10,000+ fish in Kelsey Creek alone on a single viewing. Also in 2010, Manning Creek's spawning run was described as "the best run in 30 years".
2. Presence/Absence surveys from year to year fail to take into account weather conditions and specifically spring rainfall data that directly impact stream flows. Seasonal variations, including rainfall totals, should be overlaid with scientific hitch count surveys of spawning fish. This information would provide data necessary to support the statement made in the Petition, "water quantity was the most important factor in sustaining young hitch".
3. The use of citizen science methodology is the sole basis for estimating hitch populations provided in the Petition. To make the best, informed decision, the use of sound, peer-reviewed science should be utilized.
4. The Petition asserts historical hitch runs going back to the 1960's through the early 1990's have decreased. However, no effort has been made to establish what constitutes a viable population of hitch. The Chi Council reports large numbers of spawning hitch every year with the recent spawning years of 2010 and 2012 being two of the strongest in several years.

D. Predation and competition from introduced species

The petition minimizes the unquestionably primary contributor of decreasing hitch populations - predation and competition from introduced species of fish.

1. The introduction of the Threadfin Shad in 1985, the Mississippi Silverside in 1967 and Florida strain of Largemouth Bass in the 1970's have all had a major impact on all fish species in Clear Lake.
2. This petition refers to decreased numbers Carp and Blackfish to the point where commercial fishing is no longer practical. Other fish species that were once extremely abundant in Clear Lake, including Crappie and Bluegill have also shown steep declines in populations. It is generally believed that all of these fish species population declines are primarily a result of predation and competition from the recently introduced species of Largemouth Bass, Threadfin Shad, and Mississippi Silverside. While other fish populations have been considerably reduced, these three species have thrived.

E. Current, local efforts

Substantial efforts to improve hitch habitat are currently underway in Lake County.

1. Lake County private landowners who have barriers to spawning on their property are working to remove or modify these barriers to allow free migration of the hitch.
2. As noted in the petition, The California Department of Fish and Game, the County of Lake and the California Department of Transportation are working on correcting barriers to hitch migration on public property and surrounding public bridges.
3. Commercial gravel mining of creeks has been curtailed as a result of countywide plans.
4. Lake County has established and implemented an effective grading ordinance that reduces erosion issues associated with agricultural developments.

5. The County of Lake has adopted a General Plan that has numerous components, as outlined in the Petition, which will protect hitch habitat.
6. The ILRP continues to monitor surface water for the presence of agricultural pesticides and nutrients. Beginning in 2014, the program will be required to include monitoring of ground water.

F. Suggested measures to reduce threats to hitch population

Immediate threats to the hitch population could be reduced by implementing the following suggestions.

1. Ban commercial harvesting of both adults and juvenile Clear Lake hitch.
2. Ban recreational harvest of Clear Lake Hitch.
3. Enforce existing Fish and Game streambed management regulations.
4. Continue to work with the private landowners and municipalities on removing or modifying both public and private stream migration barriers and improving habitat for the Clear Lake Hitch.

To conclude, LCFB sincerely appreciates the Commission's review of the comments and information provided in this letter as you consider whether listing the Clear Lake Hitch may be warranted. The information we have provided and the comments included herein are intended to provide accurate data for you to analyze. We also stand ready to assist you in providing any additional information on local conditions and best management practices that support the conservation of our local natural resources.

Sincerely,



Marc Hooper
President

Ray Mostin, 81, Kelseyville resident and farmer

It is my experience that every 10 years there is a major flood in our area. There have been erratic hitch runs ever since the 1930s; the migration runs go up and down. Our creeks used to be shallow, wandering creeks. Now the creek depth is 20 feet from creek bank to creek bottom. The main contributor to the deepening of creeks has been gravel extraction. I am a graduate of UC Berkeley with a degree in geology. The historic, early 1900 photo everyone sees is not typical of every hitch run. Originally, the historic, shallow creek levels allowed the creeks to wander and meander.

The farmers were concerned about the way creeks were deepening as a result of gravel mining and we ended up signing a petition that we presented to the Lake County Board of Supervisors with the threat of a lawsuit if mining was not stopped. As a result of our concerns, mining was stopped. Years ago, Kelsey Creek meandered all the way to where it entered Clear Lake. Our State Park system changed that point of entry when they engineered a straight approach of Kelsey Creek in to Clear Lake. I estimate a loss of 14 million cubic yards of gravel that has been extracted or removed from Kelsey Creek. The farmers in this area want to protect the gravel and we know the gravel protects hitch spawning habitat.

The straightening of Kelsey Creek has increased the velocity at which the creek flows and has increased the carrying capacity of waters to move gravel. Gravel extraction has caused more erosion than any other activity in the creek. Over time, the State Park did improve some areas for habitat and Lake County has provided some rip-rap projects to prevent further erosion. The farming community has worked hard, as noted in the ground water recharge study, to improve creek habitat.

There have been fish kills documented and this can be attributed to occasional rising temperatures in the lake, and a reduced food source. The competition for food in the lake has been severely impacted by the increased population of introduced bass. The report titled "Human Influences to Clear Lake, a 20th Century History"¹, written in 2009 by Greg Giusti is an important document to read (<http://celake.ucanr.edu/files/164054.pdf>). Giusti names 12 native fish species and numerous non-native, introduced fish. The increased competition of non-native species is directly responsible for killing off hitch populations.

¹See attached scanned pdf

From Human influences to clear lake Conf.
by Greg Giusti March 2009

control carp. The sea lions remained in Lake Merced until the fish supply became exhausted and they simply walked back to the ocean. The idea was finally abandoned because "It was thought, however, that the swamp and tule land surrounding [Clear Lake] would harbor the carp and furnish them with areas that the sea lions would not reach (California Fish Commission Report for 1897-98, p. 33).

Unfortunately, not all accounts are so nonsensical. Historical accounts tell us "Clear Lake once 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, but according to Capt. J.D. Dondero of the Division of Fish and Game, the establishment of white catfish in Clear Lake, which he said occurred in the 1920s, "... solved this problem." The population of non-game fish diminished, and the windrows of dead fish were a thing of the past (pers. comm.)".

[Source: Fish Bulletin 178]

12
Fish have and continue to play an important economic and social role for Clear Lake residents and visitors. Commercial, sport and recreational utilization of fish have long been important aspects of the natural system. Clear Lake's pre-settlement fish fauna was dominated by species found naturally occurring in both the Russian and Sacramento River systems; as a result of the Lake's connection to both systems over geologic times. Native fish include: Pacific lamprey* (*Lampetra tridentate*), Sacramento perch* (*Archoplites interruptus*), hitch (*Lavinia exilicauda*), Clear Lake split tail* (*Pogonichthys ciscoides*), Sacramento blackfish (*Orthodon microleptidotus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus cocidentlis*), prickly sculpin (*Cottus gulosus*), tule perch (*Hysterocarpus traski*), rainbow trout (*Oncorhynchus mykiss*), three-spined stickleback (*Gasterosteus aculeatus*), and thick-tailed chub* (*Gila crassicauda*). Those fish marked with an asterisk are considered extirpated from the Lake.

Commercial fishing for live-fish export to San Francisco's Asian markets continued from the early part of the 20th century until the first decade of the 21st century.

resulting in quarantine and eradication efforts. A list of introduced non-native species and the year of their introduction is presented in Fig. 6.

FIG. 6. NON-NATIVE SPECIES INTRODUCTIONS TO CLEAR LAKE:

- whitefish (*Coregonus clupeaformis*), 1875, failed;
- brown bullhead (*Ameiurus nebulosus*), 1875;
- white catfish (*Ameiurus catus*), 1875;
- smallmouth bass (*Micropterus dolomieu*), 1875;
- common carp (*Cyprinus carpio*), 1880;
- grass pickerel (*Esox americanus*), 1896, failed;
- golden shiner (*Notemigonus crysolencus*), 1896 & 1950, failed;
- northern largemouth bass (*Micropterus salmoides*), 1897;
- bluegill (*Lepomis macrochirus*), 1906;
- black crappie (*Pomoxis nigromaculatus*), 1906;
- channel catfish (*Ictalurus punctatus*), 1908;
- lake trout (*Salvelinus namaycush*), 1923 & 1924, failed;
- pumpkinseed (*Lepomis gibbosus*), 1942;
- white crappie (*Pomoxis annularis*), 1945;
- inland silversides (*Menidia beryllina*), 1962;
- Florida-strain largemouth bass (*Micropterus salmoides*), 1967;
- Florida-strain black crappie (*Pomoxis nigromaculatus*), 1984;
- threadfin shad (*Dorosoma petenense*), 1985;
- *Hydrilla verticillata*, 1994.

The threat of more invasive species becoming established in Clear Lake persists to the present time. Recent concerns over Dressenid mussels (quagga and zebra), New Zealand mud snails, and other commercially sold aquarium fish species pose a constant threat of adding more stress to the lake's system.

SUMMARY

Early 20th century exploitation of mined resources has left a prolonged and costly legacy on Clear Lake. The resultant 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.

Thomas, Kevin@Wildlife

From: John McDaniel <johnmc@mcdanielmfg.com>
Sent: Wednesday, May 22, 2013 11:36 AM
To: Clear Lake Hitch
Subject: Clear Lake Hitch

Greetings,

I am not a biologist or any kind of wildlife expert. I am a fisherman. I have been fishing at Clear Lake for years. The Bass population of Bass in that lake is exceptional. The thought of removing, relocating or killing the Bass in Clear Lake is unacceptable. Maybe the thought should be to remove the Hitch to a safer location. That won't work. The Hitch are a food source for the Bass in the lake. Maybe the better solution would be to harvest the Hitch, take them to a hatchery where there eggs can be harvested and grown to a certain size and replace the fry back into Clear Lake. Just a thought. This might be a reasonable way to save the economy in the towns and business that depend on visiting fishermen and tournaments for their livelihoods. Sometimes the easiest approach (removing the Bass) is not the best.

Thank you,

John J McDaniel
President
McDaniel Manufacturing Inc.
Phone : 530-626-6336
Fax : 530-626-6722

Good habits formed at youth make all the difference.
—Aristotle

BOB
MYSKEY

2

Sunday
January 2011

Daily Notes

2nd Day 363 Left Week 52

FISH RECAP—YEAR—NUMBERS CAUGHT BY SIZE
AVERAGE # OF FISH CAUGHT PER OUTING

SIZE	YEAR	05	06	07	08	09	10	11	12
1 TO 3 LBS		2,466	2,664	2,798	1,761	1,466	814	569	574
3+		171	282	444	275	418	484	507	449
4		53	126	142	66	122	164	164	162
5		27	24	43	39	31	59	90	59
6		7	13	13	7	17	15	35	37
7		7	7	8	6	6	1	2	10
8		7	1	7	4	2	5	7	4
9		2	2	6	3	2	1	0	1
10		4	1	1	1	0	1	0	1
11		2	1	0	0	0	0	0	0
TOTAL CAUGHT		2746	3121	3473	2162	2064	1542	1374	1370
DAYS FISHED		140	185	183	151	140	141	148	140
AVERAGE # OF FISH CAUGHT PER TRIP		19.6	16.8	18.9	14.3	13.4	10.9	9.28	9.78
		42 lb/day	37.69 lb/day	43.52	32.84	35.76	29.69	27.33	27 lb/day

07 WAS THE PEAK

O/O DRAMATIC DROP
IN AVERAGE #'S
+ IN 1 TO 3 LB FISH

O/O DOES SHOW
AN INCREASE OF
3, 4 + 5 LBERS



ROBINSON RANCHERIA

CITIZENS BUSINESS COUNCIL

The Robinson Rancheria of Pomo Indians would like to express our support for the California listing of the Clearlake Chi hitch (*Lavinia exilicauda chi*) as a threatened species. We believe that they should be listed as soon as possible in order to help protect them from possible extinction in the near future. The hitch species population is now under a significant amount of stress from a variety of causes, most of which are a result of human actions during the past 150 years. The Clear Lake hitch have been an abundant species in the Clearlake basin for many thousands of years and have never before had to survive in such a change of conditions.

Potential Causes of *Lavinia exilicauda chi* decline:

There are a variety of in stream structures, including dams, bridges, and other kinds of barriers to the hitch reaching their spawning habitat. The dams and detention structures have been observed to also cause eggs to build up in places and suffocate from loss of oxygen.

Changes made to the stream channels making them either too steep and fast moving, or too shallow. Gravel mining has changed the stream bottom heights by 15 feet in places and there has been vegetation canopy cover loss, which is leaving fish more susceptible to predators.

Water diversions pumped from aquifers, and directly from the streams for agriculture and domestic uses affecting surface flows in tributary streams resulting in streams drying up early and therefore allowing the hitch fry less time to make their way downstream to the lakeshore or slough, and to reach a size large enough for them to have a sufficient chance of survival. These water diversions also result in more hitch adults and fry to be trapped and perish in receding waters.

There has been a loss of fish nursery areas from lakeshore alterations whereby tules and dead wood habitat has been cleared so it is more difficult for young fish to evade predators.

The introduction of non-native fish is also one of the primary reasons for the apparent hitch decline. The bass in particular and also the channel catfish are known to be preying on the hitch significantly and are definitely successful predators to some extent since large hitch have been found in their stomachs. Other introduced fish compete for the available food with the hitch. Threadfin shad, a zooplankton feeder, are said to eliminate daphnia, one of the principle foods of the hitch. The Mississippi silverside is another introduced zooplankton feeder which also eats some of the same food as the hitch. The Clear Lake gnat was nearly exterminated with pesticides and it was a primary food source for the hitch and the gnats numbers are still very low now likely because of the the Mississippi silverside and the threadfin shad eating them.





ROBINSON RANCHERIA

CITIZENS BUSINESS COUNCIL

Water chemistry and quality, intense agriculture from orchards and vineyards has resulted in effluent containing fertilizers, pesticides and sediment into the lake which has contributed to lake eutrophication and bluegreen cyanobacteria blooms.

In addition there are a variety of urbanization related impacts affecting the hitch to unknown degrees. These are things such as road building, lot clearing, logging, mining, removing wetlands, vehicle in stream crossings, increased urban and rural water needs, septic systems leaking into lake water, and boating which can add stress to fish.

There is the added effect of climate change, which is generally causing the streams to dry up sooner and again leaving the hitch less time to spawn, and for the fry to mature before making their way downstream.

Changes in the balance of aquatic algae in the lake, which may change the food supply for daphnia, rotifers and other zooplankton the hitch eat, or which the hitch may eat directly because they are omnivores. One belief is that rotifers cannot eat the lymblia, which is becoming more predominant, but can eat the anabaena.

The Clear Lake hitch has also been carrying a large parasite load of non-native anchor worms for a number of years and this is likely increasing their mortality.

The Clear Lake Hitch is a culturally significant native fish that is an important component of the traditional food gathering by Robinson Rancheria tribal members and the other Tribes of the Clear Lake basin. The protection of the Clear Lake Hitch population is a multi-Tribal effort intended to help stop the decline of Hitch populations in Clear Lake.

The Tribe provided a copy of the Hitch Adaptive Management Plan in 2011 and the 'Final Report Clear Lake Hitch Study and Recovery Project' prepared for the U.S. Fish and Wildlife Service in 2011. Please let us know if you need additional copies of these documents or clarification pertaining to any of the information or data contained in these or other Robinson Rancheria documents. I can be reached at the Robinson Rancheria Environmental Center at 1645 E. Hwy 20, Nice, California.

Ph. 707-275-0205
Fax 707-275-0470
drogers@robinsonrancheria.org

Sincerely, *Dean Rogers*

Dean Rogers, Water Resource Manager, Mailing address, P.O. Box 1580, Nice, CA 95464



Seely Orchard

*PO Box 218
Upper Lake CA 95485
(707) 275-2353*

To Whom It May Concern,

In 1954, the Seely family purchased a pear ranch in Upper Lake which borders Middle Creek on both sides. In those days, the Hitch population was so plentiful that you couldn't walk across the creek without stepping on them. We were pumping irrigation water out of the creek and had two creek crossings for equipment as was the practice of the former owner. Many other pear farmers upstream were also pumping out of Middle Creek. The levee system was new and the levee district eradicated all plant growth bank to bank. The fire protection district burned the grass on the levees every summer. This was the "normal" until the mid 1990's.

The Middle Creek of today is much different than that of the 1950's. A wide of variety of vegetation covers both banks supporting a wide variety of wildlife. What hasn't changed, is the way our family uses the creek and its water resources.

For those of us who have lived and worked in this ecosystem for 60 years, we don't feel that our agricultural practices have been the cause of the hitch decline. With the sharp decline of the pear farming industry in this county since the 1990's, there are fewer farmers using the Middle Creek watershed to irrigate their crops as much of that acreage is now fallow. Agriculture in our area is not drawing the water it once did and yet agriculture is the industry that seems to take the blame for most environmental issues.

Currently, our farm pumps water from Middle Creek for frost protection and spring irrigation. Water is the only method used for crop frost protection since the industry moved away from burning fossil fuels. This county is made up of small farms. When presented with the threat of government limiting or completely taking away the water rights which it has enjoyed for the entire farming history of Lake County, the local family farms will become the endangered species along with its contributions to our local economy.

No Farms, No Food.

Sincerely,

The Seely Family
Edward E. Seely, Jeff Seely, Eric Seely, Colleen Rentsch
Upper Lake, CA

Sierra Club Lake Group

PO Box 27 Lakeport, CA 95453

June 12, 2013

Kevin Thomas
California Department Fish and Wildlife
701 Nimbus Road
Rancho Cordova, CA 95670.

via email to CLH@wildlife.ca.gov

RE: CESA listing for the Clear Lake hitch: SUPPORT

Dear Mr. Thomas:

The Sierra Club Lake Group represents some 400 Sierra Club members living in Lake County, and is a branch of the 9,000-member Redwood Chapter. Preservation of biological diversity is, as it has always been, central to the Club's core mission to "Enjoy, Explore, and Protect the Planet," and we therefore strongly support the listing of the Clear Lake hitch (*lavinia exilicauda chi*) under the California Endangered Species Act (CESA).

Lake Group has been actively involved in local efforts to preserve this endemic fish since 2004, when an informal group of Sierra Club volunteers began monitoring the annual spawning migration. This effort led to the creation of the Chi Council later that year. Subsequently we have played an important role in the recruitment of volunteers, and have done a great deal to spread awareness of the plight of the hitch and the activities of the Chi Council, local tribes, and other stakeholders to halt or reverse their population decline.

Alas, it appears that these well-intended local actions have been inadequate to the task. It was already obvious in 2004 that hitch populations were dramatically reduced from their historic levels, but at that time substantial spawning runs were nonetheless still observed in Clear Lake tributaries far distant from the creeks in the Big Valley watershed. In particular, viable spawning cohorts numbering in the thousands were regularly seen in the Middle, Scotts, and Clover creek complex at the north end of the lake. Aside from a few scattered sightings, this population seems to have completely disappeared subsequent to 2006. This distressing loss has taken place *despite* investment of considerable monetary and human resources by the County of Lake in habitat improvements, especially the installation of a series of weirs to allow fish passage at a barrier at the Rancheria Road bridge that prevented the hitch from accessing some ten miles of their historic spawning grounds on Middle Creek.

Additionally, fish capture during the course of tribal tagging projects has revealed that the remaining spawning adults are heavily infested with parasites and nearly universally subject to skin lesions of unknown origin—indications that the species is under extreme stress.

The causes of hitch population decline are not definitively understood: indeed, one of the significant advantages of CESA listing would be potential access to the funding sources needed for authoritative scientific studies of their biology and their position in the ecology of Clear Lake. Nonetheless, a number of contributing factors seem obvious. Barriers to migration that artificially restrict spawning territory—barriers present on

every major Clear Lake tributary to a greater or lesser extent—have received the most public attention, though they are probably not the most important limiting factor. Dramatic loss of wetland habitat, especially the tule marshes that shelter juvenile fish, food competition from introduced fish such as silversides and threadfin shad, predation from other introduced fish such as largemouth bass, especially the voracious Florida strain, and impairments to water quality from heavy metal pollution and excessive sedimentation all are likely to have played a role in hitch decline.

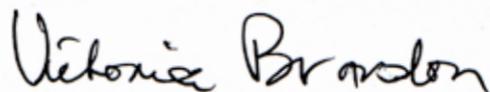
On top of this diverse array of longstanding stressors the last few years have been characterized by anomalous weather patterns, sparse spring rains, and dramatically reduced stream flows during the migration season. In the winter of 2013, removal of riparian vegetation along a key segment of Adobe Creek—along with Kelsey, one of the two creeks where hitch have been known to spawn in substantial numbers in recent years—may also have had a dramatically negative effect on adult survival and reproductive success.

The consequence of this perfect storm has been a sparse spawning run in 2012 and a nearly nonexistent spawning run in 2013. Adverse climatic conditions and absence of normal spawning behavior have been known in the past without apparently causing irreversible harm, but that was when Clear Lake's hitch population was abundant and thriving, a description that certainly does not apply today.

This fish is under extreme stress, and may indeed have already passed the point of possible recovery. But according to the mandate expressed by both the state and federal Endangered Species Act, it is our responsibility as citizens to use every means in our power to prevent extinction, because every extinction impoverishes us all, and impoverishes the planet as a whole. Listing the hitch under CESA cannot guarantee its long term survival, but listing is the only plausible means available to provide the resources needed to support a good faith effort to restore the population of this iconic fish to a viable level. As an additional benefit, the improvements likely to improve the longterm survival chances of the hitch—wetland restoration in particular—will also benefit the entire ecosystem of Clear Lake and the communities that surround it.

The evidence clearly demonstrates that after barely surviving for a number of years this species is now declining with terrifying rapidity. Its plight is dire, and the need for action urgent, with CESA listing offering its only hope of survival. The Sierra Club therefore urges the staff of the California Department of Fish and Wildlife to recommend listing to the Fish and Game Commission in the most strenuous terms possible.

Yours sincerely,

A handwritten signature in black ink that reads "Victoria Brandon". The signature is written in a cursive, flowing style.

Victoria Brandon
Conservation Chair, Sierra Club Lake Group

Thomas, Kevin@Wildlife

From: CADILLAC PAT <cadillacpat71@gmail.com>
Sent: Thursday, June 13, 2013 6:30 AM
To: Clear Lake Hitch
Subject: HITCH

LOOKS FARLEY SIMPLE TO US. EVER SINCE THE LARGE MOUTH BASS HAVE BEEN PUT INTO THE LAKE MANY YEARS AGO THE CRAPPIE, BLUE GILL AND HITCH ARE JUST SCOOPED UP BY THESE LARGE MOUTH PREDATORS. LARGE IS A UNDERSTATEMENT, THERE MOUTH IS BIGGER THEN THE GIRTH OF THERE BODY WHEN IT'S OPEN. IT DOESN'T TAKE MUCH TO SEE WHEN YOU LOOK AT THE BASS TO TELL WHAT THEY DO 24 HOURS A DAY, EAT EVERY THING IN SIGHT. THANK YOU, PAT SPERLING IN LAKEPORT. 60 YEARS IN LAKEPORT.

Thomas, Kevin@Wildlife

From: rkwnch@pacific.net
Sent: Tuesday, May 14, 2013 10:57 AM
To: Clear Lake Hitch
Cc: ceo@lakecochamber.com
Subject: Hitch

I grew up on a watercourse leading from Hopland Mountain to Clear Lake. In the late 40's to the late 60's, when weather was more consistent, it seemed like we could depend on a run of Hitch annually which was in such numbers as to boggle the mind. Even folks from the nearby Reservation came to catch sacksfull for drying.

But lately, there have been years when not one Hitch attempted the run. In my opinion, this may be the result of:

1. Large and inconsistent variations in air/water temperature, which may have been one of the signals to the fish to migrate.
2. Early drying-up of the seasonal creeks, sometimes in consecutive years. This might reduce the population memory of which creek is "home".
3. Increased residential and industrial development on or near the watercourses. There is the alarming tendency of some less-evolved humans to view waterways as garbage disposals and the stuff thrown into them is more and more toxic.
4. More competition for water and less leadership to conserve, budget and share it. Private dams are usually undiscovered which could have the same effect as a shortened streamflow Every year.
5. Pandering to the profitability of bass contests which probably gives the bass a serious evolutionary advantage over the Hitch.

Government will want to study the Hitch issue to death, and will continue to buy more studies until the species has passed into oblivion. But enlightened leadership might be found for mitigation of #s 3-5 above. If I might be indulged for a suggestion re #2 above, it might provide an inexpensive remedy. Some years ago, someone constructed "Gravel movement barriers" on the Lake County side of the streams around Hwy 20 in the mountains East of The Oaks. The goal seemed to be gravel retention. A concrete dam was built across the smaller parts of the stream, but only as high as the elevation of the gravel. Thus it did not appear to and did in fact NOT dam up the water permanently, in the act of keeping gravel in place. It DID extend the flow of the stream to a later date in the Spring by holding water (that ran thru subsurface gravel) longer.

Now the Resource Conservation Districts in this county do not have a tax base from which to draw funds to test a plan such as the above to mitigate the effect of global warming weather upset on creekflow. But if money could be found to have them select a watercourse that is currently in danger of losing its Hitch run due to intermittency, place gravel movement barriers in the region of previous Hitch spawning, make and protect gravel streamfloors to encourage spawning, and then observe the results, it might be an inexpensive entre' to what direction the county could take as protection.

Someone of course would have to defend against the overzealous effort of the Yolo Water Company, which would see this from a differing perspective.

Kent Wooldridge

Appendix E

Appendix E. Comments from peer reviewers on the Status Review report



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
Sacramento, CA 95811
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director



January 13, 2014

Camm Swift
Retired, Natural History Museum of Los Angeles County
6465 Elmo Road
Cumming, GA 30028-4720

Dear Dr. Swift

CLEAR LAKE HITCH (*LAVINIA EXILICAUDA CHI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife (Department) Draft Status Report of the Clear Lake hitch (*Lavinia exilicauda ch*). A copy of the Department's peer review draft status report, dated January 2014, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of Clear Lake hitch in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). The Department would appreciate receiving your peer review input on or before February 10, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened. The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission.

The Commission first received the petition to list Clear Lake hitch as threatened on September 25, 2012. The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on March 22, 2013 following publication of regulatory notice by the Office of Administrative Law. The Clear Lake hitch is currently protected under CESA in California in that capacity.

The peer review Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the best scientific information available regarding the status of Clear Lake hitch in California. Headed into peer review, the Department believes the best available science indicates that listing the species as threatened under CESA is warranted at this time. To be clear, we ask that you focus your review on the scientific information and the Department's related assessment of

Conserving California's Wildlife Since 1870

Name, Title
Business
Date
Page 2

your review on the scientific information and the Department's related assessment of the required population and life history elements prescribed in CESA rather than focusing on the tentative conclusion we share as a matter of professional courtesy. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the best scientific information available regarding the status of Clear Lake hitch in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA (*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important as well as whether they indicate, in your opinion, that Clear Lake hitch is likely to become, in the foreseeable future, at serious risk of becoming extinct throughout all or a significant portion of its range in California.

We ask that you assess our work for quality and conduct a thorough and proper review. As with all peer review processes, the reviewer is not the final arbiter, but your comments will inform our final decision-making. Also, please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Kevin Thomas at kevin.thomas@wildlife.ca.gov, or he may be reached by telephone at (916) 358-2845.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Stafford Lehr
Chief, Fisheries Branch

Enclosure(s)

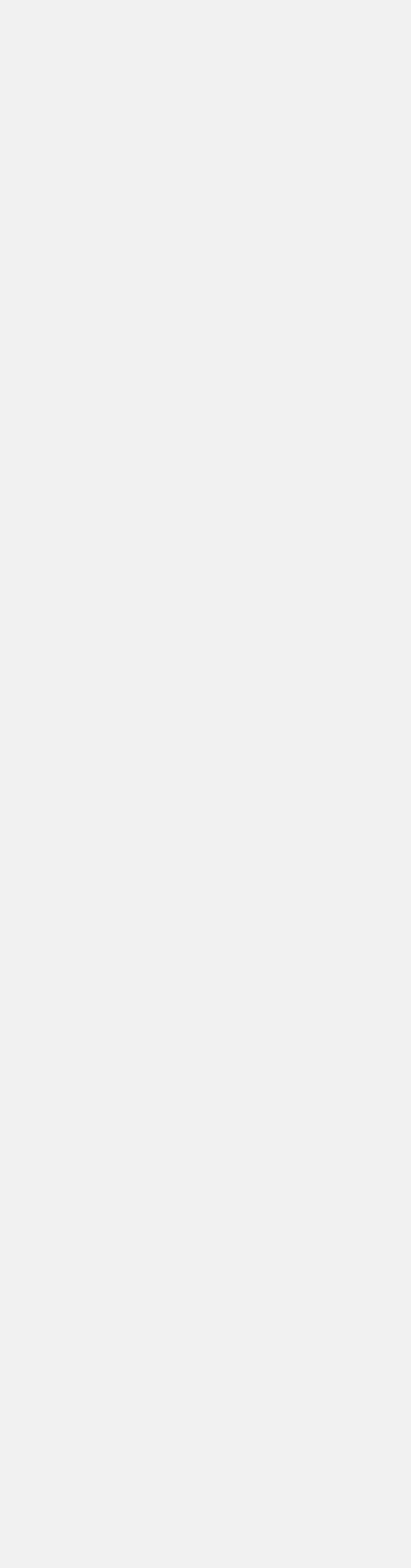
cc: Tina Bartlett
CDFW-NCR

Name, Title
Business
Date
Page 3

CDFW-OGC

Katherine Hill
CDFW-NCR

Kevin Thomas
CDFW-NCR



Peer Review of: Preliminary Draft of "Status Review of Clear Lake Hitch (*Lavinia exilicauda chi*), January, 2014, Report to the Fish and Game Commission by Charlton H. Bonham, Director, California Fish and Wildlife

By Camm C. Swift, Ph.D., 10 February 2014

This report provides exhaustive support for the severe decline and justifies threatened or endangered status for the Clear Lake Hitch (CLH). Comments on the details of the report are given first, followed by more general discussion. References cited are given at the end only when referring to papers not cited in the Draft Report.

For a broader audience, I think the title should include the trailer "...a native minnow (Pisces, Cyprinidae) of California." The title of my early paper on the embryological development in this species left out the "...minnow (Pisces, Cyprinidae)...", and many times I have been asked, "What is a hitch, anyhow?"

p. 7, line 12-13, CLH can be separated from native minnows by having a higher anal ray count, which is technically accurate, but in my experience a mistake sometimes made in rapid field identifications is to confuse hitch with the non-native golden shiner because it also has a long anal fin. Apparently golden shiners were only in Clear Lake briefly in the late 1800s. But since they are widely sold as bait since becoming legal to raise and use for bait in California in 1955 (Moyle 2002), it would be surprising if they did not turn up in Clear Lake once in a while and maybe even frequently. The rise of bass fishing would have made these larger bait minnows popular. It makes me wonder whether some of the hitch records taken by commercial fishermen and the Vector Control surveys may have been golden shiners. In both cases the hitch were secondary to the objectives of the studies and less attention may have been paid to them as they were field identified and released. This would mean that the hitch themselves were even less common than the records indicate. However, apparently no records of golden shiner exist since 1896 (Thompson et al. 2013) which seems surprising.

It also seems surprising in retrospect that golden shiners did not "take" in Clear Lake since they like clear vegetated waters which were prevalent back then.

Page 7, line 27-32, Aguilar et al. 2009 and Hopkirk (1973) are credited with molecular (microsatellite) and morphological data, respectively, to support subspecific recognition. It is stated that mtDNA do not support it but no reference is given and such is needed here to support this statement. It is well known that microsatellite (nuclear) DNA provides stronger evidence of systematic differences than mitochondrial data.

P. 11, lines 21-33

Commercial data is given as catch (number of fish) per days [fished?] or times "operations occurred." Presumably the effort was not, or cannot be, better quantified, such as time fished, or hauls or net sets made, or some other indication. Did the commercial fishermen do more or less the same thing every time?

Similarly the observational data is apparently number of fish observed [in spawning creeks] by number of observation periods. Do we have any indication of length of these periods, or how much stream was observed on each occasion? Without more information on how this data "looks" or was taken its hard to assess its value. (also on page 13, line 27-28).

Finally some similar questions about the LCVCCD is given as number of fish caught by year. It would seem that this effort may have been more quantified since they were after abundance data on silversides and shad. Like the number of hauls, or meters of shoreline seined, or something similar. No indication is given that this was the case, and perhaps it is not available, but would be valuable if it exists to make the estimates more quantitative. Although I guess they were staggered to be mostly after the hitch would have been in the areas targeted.

p. 12, Figure 2, is interesting, as noted in the text, in that the peaks and valleys of the various methods correspond which strengthens their validity as trends. Even the commercial peaks are delayed a year or so behind the LCVCCD ones as expected since the former would be adults from the younger cohorts sampled by the latter.

p. 13, lines 25-43, Good discussion of spawning tributaries and documentation of dramatic drop in tributaries utilized in the last 10 years or so, including a shift of the primary spawning from Kelsey to Adobe Creeks. This would seem to be a major change since Kelsey Creek is considered to have been the most, or nearly most, important stream for over 100 years. How does the amount and quality of habitat compare between the two systems? Also the drop from 12-13 tributaries to two or three in the last 10-15 years would seem to be a major reduction but is not quantified nor emphasized. Adobe Creek is a somewhat smaller drainage on the map but how do they compare in flow or water supply? What about the largest system (drainage coming in from the northwest)? It is much larger than any of the others as illustrated on Figure 1. It would seem to have been a great loss if formerly utilized to the extent its size suggests. It seems like the number of tributaries lost could be strengthened by adding up the meters or kilometers of spawning/nursery habitat lost or something similar.

p. 14, line 1 onward, it is not clear to me why or how water quality conditions and lake depth influenced or make the LCVCD beach seine data less useful. Since they were designed (design not included here) to get at abundance of threadfin shad and Mississippi silversides, it would seem they would provide trend data for CLH also. Despite the fact they may not have been in the ideal season, habitat, or time of year, they did get CLH and if somehow regularly and consistently done should provide trends. The discussion suggests this latter may not be the case but does not exactly explain why, giving the impression that this possibly good source of data is being under-utilized. The fact that it corresponds, or is consistent with trends in the other catch data indicate it may be more useful than indicated.

p. 15, Fig. 4, catches by LCVCD mostly low, as expected from above, but peaks seem in or near particularly wet years, like 97-98, 2005-2006 but others not so much. There seems to be continued higher numbers after the 2005 wet year, possibly due to the end of commercial fishing. But the adults in spawning stream declined tremendously without corresponding data for the juveniles via LCVCD. Peaks in the commercial catch seem widely scattered and without correspondence to any data given.

One lack here is the data on other fish which may shed more light on trends. We are told that the numbers of shad and silversides parallels those of juvenile hitch somewhat, but also that non-native fish overwhelmingly dominated all three sources of catch data. Particularly the change in abundance of piscivores like black crappie, largemouth bass, channel catfish, sunfish might be instructive. Several observations in southern California have shown large numbers of YOY largemouth bass at the upper end of reservoirs as juvenile minnows and suckers are drifting or dispersing downstream and adults of these prey species being non-existent or very rare in those areas. This coincides with much more detailed work in the Colorado River (Arizona, Nevada, California) showing that non-native centrarchids strongly and negatively impact recruitment of native cyprinids and catostomids there by preying on larvae and small juveniles as they move into slow-moving marginal nursery areas. As (and if) they get larger and move into flowing water, they then become vulnerable to nocturnal catfish predators. See Minckley and Marsh (2009).

Data on these would shed more light on the possibility of these phenomena in Clear Lake.

p. 16, line 6, the sentence reads as if CDFW (called CDFG in many places in this report?) began sampling Clear Lake fishes in a regular way, but later we see that it is referring to four separate and disparate sampling events with purposes unrelated to CLH. In fact they were designed to avoid CLH as were the LCVCD samplings but with different methods. But they do document the relative rarity of CLH and overwhelming dominance of non-native species, but not what the other species are. The rarity is very significant for the purposes of this report since on line 28, CLH and other non-game fish were documented to be "...the bulk of the Clear Lake fishes..." up to 1972 and on p. 17 "...CLH [was] the third most common fish in the lake..." at that time, 1961-63.

p. 17, 19, clearly the fish has been highly impacted both by the lake being allowed to vary several feet (7.56) after building some kind of dam at the outlet, and stream changes, dams, etc. led to the loss of 92% of the spawning habitat. More information could be provided about the nature of the fluctuation related to historical fluctuations, apparently slight because of a permanent sill of some sort at the outlet. Unless evaporation exceeded inflow and allowed the lake to actually drop and dry up Putah Creek? These fluctuations may have

impacted spawning success on gravel shores which perhaps was, or had become, more important as streams were compromised?

p. 24, line 42, it would seem clear and could be better emphasized that lead (Hg) levels are high enough to adversely impact hitch since they are documented to be at dangerous levels in fathead minnows. Fathead minnows are hardy (more tolerant to pollutants like lead), shorter-lived, and smaller fish than CLH. Thus CLH being longer-lived and larger would be expected to concentrate more Hg and also to be more sensitive to it as well.

p. 25, line 5, The outlawing of commercial catch for catfish may well have increased their ability to prey on other fish in the lake. Aggressive control of invasive catfishes in other systems has increased native sport fish populations. As noted (p. 26, lines 18,19) the lake has already lost Sacramento perch, splittail, and thicketail chub, and pikeminnow are greatly diminished in the lake (Thompson et al. 2013), undoubtedly for many of the same reasons proposed here for CLH. It is particularly surprising that blackfish have been extirpated since they are one of the few native fishes seemingly surviving in the southern San Joaquin Valley in face of large numbers of non-native game and forage fish. In Clear Lake, catfish could be preying on both sunfishes and larger hitch and the sunfish and juvenile bass prey on the smaller hitch.

p. 28, it was surprise to see that a 1988 creel census found CLH to be 2% of the sport catch, indicating they were still fairly common. Possibly local papers or newsletters have some hunting and fishing columnists that might have some kind of continuing record of catches? Or local anglers?

p. 33 onward, Present or threatened modifications or destruction of habitat: This has been very well and convincingly covered. Only the possible effects of fluctuating lake levels might be slighted as noted above.

Overexploitation, seems an unlikely effect since the only evidence of major take of the species was back when it was very abundant. Even the only likely current exploiters, the local native Americans, seem to have largely reduced their take to just a few for ceremonial purposes. The 1988 creel survey indicated some exploitation and in the absence of golden shiners, they may be targeted as large bait for largemouth bass.

Predation, while this is entertained, lack of a smoking gun leaves predation by non-native fish underappreciated for this species and place in this report. The effect of introduced centrarchids and ictalurids on native minnows and suckers has been well documented in analogous systems like the Colorado River (Minckley and Marsh 2009) and certainly must have had an effect here. This report makes them seem less important by restricting discussion to this one species, and only slightly noting the splittail, blackfish, and Sacramento Perch have all already been completely lost. It would be important to know how and why the hitch is able to hang on, perhaps like the pikeminnow, by residing partly in the streams? In any case given the history here and elsewhere with other species, survival may depend on actually fencing off some rearing areas for the juveniles to allow them to reach sufficient size to reduce predation. Largemouth bass breed relatively early and many juveniles could congregate near the stream mouths for the larvae and juvenile hitch coming downstream. This is in addition to larger bass feeding on the adults massing near the stream mouths during spring spawning migrations.

Competition also seems very likely since the food of silversides and gizzard shad are somewhat similar, but presumably little chance exists for limiting these two species at this point. No mention is made of zebra or other invasive mussels except for the mention of quagga mussel inspections. They seem virtually certain to show up, if not already, and could affect the dynamic of pelagic feeding species with their filtering effects on water quality. I did not see this addressed. I also did not note any mention of non-native crayfish or molluscs which infest many of California's waters. They could have an effect on egg survival if they prey on them, or by feeding the exotic predators that otherwise might not be as abundant.

Diseases, I do not know of any other disease factors that should be considered, but the introduction of other non-natives always has the potential of bringing in other parasites and diseases. There must be pressure to bring in things like hybrid striped bass, etc that are being brought into other lakes at least in southern California.

Undoubtedly climate change will affect the lake, but parceling out effects specific to CLH is probably very conjectural and less likely to accomplish much compared to addressing the more direct known effects of habitat change and the mix of non-native species.

Page 37, Management recommendations are comprehensive and seem to cover all the things that need to be done to recover the species. Since it might be hard to do all of these soon, some prioritization could be in order. Adequate monitoring to establish population trends is a very important thing to establish as soon as possible. Improving habitat and managing predators are close behind as the most important adverse aspects affecting the species according to all the evidence. Given how dire the situation seems to be, identifying local refuges free of exotic predators could be a high priority also. Presumably two to four of these with several hundred fish each would maintain genetic diversity.

Overall this is a very comprehensive and detailed account that more than justifies special conservation status for the CLH. Hopefully many of the recommendations made here can be implemented to save the last few remnants of what was once a diverse native fish fauna.

Minckley, W. L. and P. Marsh. 2009. Inland fishes of the greater southwest. Chronicle of a vanishing biota.

Page	Line	Reviewer Comment	Department Response
1	Title	For a broader audience, I think the title should include the trailer "...a native minnow (Pisces, Cyprinidae) of California." The title of my early paper on the embryological development in this species left out the "...minnow (Pisces, Cyprinidae)...", and many times I have been asked, "What is a hitch, anyhow?"	No Change- The title is consistent with other species status reviews.
7	12-13	CLH can be separated from native minnows by having a higher anal ray count, which is technically accurate, but in my experience a mistake sometimes made in rapid field identifications is to confuse hitch with the non-native golden shiner because it also has a long anal fin. Apparently golden shiners were only in Clear Lake briefly in the late 1800s. But since they are widely sold as bait since becoming legal to raise and use for bait in California in 1955 (Moyle 2002), it would be surprising if they did not turn up in Clear Lake. It also seems surprising in retrospect that golden shiners did not "take" in Clear Lake since they like clear vegetated waters which were prevalent back then. once in a while and maybe even frequently. The rise of bass fishing would have made these larger bait minnows popular. It makes me wonder whether some of the hitch records taken by commercial fishermen and the Vector Control surveys may have been golden shiners. In both cases the hitch were secondary to the objectives of the studies and less attention may have been paid to them as they were field identified and released. This would mean that the hitch themselves were even less common than the records indicate. However, apparently no records of golden shiner exist since 1896 (Thompson et al. 2013) which seems surprising.	Noted- There is no indication that golden shiner would occur any more frequently in the commercial or seine records than they do in our standard survey efforts. Golden shiner are encountered every year in very small numbers and do not seem to be well established in the lake. Even if the were collected and incorrectly-identified based on other survey efforts they would not make up a large portion of the catch.
7	27-32	Aguilar et al. 2009 and Hopkirk (1973) are credited with molecular (microsatellite) and morphological data, respectively, to support subspecific recognition. It is stated that mtDNA do not support it but no reference is given and such is needed here to support this statement. It is well known that microsatellite (nuclear) DNA provides stronger evidence of systematic differences than mitochondrial data.	Accepted- reference added to document.
11	21-33	Commercial data is given as catch (number of fish) per days [fished?] or times "operations occurred." Presumably the effort was not, or cannot be, better quantified, such as time fished, or hauls or net sets made, or some other indication. Did the commercial fishermen do more or less the same thing every time?	Noted- All commercial data was recorded on data sheets that only required the date, location, and number of CLH captured.
11	21-33	Similarly the observational data is apparently number of fish observed [in spawning creeks] by number of observation periods. Do we have any indication of length of these periods, or how much stream was observed on each occasion? Without more information on how this data "looks" or was taken its hard to assess its value. (also on page 13, line 27-28).	Noted- Limitations of the observation data are discussed in the document. No data on duration of survey or survey reach length is available.
11	21-33	Finally some similar questions about the LCVCD is given as number of fish caught by year. It would seem that this effort may have been more quantified since they were after abundance data on silversides and shad. Like the number of hauls, or meters of shoreline seined, or something similar. No indication is given that this was the case, and perhaps it is not available, but would be valuable if it exists to make the estimates more quantitative. Although I guess they were staggered to be mostly after the hitch would have been in the areas targeted.	Noted- Data was used in the format provided to the Department, additional information was not made available.
12	Figure 2	is interesting, as noted in the text, in that the peaks and valleys of the various methods correspond which strengthens their validity as trends. Even the commercial peaks are delayed a year or so behind the LCVCD ones as expected since the former would be adults from the younger cohorts sampled by the latter.	Noted- This is what we would assume from the sampling methods, however no lengths were given with either the commercial or seine data to determine if juvenile or adult fish were captured.

13	25-43	<p>Good discussion of spawning tributaries and documentation of dramatic drop in tributaries utilized in the last 10 years or so, including a shift of the primary spawning from Kelsey to Adobe Creeks. This would seem to be a major change since Kelsey Creek is considered to have been the most, or nearly most, important stream for over 100 years. How does the amount and quality of habitat compare between the two systems? Also the drop from 12-13 tributaries to two or three in the last 10-15 years would seem to be a major reduction but is not quantified nor emphasized. Adobe Creek is a somewhat smaller drainage on the map but how do they compare in flow or water supply? What about the largest system (drainage coming in from the northwest? It is much larger than any of the others as illustrated on Figure 1. It would seem to have been a great loss if formerly utilized to the extent its size suggests. It seems like the number of tributaries lost could be strengthened by adding up the meters or kilometers of spawning/nursery habitat lost or something similar.</p>	<p>Noted- A complete habitat assessment of all the spawning tributaries has not been completed. It is discussed how the primary spawning tributary has switched from Kelsey to Adobe Creek. The number of spawning tributaries has not dropped over the last ten years but rather fluctuated. The second lowest number was recorded in 2007 followed by several years of increased use until another drop in 2013. Additional information on spawning tributaries has been added to the document. Amount of lost spawning habitat is discussed in the Dams, Barriers, and Diversions section.</p>
14	1 onward	<p>it is not clear to me why or how water quality conditions and lake depth influenced or make the LCVCD beach seine data less useful. Since they were designed (design not included here) to get an abundance of threadfin shad and Mississippi silversides, it would seem they would provide trend data for CLH also. Despite the fact they may not have been in the ideal season, habitat, or time of year, they did get CLH and if somehow regularly and consistently done should provide trends. The discussion suggests this latter may not be the case but does not exactly explain why, giving the impression that this possibly good source of data is being under-utilized. The fact that it corresponds, or is consistent with trends in the other catch data indicate it may be more useful than indicated.</p>	<p>Accepted- the sentence has been reworded to reflect the desired intent of the original sentence.</p>
15	Figure 4	<p>catches by LCVCD mostly low, as expected from above, but peaks seem in or near particularly wet years, like 97-98, 2005-2006 but others not so much. There seems to be continued higher numbers after the 2005 wet year, possibly due to the end of commercial fishing. But the adults in spawning stream declined tremendously without corresponding data for the juveniles via LCVCD. Peaks in the commercial catch seem widely scattered and without correspondence to any data given.</p>	<p>Noted- the data sets available for the status review do not provide clear estimates of CLH populations. The only provide an glimpse into the fluctuating nature of the population.</p>
15	Figure 4	<p>One lack here is the data on other fish which may shed more light on trends. We are told that the numbers of shad and silversides parallels those of juvenile hitch somewhat, but also that non-native fish overwhelmingly dominated all three sources of catch data. Particularly the change in abundance of piscivores like black crappie, largemouth bass, channel catfish, sunfish might be instructive. Several observations in southern California have shown large numbers of YOY largemouth bass at the upper end of reservoirs as juvenile minnows and suckers are drifting or dispersing downstream and adults of these prey species being non-existent or very rare in those areas. This coincides with much more detailed work in the Colorado River (Arizona, Nevada, California) showing that non-native centrarchids strongly and negatively impact recruitment of native cyprinids and catostomids there by preying on larvae and small juveniles as they move into slow-moving marginal nursery areas. As (and if) they get larger and move into flowing water, they then become vulnerable to nocturnal catfish predators. See Minckley and Marsh (2009). Data on these would shed more light on the possibility of these phenomena in Clear Lake.</p>	<p>Noted- A comprehensive paper on the fish distribution as seen during the Department's general fish surveys conducted over the last ten years or so is currently being compiled.</p>
16	6	<p>the sentence reads as if CDFW (called CDFG in many places in this report?) began sampling Clear Lake fishes in a regular way, but later we see that it is referring to four separate and disparate sampling events with purposes unrelated to CLH. In fact they were designed to avoid CLH as were the LCVCD samplings but with different methods. But they do document the relative rarity of CLH and overwhelming dominance of non-native species, but not what the other species are. The rarity is very significant for the purposes of this report since on line 28, CLH and other non-game fish were documented to be "...the bulk of the Clear Lake fishes..." up to 1972 and on p. 17 "...CLH [was] the third most common fish in the lake..." at that time, 1961-63.</p>	<p>Noted- CDFG refers to references that were titled as the California Department of Fish and Game prior to the name change to the California Department of Fish and Wildlife. The paragraph was reworded to clarify the sampling regularity in question. The goal of the status review is to evaluate all existing data on CLH. Not all data allows for a specific conclusion to be drawn.</p>

17,19	all	<p>clearly the fish has been highly impacted both by the lake being allowed to vary several feet (7.56) after building some kind of dam at the outlet, and stream changes, dams, etc. led to the loss of 92% of the spawning habitat. More information could be provided about the nature of the fluctuation related to historical fluctuations, apparently slight because of a permanent sill of some sort at the outlet. Unless evaporation exceeded inflow and allowed the lake to actually drop and dry up Putah Creek? These fluctuations may have impacted spawning success on gravel shores which perhaps was, or had become, more important as streams were compromised?</p> <p>it would seem clear and could be better emphasized that lead (Hg) levels are high enough to adversely impact hitch since they are documented to be at dangerous levels in fathead minnows. Fathead minnows are hardy (more tolerant to pollutants like lead), shorter-lived, and smaller fish than CLH. Thus CLH being longer-lived and larger would be expected to concentrate more Hg and also to be more sensitive to it as well.</p>	<p>Accepted- Additional information provided on lake levels.</p> <p>Noted- without actual mercury contamination numbers for CLH the Department is satisfied with listing the possible biological impacts from mercury contamination. The paragraph concludes by saying it is reasonable to suspect CLH are experiencing effects of mercury contamination.</p>
24	42	<p>The outlawing of commercial catch for catfish may well have increased their ability to prey on other fish in the lake. Aggressive control of invasive catfishes in other systems has increased native sport fish populations. As noted (p. 26, lines 18,19) the lake has already lost Sacramento perch, splittail, and thicktail chub, and pikeminnow are greatly diminished in the lake (Thompson et al. 2013), undoubtedly for many of the same reasons proposed here for CLH. It is particularly surprising that blackfish have been extirpated since they are one of the few native fishes seemingly surviving in the southern San Joaquin Valley in face of large numbers of non-native game and forage fish. In Clear Lake, catfish could be preying on both sunfishes and larger hitch and the sunfish and juvenile bass prey on the smaller hitch.</p>	<p>Noted- There is no specific data to suggest that stopping catfish harvest resulted in a decrease in CLH numbers. However, it is reasonable to assume that commercial harvest of catfish could have beneficial impacts on CLH populations.</p>
25	5		
28	44	<p>it was surprise to see that a 1988 creel census found CLH to be 2% of the sport catch, indicating they were still fairly common. Possibly local papers or newsletters have some hunting and fishing columnists that might have some kind of continuing record of catches? Or local anglers?</p>	<p>Noted- The Department receives incidental reports of CLH being captured by anglers. As noted in the management actions section the Department seeks to conduct more creel surveys to better understand the capture rates for all Clear Lake fishes.</p>
33	onward	<p>Present or threatened modifications or destruction of habitat: This has been very well and convincingly covered. Only the possible effects of fluctuating lake levels might be slighted as noted above.</p>	<p>Accepted- Additional information provided on lake levels.</p>
33	onward	<p>Overexploitation, seems an unlikely effect since the only evidence of major take of the species was back when it was very abundant. Even the only likely current exploiters, the local native Americans, seem to have largely reduced their take to just a few for ceremonial purposes. The 1988 creel survey indicated some exploitation and in the absence of golden shiners, they may be targeted as large bait for largemouth bass.</p>	<p>Noted- The Department does not feel that overexploitation is threatening the continued existence of CLH.</p>
33	onward	<p>Predation, while this is entertained, lack of a smoking gun leaves predation by non-native fish under-appreciated for this species and place in this report. The effect of introduced centrarchids and ictalurids on native minnows and suckers has been well documented in analogous systems like the Colorado River (Minckley and Marsh 2009) and certainly must have had an effect here. This report makes them seem less important by restricting discussion to this one species, and only slightly noting the splittail, blackfish, and Sacramento Perch have all already been completely lost. It would be important to know how and why the hitch is able to hang on, perhaps like the pikeminnow, by residing partly in the streams? In any case given the history here and elsewhere with other species, survival may depend on actually fencing off some rearing areas for the juveniles to allow them to reach sufficient size to reduce predation. Largemouth bass breed relatively early and many juveniles could congregate near the stream mouths for the larvae and juvenile hitch coming downstream. This is in addition to larger bass feeding on the adults massing near the stream mouths during spring spawning migrations.</p>	<p>Noted- This section provides a summary of the Predation section earlier in the document. There is little known about the predation rates of CLH by any species in Clear Lake. It will take further actions to determine the extent and possible actions to address this issue.</p>

33	onward	<p>Competition also seems very likely since the food of silversides and gizzard shad are somewhat similar, but presumably little chance exists for limiting these two species at this point. No mention is made of zebra or other invasive mussels except for the mention of quagga mussel inspections. They seem virtually certain to show up, if not already, and could affect the dynamic of pelagic feeding species with their filtering effects on water quality. I did not see this addressed. I also did not note any mention of non-native crayfish or molluscs which infest many of California's waters. They could have an effect on egg survival if they prey on them, or by feeding the exotic predators that otherwise might not be as abundant.</p>	<p>Noted- Competition from introduced fishes is impacting CLH. There is a need to understand the interactions for resources in the lake. Management actions are proposed to help address these issues.</p>
33	onward	<p>Diseases, I do not know of any other disease factors that should be considered, but the introduction of other non-natives always has the potential of bringing in other parasites and diseases. There must be pressure to bring in things like hybrid striped bass, etc that are being brought into other lakes at least in southern California.</p>	<p>Noted- The Department has not received any requests for additional species to be added to Clear Lake.</p>
33	onward	<p>Undoubtedly climate change will affect the lake, but parceling out effects specific to CLH is probably very conjectural and less likely to accomplish much compared to addressing the more direct known effects of habitat change and the mix of non-native species.</p>	<p>Noted- Climate change impacts are based on models for climate change in California. Any impacts would need to be studied as climate change occurs in the coming years.</p>
37	onward	<p>Management recommendations are comprehensive and seem to cover all the things that need to be done to recover the species. Since it might be hard to do all of these soon, some prioritization could be in order. Adequate monitoring to establish population trends is a very important thing to establish as soon as possible. Improving habitat and managing predators are close behind as the most important adverse aspects affecting the species according to all the evidence. Given how dire the situation seems to be, identifying local refuges free of exotic predators could be a high priority also. Presumably two to four of these with several hundred fish each would maintain genetic diversity.</p>	<p>Noted- The Department will prioritize implementation of management actions based on available resources.</p>



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
Sacramento, CA 95811
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director



January 13, 2014

Gregory Giusti
Forest and Wildlands Ecology Advisor
University of California, Davis – Cooperative Extension
883 Lakeport Blvd
Lakeport, CA 95453

Dear Mr. Giusti

CLEAR LAKE HITCH (*LAVINIA EXILICAUDA CHI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife (Department) Draft Status Report of the Clear Lake hitch (*Lavinia exilicauda chi*). A copy of the Department's peer review draft status report, dated January 2014, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of Clear Lake hitch in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). The Department would appreciate receiving your peer review input on or before February 10, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened. The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission.

The Commission first received the petition to list Clear Lake hitch as threatened on September 25, 2012. The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on March 22, 2013 following publication of regulatory notice by the Office of Administrative Law. The Clear Lake hitch is currently protected under CESA in California in that capacity.

The peer review Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the best scientific information available regarding the status of Clear Lake hitch in California. Headed into peer review, the Department believes the best available science indicates that listing the species as threatened under CESA is warranted at this time. To be clear, we ask that you focus

Conserving California's Wildlife Since 1870

Name, Title
Business
Date
Page 2

your review on the scientific information and the Department's related assessment of the required population and life history elements prescribed in CESA rather than focusing on the tentative conclusion we share as a matter of professional courtesy. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the best scientific information available regarding the status of Clear Lake hitch in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA (*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important as well as whether they indicate, in your opinion, that Clear Lake hitch is likely to become, in the foreseeable future, at serious risk of becoming extinct throughout all or a significant portion of its range in California.

We ask that you assess our work for quality and conduct a thorough and proper review. As with all peer review processes, the reviewer is not the final arbiter, but your comments will inform our final decision-making. Also, please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Kevin Thomas at kevin.thomas@wildlife.ca.gov, or he may be reached by telephone at (916) 358-2845.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Stafford Lehr
Chief, Fisheries Branch

Enclosure(s)

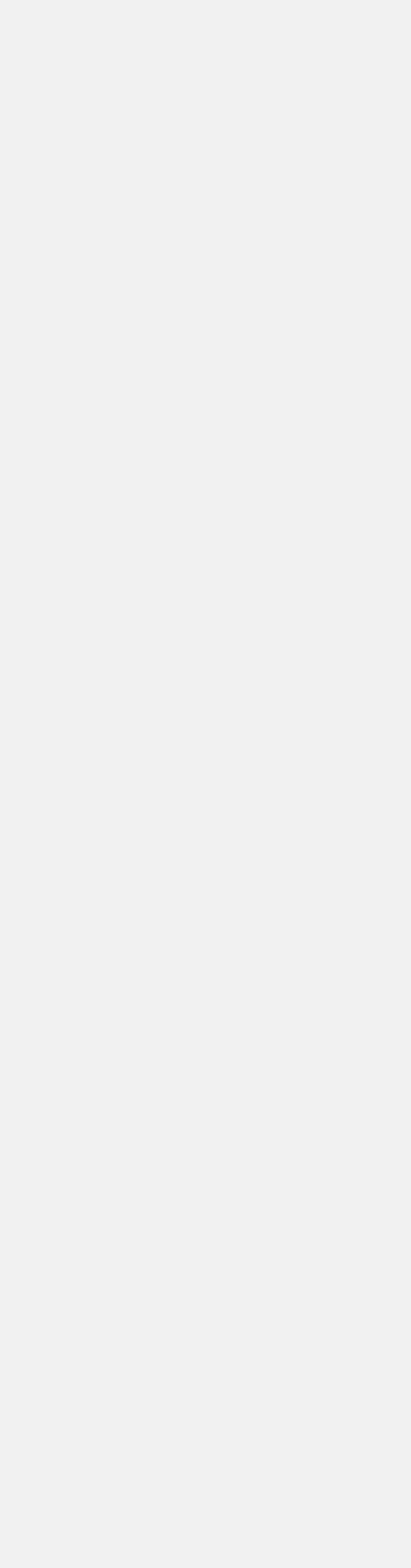
cc: Tina Bartlett
CDFW-NCR

Name, Title
Business
Date
Page 3

Thomas Gibson
CDFW-OGC

Katherine Hill
CDFW-NCR

Kevin Thomas
CDFW-NCR



1
2
3 **State of California**
4 **Natural Resources Agency**
5 **Department of Fish and Wildlife**
6
7

8
9 **REPORT TO THE FISH AND GAME COMMISSION**
10

11
12
13
14 **A STATUS REVIEW OF CLEAR LAKE HITCH (*Lavinia exilicauda ch*)**
15

16
17 **January 2014 Preliminary Draft for Peer Review**
18
19
20



21
22 Clear Lake hitch adult. Photo courtesy of Rick Macedo
23
24

25
26 **Charlton H. Bonham, Director**
27 **Department of Fish and Wildlife**
28
29
30



31
32 Report to the Fish and Game Commission

A STATUS REVIEW OF CLEAR LAKE HITCH

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

Contents

LIST OF FIGURES.....	4
LIST OF APPENDICES	4
EXECUTIVE SUMMARY	5
Background	5
Summary of Findings.....	5
Status	5
Threats	5
Petitioned Action	5
Management and Recovery Recommendations.....	6
INTRODUCTION.....	6
Petition History	6
Department Review	6
BIOLOGY.....	7
Species Description	7
Taxonomy.....	7
Range and Distribution	7
Life History	9
Habitat that May be Essential to the Continued Existence of the Species.....	10
SPECIES STATUS AND POPULATION TRENDS.....	10
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE.....	18
Present or Threatened Modification or Destruction of Habitat	18
Wetland Habitat Loss.....	18
Spawning Habitat Exclusion and Loss	18
Water Quality Impacts	22
Overexploitation	25
Commercial Harvest.....	25
Cultural Harvest	25
Predation and Competition	26
Disease and Parasites.....	27

1	Other Natural Occurrences or Human Related Activities	27
2	Climate Change	27
3	Recreational Activities	28
4	REGULATORY AND LISTING STATUS.....	29
5	Federal	29
6	State	29
7	Other Rankings.....	30
8	EXISTING MANAGEMENT EFFORTS.....	30
9	Resource Management Plans	30
10	Monitoring and Research.....	32
11	Habitat Restoration Projects.....	32
12	Impacts of Existing Management Efforts.....	32
13	SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE HITCH IN CALIFORNIA	33
14	Present or Threatened Modification or Destruction of Habitat	34
15	Overexploitation	34
16	Predation.....	34
17	Competition	35
18	Disease	35
19	There are no known diseases that are significant threats to the continued existence of CLH.	35
20	Other Natural Occurrences or Human-related Activities	35
21	SUMMARY OF KEY FINDINGS	35
22	RECOMMENDATION FOR PETITIONED ACTION	36
23	PROTECTION AFFORDED BY LISTING	36
24	MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES	37
25	PUBLIC RESPONSE	38
26	PEER REVIEW.....	38
27	LITERATURE CITED	39
28		
29		
30		

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

LIST OF FIGURES

Figure 1. Map depicting the Clear Lake watershed. 8
Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis. 12
Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013. 14
Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010. 15
Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001. 16
Figure 6. Photo from 1890s depicting spawning CLH being stranded in Kelsey Creek. 17
Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed. 20

LIST OF APPENDICES

Appendix A. Summary graphs of spawning observations between 2005 and 2013
Appendix B. Figures depicting CLH observations on spawning tributaries
Appendix C. Description of barriers associated with CLH spawning tributaries

1 **EXECUTIVE SUMMARY**

2
3 This status review report describes the current status of Clear Lake hitch (*Lavinia*
4 *exilicauda chi*) (CLH) in California as informed by the scientific information available to
5 the California Department of Fish and Wildlife (Department, CDFW, CDFG).
6

7 **Background**

- 8 • September 25, 2012: The Fish and Game Commission (Commission) received a
9 petition from the Center for Biological Diversity to list CLH as threatened under
10 the California Endangered Species Act (CESA) (Center for Biological Diversity
11 2012).
- 12 • September 26, 2012: The Commission sent a memorandum to the Department,
13 referring the petition to the Department for its evaluation.
- 14 • October 12, 2012: The Commission provided notice of the received petition from
15 the Center for Biological Diversity to list CLH as threatened under CESA (Cal.
16 Reg. Notice Register 2012, Vol. 41-Z, p.1502).
- 17 • December 12, 2012 the Commission granted a 30-day extension on the
18 submission date for the Department's Initial Review of Petition to List the Clear
19 Lake Hitch as threatened under CESA.
- 20 • January 31, 2013: The Department provided the Commission with an Initial
21 Review of Petition to List the Clear Lake Hitch as Threatened under the
22 California Endangered Species Act pursuant to Fish and Game Code, section
23 2073.5. The Department's review recommended that the petition provided
24 sufficient information to indicate the petitioned action may be warranted, and the
25 petition should be accepted and considered (CDFW 2013).
- 26 • March 6, 2013: At its scheduled public meeting in Mt. Shasta, California, the
27 Commission considered the petition, the Department's petition evaluation and
28 recommendation, and comments received by the Commission and found that the
29 petition provided sufficient information to indicate the petitioned action may be
30 warranted.
- 31 • March 22, 2013: The Commission published its Notice of Findings in the
32 California Regulatory Notice Register (CA Reg. Notice Register 2013, Vol. 12-Z
33 p. 488), stating the petition was accepted for consideration, and designated CLH
34 as a candidate species.

35 **Summary of Findings**

36
37 *Note to Reviewer.* This Summary of Findings will be finalized after the Department
38 receives, evaluates, and incorporates peer-review comments as appropriate.

39 **Status**

40 **Threats**

41 **Petitioned Action**

42

1 **Management and Recovery Recommendations**

2 **INTRODUCTION**

3
4 This status review report addresses the Clear Lake hitch (*Lavinia exilicauda chi*) (CLH),
5 the subject of a petition to list the species as threatened under the California
6 Endangered Species Act (CESA) (Fish & G. Code § 2050 *et seq.*).

7 **Petition History**

8
9 On September 25, 2012, the Fish and Game Commission (Commission) received a
10 petition from the Center for Biological Diversity (Petitioner) to list the CLH as a
11 threatened species under CESA.

12
13 On September 26, 2012 the Commission sent a memorandum to the California
14 Department of Fish and Wildlife (Department, CDFW, and CDFG) referring the petition
15 to the Department for its evaluation.

16
17 On October 12, 2012, as required by Fish and Game Code, section 2073.3, notice of
18 the petition was published in the California Notice Register (Cal. Reg. Notice Register
19 2012, Vol. 41-Z, p.1502).

20
21 On December 12, 2012 the Commission granted a 30-day extension on the submission
22 date for the Department's Initial Review of Petition to List the CLH as threatened under
23 CESA.

24
25 On January 31, 2013, the Department provided the Commission with its Initial Review of
26 Petition to List the CLH as threatened under CESA. Pursuant to Fish and Game Code,
27 section 2073.5, subdivision (a) (2), the Department recommended that the petition
28 provided sufficient information to indicate the petitioned action may be warranted.

29
30 On March 6, 2013 at its scheduled public meeting in Mt. Shasta, California, the
31 Commission considered the petition, the Department's petition evaluation and
32 recommendation, and comments received, and found that sufficient information existed
33 to indicate the petition may be warranted and accepted the petition for consideration.

34
35 Subsequently, on March 22, 2013 the Commission published its Notice of Findings for
36 CLH in the California Regulatory Notice Register, designating the CLH as a candidate
37 species (CA Reg. Notice Register 2013, Vol. 12-Z p. 488).

38 **Department Review**

39
40 Following the Commission's action to designate CLH as a candidate species, the
41 Department notified affected and interested parties and solicited data and comments on
42 the petitioned action, pursuant to Fish and Game Code, section 2074.4 (see also Cal.
43 Code Regs., Title 14, § 670.1(f)(2)) (CDFW 2013). All comments received are included
44 in Appendix D to this report. The Department commenced its review of the status of the
45 species as required by Fish and Game Code section 2074.6.

1
2 This report reflects the Department's scientific assessment to date of the status of CLH
3 in California. At this point, the report will undergo independent and competent peer
4 review by scientists with acknowledged expertise relevant to the status of CLH. Once
5 peer review is completed Appendix E will contain the specific input provided to the
6 Department by the individual peer reviewers (Cal. Code Regs., Title 14, § 670.1(f) (2)).

7 **BIOLOGY**

8 **Species Description**

9
10 Clear Lake hitch is a member of the cyprinid family (Cyprinidae), growing to 35
11 centimeters (cm) standard length (SL), and with laterally compressed bodies, small
12 heads and upward pointing mouths (Moyle et al. 1995). They are separated from other
13 California minnows by their long anal fin consisting of 11 to 14 rays. The dorsal fin (10
14 to 12 rays) originates behind the origin of the pelvic fins. Juvenile CLH have a silver
15 coloration with a black spot at the base of the tail. As CLH grow older the spot is lost
16 and they appear yellow-brown to silvery-white on the back. The body becomes deeper
17 in color as the length increases (Hopkirk 1973; Moyle 2002). CLH show little change in
18 pigmentation during the breeding season (Hopkirk 1973). The **deep, compressed body,**
19 small upturned mouth, and numerous long slender gill rakers (26 to 32) reflect the
20 zooplankton-feeding strategy of a limnetic forager (Moyle 2002). This lake adapted
21 subspecies also has larger eyes and larger scales than other hitch subspecies.

Comment [GG1]: Hopkirk felt that the compressed body differentiated the lake ssp. from riverine ssp. You may want to identify that point as well.

Formatted: Highlight

22 **Taxonomy**

23
24 Hopkirk (1973) described CLH as a lake-adapted subspecies based primarily on the
25 greater number of fine gill rakers. CLH are distinguished from other subspecies of hitch
26 by their **deeper body, larger eyes, larger scales and more gill rakers** (Hopkirk 1973).
27 Recent research on 10 microsatellite loci supports Hopkirk's description of CLH as a
28 distinct subspecies (Aguilar et al. 2009). However, **mitochondrial DNA analysis** has not
29 been able to distinguish CLH as a distinct subspecies from other hitch in California.
30 **Yet,** based upon the morphological and microsatellite analysis there is sufficient
31 evidence to warrant the designation of CLH as a distinct subspecies of hitch (Hopkirk
32 1973; Moyle et al. 1995; Aguilar et al. 2009).

Comment [GG2]: You just addressed my previous point.

Formatted: Highlight

Formatted: Highlight

Comment [GG3]: Do you have a citation for this?

33
34 CLH can hybridize with other Cyprinidae species and hybridization is known to occur
35 with the genetically similar California roach (*Lavinia symmetricus*) (Miller 1945b; Avise
36 and Ayala 1976; Moyle and Massingill 1981; Moyle et al. *in review*). However, there is
37 no documentation of these hybrids in Clear Lake. CLH were known to hybridize in
38 Clear Lake with the now extinct thickettail chub (*Gila crassicauda*) (Moyle et al. *in review*).

39 **Range and Distribution**

40
41 The entire CLH population is confined to Clear Lake, Lake County, California, and to
42 associated lakes and ponds within the Clear Lake watershed such as Thurston Lake
43 and Lampson Pond (Figure 1). Populations previously identified in the Blue Lakes, west
44 of Clear Lake, have apparently been extirpated (Macedo 1994).

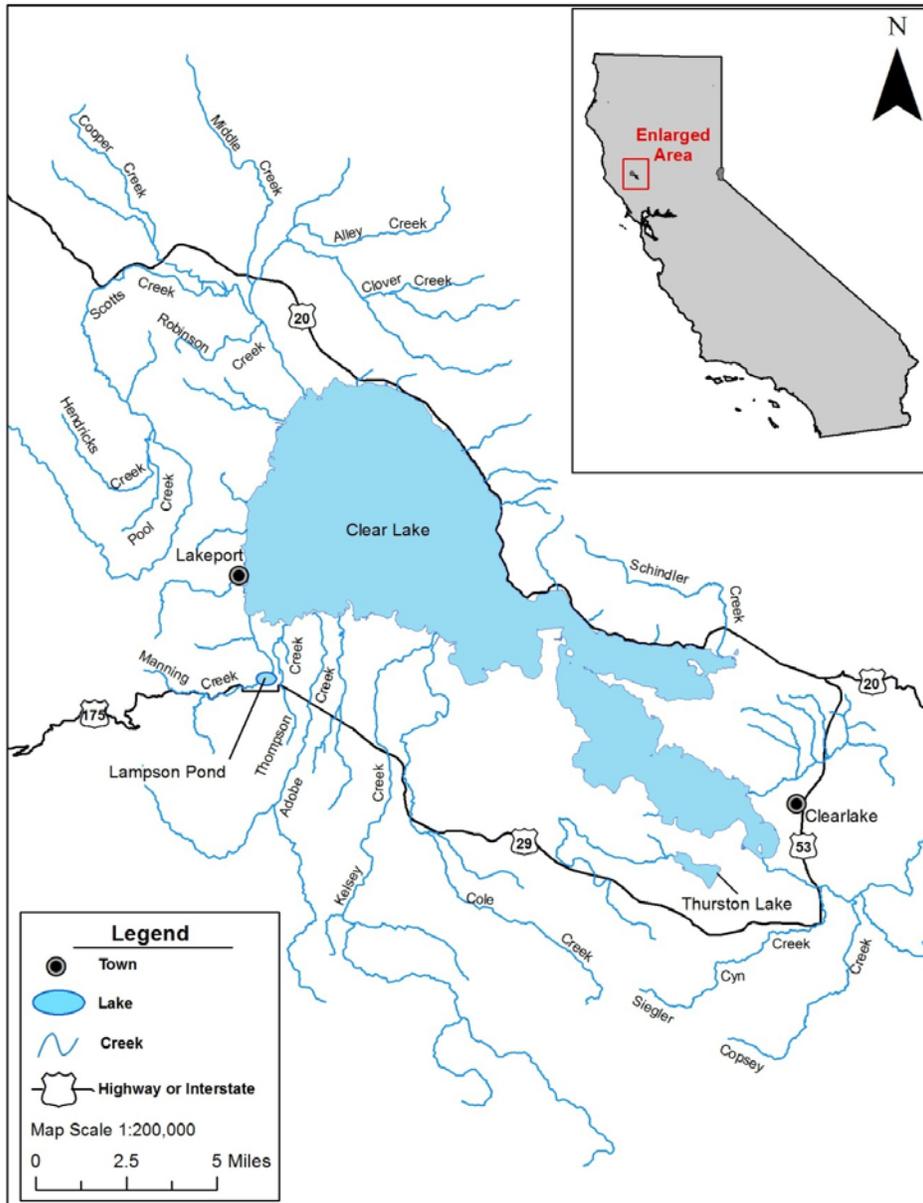


Figure 1. Map depicting the Clear Lake watershed.

1
2
3
4
5

1 **Life History**

2
3 Physical adaptations to lake conditions allow CLH greater than 50 millimeters (mm) SL
4 to feed almost exclusively on water fleas (*Daphnia* spp.) (Geary 1978; Geary and Moyle
5 1980; Moyle 2002). Stomach analysis indicates that CLH feed primarily in the day
6 rather than at night (Geary 1978). Juveniles less than 50 mm SL are found in shallow,
7 littoral zone (near-shore) waters and feed primarily on the larvae and pupae of
8 chironomidae; planktonic crustaceans including the genera *Bosnia* and *Daphnia*; and
9 historically on the eggs, larvae, and adults of Clear Lake gnat (*Chaoborus astictopus*)
10 (Lindquist et al. 1943; Geary 1978; Geary and Moyle 1980). Growth in CLH is faster
11 and total size greater than that of other hitch subspecies (Nicola 1974). By three
12 months CLH have reached 44 mm SL and will continue to grow to between 80 to 120
13 mm by the end of their first year (Geary and Moyle 1980). Females become mature by
14 their second or third year, whereas males tend to mature in their first or second year
15 (Kimsey 1960). Females grow faster and are larger at maturity than males (Hopkirk
16 1973; Geary 1978; Ringelberg and McGinnis 2009). The larger size of CLH in
17 comparison to hitch from other locations translates to greater fecundity. Accordingly,
18 spawning females in Clear Lake average 36,000 eggs each year (Geary and Moyle
19 1980) compared to an average of 26,000 eggs for hitch in Beardsley Reservoir (Nicola
20 1974).

21
22 Clear Lake tributaries are numerous and located around the lake basin (Figure 1). Most
23 streams have headwaters at higher elevations in the surrounding foothills; others have
24 headwaters in lower elevations of the basin, and nearly all have of low gradients prior to
25 entering the lake. Some streams are more substantial than others with flowing water
26 year round. Most are seasonal with remnant pools occurring by late spring, and
27 subsequently dry during summer months. Those that retain water year round often
28 have long stream reaches that are ephemeral. CLH spawn in these low-gradient
29 tributary streams and form spawning migrations that resemble salmonid small-scale
30 salmon-runs. Spawning migrations usually occur in response to heavy spring rains,
31 from mid-February through May and occasionally into June (Murphy 1948b; Kimsey
32 1960; Swift 1965; Chi Council for Clear Lake Hitch (CCCLH) 2013 (unpublished data)).
33 During wet years, CLH spawning migrations may also opportunistically extend into the
34 upper reaches of various small tributaries, drainage ditches, and even flooded meadows
35 (Moyle et al. *in review*). CLH have also been observed spawning along the shores of
36 Clear Lake, over clean gravel in water 1 to 10 cm deep where wave action cleans the
37 gravel of silt (Kimsey 1960). The success of these atypical spawning areas is not
38 clearly understood and may be limited due to losses from egg desiccation and juvenile
39 predation (Kimsey 1960; Rowan, J. personal communication, October 10, 2013,
40 unreferenced).

41
42 CLH spawn at water temperatures of 14 to 18°C in the lower reaches of tributaries. Egg
43 deposition occurs along the margins of streams in very shallow riffles over clean, fine-
44 to-medium sized gravel (Murphy 1948b; Kimsey 1960). Eggs are fertilized by one to
45 five males as they are released from the females (Murphy 1948b; Moyle 2002). Eggs
46 are non-adhesive and sink to the bottom after fertilization, where they become lodged
47 among the interstices in the gravel. The eggs immediately begin to absorb water and
48 swell to more than double their original size. This rapid expansion provides a protective

Formatted: Highlight

Comment [GG4]: I'm not sure about this. This may be true in the headwater regions of Kelsey Creek, Cole Creek and possibility others, but I believe surface water is found beyond the reach of hitch.

Formatted: Highlight

1 cushion of water between the outer membrane and the developing embryo (Swift 1965)
2 and may help to secure eggs in gravel interstices. The embryos hatch after
3 approximately 7 days, and larvae become free-swimming after another 7 days (Swift
4 1965). Larvae must then move downstream to the lake before stream flows become
5 ephemeral (Moyle 2002).

6
7 Within Clear Lake, larvae remain near shore and are thought to depend upon stands of
8 tules (*Schoenoplectus acutus*) and submerged weeds for cover until they assume a
9 limnetic lifestyle (CDFG 2012). Juvenile CLH require rearing habitat with water
10 temperatures of 15° C or greater for survival (Moyle 2002; Franson 2012 and 2013).
11 Juveniles are found in littoral shallow-water habitats and move into deeper offshore
12 areas after approximately 80 days, when they are between 40 to 50 mm SL (Geary
13 1978; CDFG 2012). Adult CLH are usually found in the limnetic zone (well-lit, surface
14 waters away from shore) of Clear Lake. The limnetic feeding behavior of adult fish is
15 supported by stomach analysis of CLH where very little content of benthic midges was
16 found, even though the fish were collected in the profundal (deep-water) habitat during
17 the survey (Cook et al. 1964). Additional data collected by the Department during the
18 early 1980s indicates CLH are present in the littoral zone from April to July and are
19 absent from this habitat during other months (Week 1982).

20
21 Adult CLH are vulnerable to predation during their spawning migration by mergansers
22 (*Mergus* spp.), herons (*Ardea* spp.), bald eagles (*Haliaeetus leucocephalus*), and other
23 birds, river otter (*Lontra canadensis*), northern raccoon (*Procyon lotor*), and striped
24 skunk (*Mephitis mephitis*) (Bairrington 1999). In addition, CLH have been recovered
25 from the stomachs of black bass (*Micropterus* spp.) caught in the lake (Bairrington
26 1999). Most predation by black bass likely occurs during spring staging periods as CLH
27 congregate and begin to ascend tributaries to spawn (Rowan, J. personal
28 communication, October 10, 2013, [unreferenced](#)).

Comment [GG5]: Should we list other fish species e.g. catfish, other centrarchids?

29 **Habitat that May be Essential to the Continued Existence of the Species**

30
31 At various life stages CLH utilize stream and lacustrine (lake) habitat present in the
32 watershed (Figure 1). Adult fish spawn in the tributaries of the lake during the spring
33 and juvenile fish emerge from the tributaries and utilize near shore habitats to continue
34 growth and seek refuge from predators. As juveniles mature into adults they move to
35 the main body of the lake and assume a limnetic lifestyle until returning to spawn in the
36 tributaries the following spring.

37 **SPECIES STATUS AND POPULATION TRENDS**

38
39 An assessment of the status of CLH should include statistically valid population
40 estimates conducted over time, to provide population data and trends. CLH studies to
41 date have consisted primarily of qualitative sampling and are not suitable for deriving
42 population estimates; however, these study results can provide insight into the current
43 status of the species.
44

1 The population trends for this status review focus on three sets of data available to the
2 Department for analysis. First, commercial catch records, submitted to the department
3 by operators on Clear Lake, contain incidental catch information on CLH dating back to
4 1961. Operators were required to keep records of CLH caught incidentally while
5 operations focused on other species in the lake. Second, the Lake County Vector
6 Control District (LCVCD) has been conducting sampling efforts along the shoreline of
7 Clear Lake since 1987. Although sampling efforts are not specific to CLH, LCVCD
8 recorded incidental data on CLH captured during each sampling. Third, spawning
9 observation data have been collected by volunteers with the CCCLH since 2005.
10 Spawning observation data provide an estimate of the number of CLH in any given
11 spawning tributary during the observation period. Results are summarized by the
12 CCCLH each year following the completion of the spawning season. Information on
13 population trends prior to 1961 is focused on small sampling efforts, published articles,
14 and traditional ecological knowledge from tribal members. Although not quantifiable,
15 this data provides an idea of the status and distribution of CLH prior to larger qualitative
16 sampling efforts.

Comment [GG6]: I think you should spell this out the first time.

17
18 Environmental conditions required for successful spawning and biological impacts to the
19 survivorship of CLH are highly variable from year to year and often result in multiple
20 years with reduced spawning success or reduced recruitment into the population. The
21 information presented in Figure 2 comes from the three qualitative sampling efforts
22 conducted at Clear Lake and measured rainfall totals during the past 52 years in the
23 watershed. Trend data in commercial catch records were represented for a given year
24 by totaling the number of CLH captured per year and dividing by the number of days
25 commercial operations occurred. Commercial catch data are comprised primarily of
26 adult CLH. The CLH spawning trend data were calculated by totaling the number of
27 CLH observed and dividing by the number of observation periods. LCVCD data on CLH
28 captures represent the total number of CLH captured per year. LCVCD data is
29 comprised primarily of juvenile CLH. The data represented from Table 6 of CDFG
30 (1999) were calculated by using 20,000 as a total catch baseline for percent of total
31 catch for CLH. Total rainfall data for January to June of each year was measured at the
32 Clear Lake Highlands and U.S. Geological Survey rainfall gauges. Figure 2 does not
33 reflect population numbers but rather trends in the abundance of CLH in any given year.
34 As a proxy for changes in an established population size, biologists often use qualitative
35 information as an indicator of population trends.

Comment [GG7]: I know what your intention is here but we really don't have "spawning success" data i.e. fecundity numbers. Maybe "reduced number of adults observed" or something similar. None of the counts include night time observations.

Formatted: Highlight

36
37 The trends of all data show a highly variable population that responds both positively
38 and negatively to environmental parameters and varies significantly from year to year.
39 Rainfall totals do not appear to be significantly correlated to the abundance of CLH
40 during the timeframe. It is likely that a combination of environmental factors is
41 impacting the CLH population. The fluctuating abundance trend has continued
42 throughout the duration of the qualitative sampling efforts and indicates CLH
43 populations have at times been extremely low and at other times relatively robust.
44

Comment [GG8]: You might want to consider a line that identifies turbidity following a rain can affect observation data collection. Simply to identify another variable.

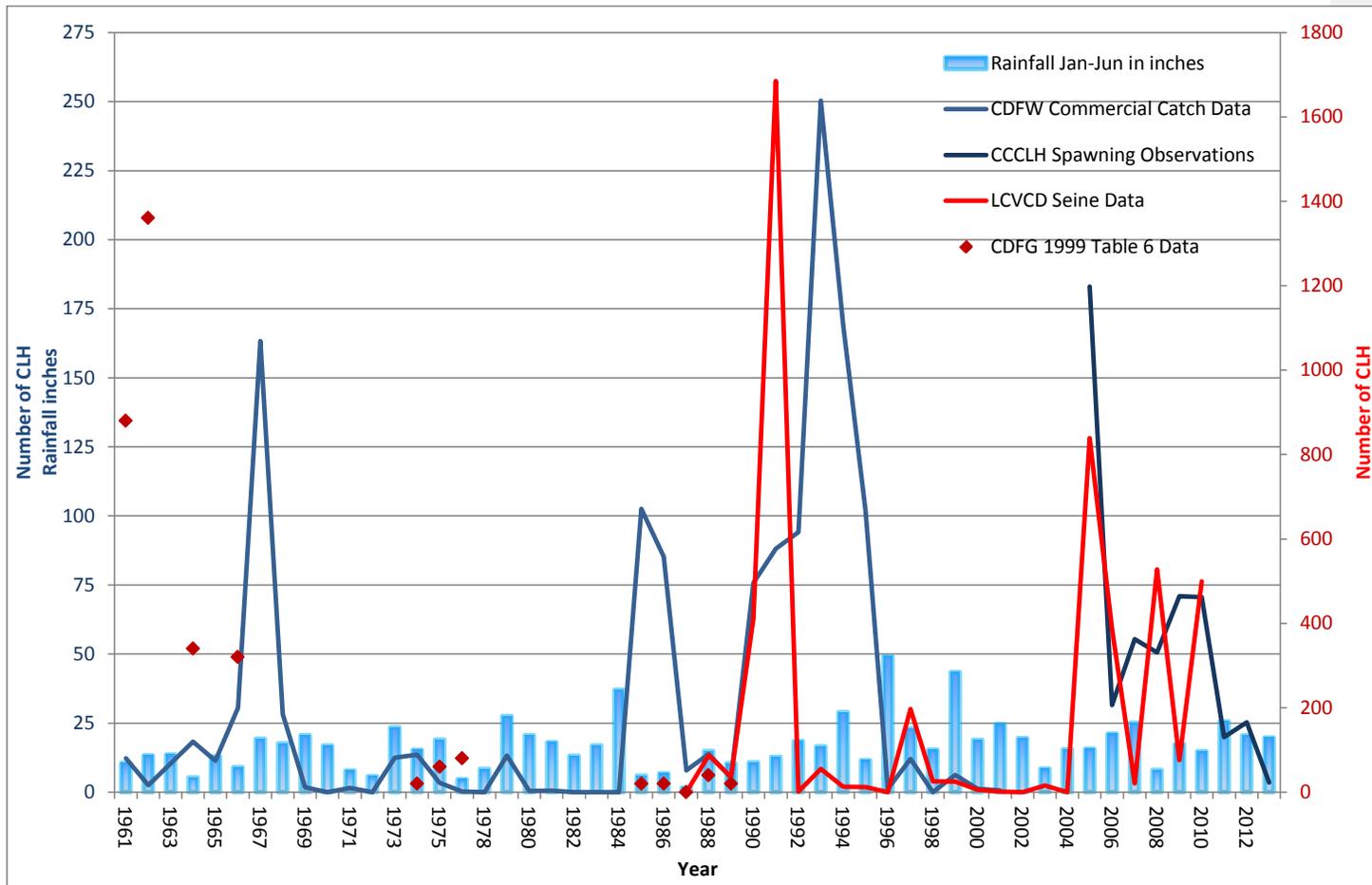


Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis.

1 In 2013 the Department conducted a mark-and-recapture study to gain a better
2 understanding of the CLH spawning population in Cole and Kelsey creeks.
3 Unfortunately, too few individuals were marked and recaptured to give a statistically
4 valid population estimate (Ewing 2013). Electrofishing surveys in June 2012 identified
5 thousands of young of year CLH in near shore habitats along the southwestern
6 shoreline of Clear Lake (CDFG 2012). Volunteers with the CCCLH conducted direct
7 observations of CLH in spawning tributaries of Clear Lake in 2013, and spawning
8 observations identified less than 500 CLH present (CCCLH 2013). Of those fish, 300 to
9 400 were found below the Kelsey Creek detention dam. No single day count totaled
10 more than 70 fish in any spawning tributary in 2013 (CCCLH 2013).

11
12 CCCLH qualitative spawning observations between 2005 and 2013 indicated peak
13 single day CLH spawning runs of 1,000 to 5,000 fish (CCCLH 2013), and daily
14 observation averages ranged from 3.5 to 183.1 fish (Figure 2). However, these
15 observations make no distinction between previously counted fish, and it may be more
16 prudent to look at fixed location single day counts from this time period. The highest
17 number of CLH observations recorded was approximately 5,000 during 2005;
18 concurring with beach seine data that demonstrate a higher than average number of
19 CLH caught in 2005 as well (CCCLH 2013; LCVCD 2013). The increased number of
20 juvenile CLH captured in the 2005 beach seine sampling is the likely reason for the
21 increase in adult spawning observations between 2007 and 2009. Appendix A contains
22 summary graphs and figures, prepared by CCCLH, for observations made between
23 2005 and 2013.

24
25 There is sufficient information from these spawning observations to suggest the number
26 of spawning tributaries being used by CLH decreased in 2013 compared to the average
27 from 2005 to 2012 (Figure 3) (CCCLH 2013). However, the data limitations do not allow
28 for quantification of observation time on each creek (survey effort) compared with the
29 number of fish observed to aid in understanding the extent of use in each tributary.
30 Appendix B contains figures depicting the decline in annual spawning runs in Clear
31 Lake tributaries between 2005 and 2013 (CCCLH 2013). Historic accounts and habitat
32 suitability predications suggest that CLH originally spawned, to some degree, in all the
33 tributaries to Clear Lake (Robinson Rancheria Ecological Center (RREC) 2011).
34 However, reports on Pomo geography speak of Pomo tribes in the area travelling to
35 Kelsey Creek to capture CLH and even of war when a tribe tried to divert Kelsey Creek
36 to gain control of the important CLH supply (Barrett 1906; Kniffen 1939). Based on the
37 reports it is unclear to what extent CLH spawned in other tributaries to Clear Lake. It
38 can be surmised the majority of CLH spawning occurred in Kelsey Creek during this
39 period. Over the past eight years the number of occupied spawning tributaries has
40 decreased from a high of 12 in 2006 to three in 2013 (CCCLH 2013). Currently, Adobe
41 Creek seems to have the largest spawning run in the Clear Lake watershed while
42 Kelsey and Cole creeks support smaller spawning runs. Based on historical accounts
43 the primary spawning tributary has shifted from Kelsey Creek to Adobe Creek (Kniffen
44 1939; CCCLH 2013).

Comment [GG9]: Good point.

Comment [GG10]: More than fish numbers, I think this is a salient point. Trend analysis is more important than a single year data point due to the lack of flow in many historic spawning tribs in 2013.

Comment [GG11]: Does this identify a need to better quantify and standardize a protocol to estimate annual fish migration numbers?

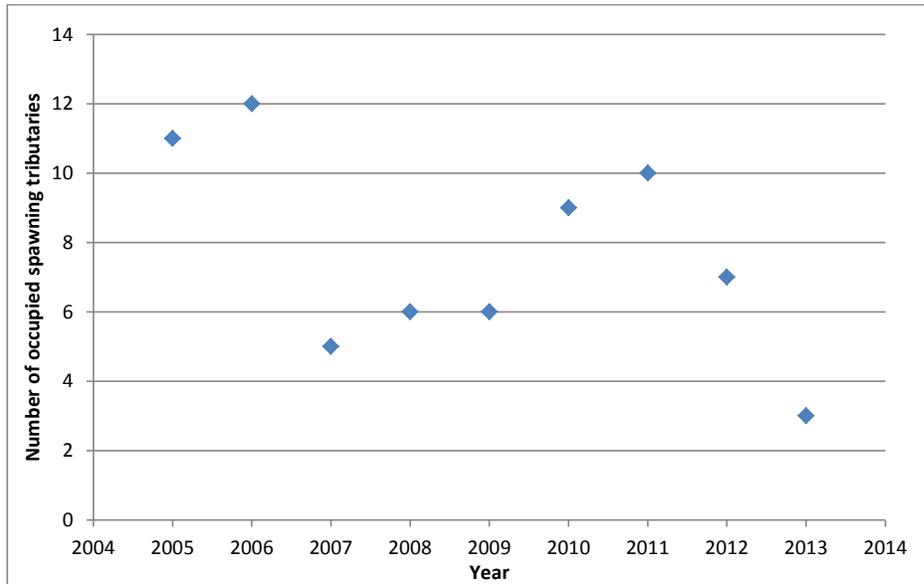


Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013.

1
2
3
4
5 LCVCD has been collecting beach seine data at various sites around the lake for more
6 than two decades. The sampling is designed to measure abundance of threadfin shad
7 (*Dorosoma petenense*) and inland silversides (*Menidia beryllina*) as part of a Clear Lake
8 gnat (*Chaoborus astictopus*) surveillance program. Incidental captures of CLH are
9 recorded during these surveys; however, the data collected are not appropriate for a
10 statistically valid evaluation of CLH populations as the sample design varies significantly
11 in timing, water quality conditions, and lake depth during surveys. Additionally, sample
12 locations are in areas that contain open unvegetated beaches that are not preferred
13 habitat for CLH. Although surveys were not conducted to assess CLH, capture data for
14 these surveys is consistent with other data sources in demonstrating a population that
15 has poor recruitment in many years interspersed with few years of high levels of
16 recruitment (Figure 4) (LCVCD 2013). In most years less than 100 CLH are captured
17 during the surveys (17 of 24 years). Four of the six years when more than 100 CLH
18 were captured were between 2005 and 2010. The greatest numbers of CLH were
19 captured in 1991, a year that was described by the Department as a boom for juvenile
20 fish in the lake (Bairrington 1999). Commercial fisheries data from 1991 also indicate
21 an increase in CLH numbers captured during operations; over 6,000 CLH were
22 captured and released by commercial fishery operators between March and May in
23 1991 (CDFW Commercial Fisheries Data). Data from the early 1990s also indicate an
24 increase in zooplankton and macroinvertebrate numbers resulting in increased available
25 forage for CLH (Winder et al. 2010).
26

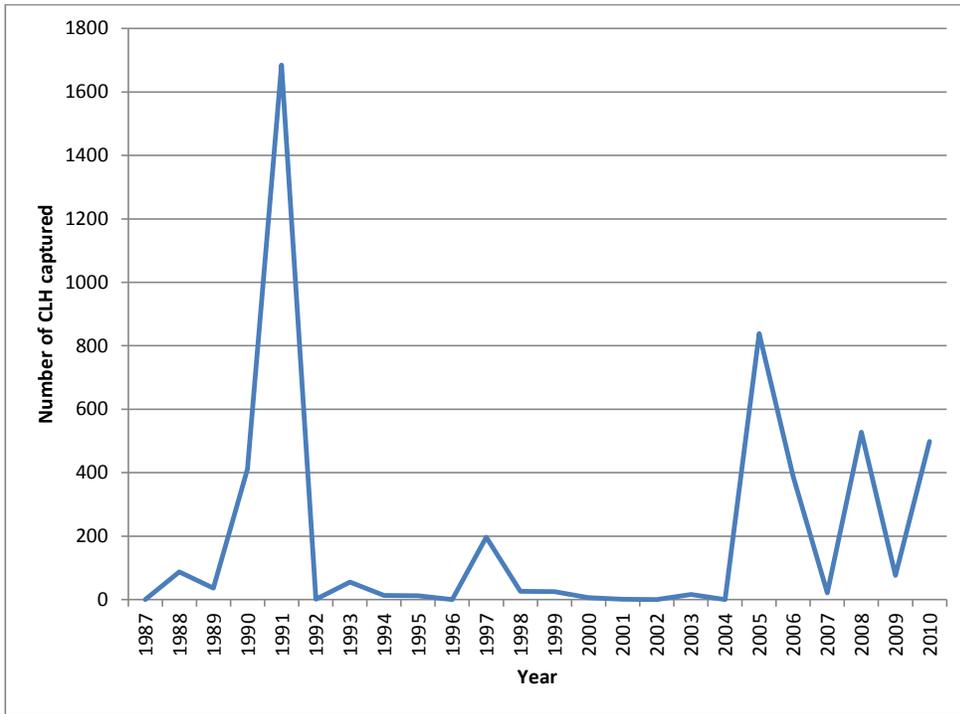


Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010.

1
2
3
4
5
6
7
8
9
10
11
12

The data available to the Department that cover the greatest timeframe come from commercial harvest records for Clear Lake. These data, 1961 to 2001, provide estimates of CLH numbers captured incidentally during operations (Figure 5). Multiple times throughout the past 50 years the number of CLH captured has surpassed 10,000 fish. There are also several years where CLH were almost or entirely absent from sample collections. These data suggest that CLH can sustain a population through multiple years of suppressed spawning or recruitment or both.

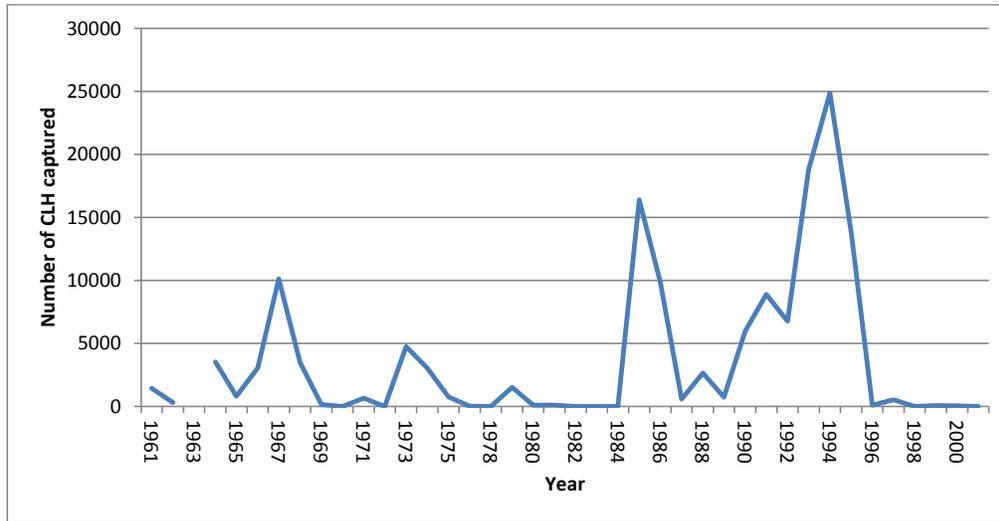


Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001.

In the 1980s, the Department began sampling Clear Lake fishes to assess native and sport fish populations in the lake. Surveys found CLH occupying littoral habitats between April and July each year (Week 1982). The surveys were directed towards littoral zone use and provide no information on CLH outside of those months (Week 1982). An electrofishing survey was completed in April of 1987, and CLH was the most abundant fish sampled at locations around Rattlesnake Island and Clearlake Oaks subdivision; however, only a total of 52 CLH were captured during the survey (CDFG 1988). It must be noted that this sampling was on a very small scale, targeted black crappie (*Pomoxis nigromaculatus*), and occurred in habitats where CLH would likely be found during this time period. Additional spring and fall sampling between 1995 and 2006 found CLH to be the most abundant native fish, but the overall capture numbers were relatively low with a peak catch per unit effort (CPUE) of only 0.087 for juvenile fish in the fall of 2000 and 0.169 for adult fish in the spring of 1999. CPUE's were based on the number of fish caught per minute of electrofishing (Cox 2007). Electrofishing surveys conducted during late June 2007 reported low numbers of CLH recorded during the survey (Rowan 2008). The low numbers of CLH may be attributed to the sampling timeframe in late June. As noted in Cook et al. 1964, CLH were absent from littoral zone sampling following the start of summer. In an effort to reduce impacts to CLH while sampling, the Department's Clear Lake surveys between 2008 and 2012 were all confined to the timeframe of late June and July when CLH numbers are greatly reduced in the littoral zone.

As late as 1972, CLH and other nongame fish were described as comprising the bulk of the Clear Lake fishery (Puckett 1972). The Lake County Mosquito Abatement District conducted surveys between 1961 and 1963 examining the relationship between fish and midges. These surveys identified CLH as the third most abundant fish in the lake.

Comment [GG12]: I know this is the information that is available but each anecdotal point is qualified that CLH would have been incidental to the effort. What is one to deduce from this?

1 The majority of CLH were captured in the littoral and profundal zones using gill nets.
2 However, the limnetic zone was not sampled since midges do not occur in this area. A
3 total of 1,229 fish was taken during these surveys (Cook et al. 1964).

Comment [GG13]: This last paragraph is good information.

4
5 Field notes from CDFG biologists in 1955 note CLH runs with large numbers in Kelsey
6 Creek (CDFG 1955). Similar notes from 1956 indicate spawning CLH in Kelsey Creek
7 as numbering in the hundreds and Seigler Creek containing 400 CLH for every 100 feet
8 of stream above the Anderson Brothers ford (CDFG 1956). CLH were the second most
9 abundant fish caught during various gill net surveys in the lake at that time (Lindquist et
10 al. 1943). Surveys conducted between 1938 and 1941, for examination of fish and gnat
11 interactions, describe the runs of Sacramento splittail (*Ptychocheilus grandis*) and CLH
12 as numbering in the tens of thousands (Lindquist et al. 1943). A photograph from 1890
13 depicts a spawning run so thick that CLH formed a blanket across the creek (Figure 6).
14 Early stories from the area describe fish runs so thick that streams were difficult to ford
15 by horses and wagons, and residents shoveled spawning fish to bring home for hog
16 feed (Rideout 1899). The volume of dead fish found during spawning runs on Clear
17 Lake tributaries created a stench that was intolerable to lakeshore residents (Dill and
18 Cordone 1997). It is not entirely clear if spawning runs such as those depicted in Figure
19 6 occurred every year or fluctuated based on tributary flows, but it is likely they
20 fluctuated in a similar fashion to what was observed during the past decade of CCCLH
21 spawning surveys. Regardless, the body of evidence lends support for claims of CLH
22 as common and the most abundant fish in Clear Lake during the late nineteenth and
23 early twentieth centuries (Coleman 1930; Jordan and Gilbert 1894).

Comment [GG14]: There is some local discrepancy about this picture. The image is certainly of cyprinids, but there is some dispute as to the species.

Formatted: Font color: Red

Comment [GG15]: This is all good information. It strikes me as out of place. Might it be better placed earlier in the document to provide a historical perspective followed by the information provided by Chi Council and Vector Control?



26
27
28 **Figure 6.** Photo from 1890s depicting spawning CLH being stranded in Kelsey
29 Creek.
30

1 **FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE**

2

3 **Present or Threatened Modification or Destruction of Habitat**

4

5 **Wetland Habitat Loss**

6

7 Wetlands provide critical rearing habitat for juvenile fishes native to Clear Lake (Geary
8 1978; CDFG 2012). Prior to the arrival of European settlers in the mid-1800s, Clear
9 Lake was surrounded by large tracts of wetlands. Throughout the expansion of
10 European settlements around the lake, the wetland habitat was drained and filled to
11 provide urban and agricultural lands. Currently, the Clear Lake watershed contains over
12 **16,000 acres of land dedicated to agricultural production** (Lake County Department of
13 Agriculture 2011; Forsgen Associates Inc. 2012). Comparisons of historical versus
14 current wetland habitat reveal a loss of approximately 85%, from 9,000 acres in 1840 to
15 1,500 acres by 1977 (Week 1982; Bairrington 1999; Suchanek et al. 2002; ; Lake
16 County Department of Public Works 2003; Giusti 2009; CEPA 2012). Loss of wetland
17 habitat coupled with competition for existing habitat with introduced fishes has led to a
18 decline in available rearing habitat for juvenile CLH (Week 1982).

Comment [GG16]: Not all of these acres represent converted wetlands, though some operations could potentially impact "wetland function".
Formatted: Font color: Red

19 **Spawning Habitat Exclusion and Loss**

20

21 ***Dams, Barriers, and Diversions***

22

23 Cache Creek Dam was constructed at the outlet of Clear Lake in 1915, and Yolo County
24 Flood Control and Water Conservation District (YCFWCWCD) manipulates the lake water
25 level several feet seasonally to allow for diversions for irrigation (CDWR 1975). Clear
26 Lake is allowed to fluctuate on a yearly basis, a maximum of 7.56 feet above a mean
27 level plane referred to as the "Rumsey gage" (CDWR 1975). The effects of lake water
28 manipulations on CLH populations have not been quantified. Manipulation of water
29 levels in the Clear Lake watershed likely results in decreased water quality, a reduction
30 in spawning and rearing habitat, and increased risk of predation (Converse et al. 1998;
31 Wetzel 2001; Gafny et al. 2006; Cott et al. 2008; Hudon et al 2009). All of these
32 impacts can lead to the extinction of native species that evolved in lakes free of habitat
33 modifications resulting from impoundment structures (Wetzel 2001). Impounded
34 systems also tend to be dominated by non-native species (Moyle and Light 1996).

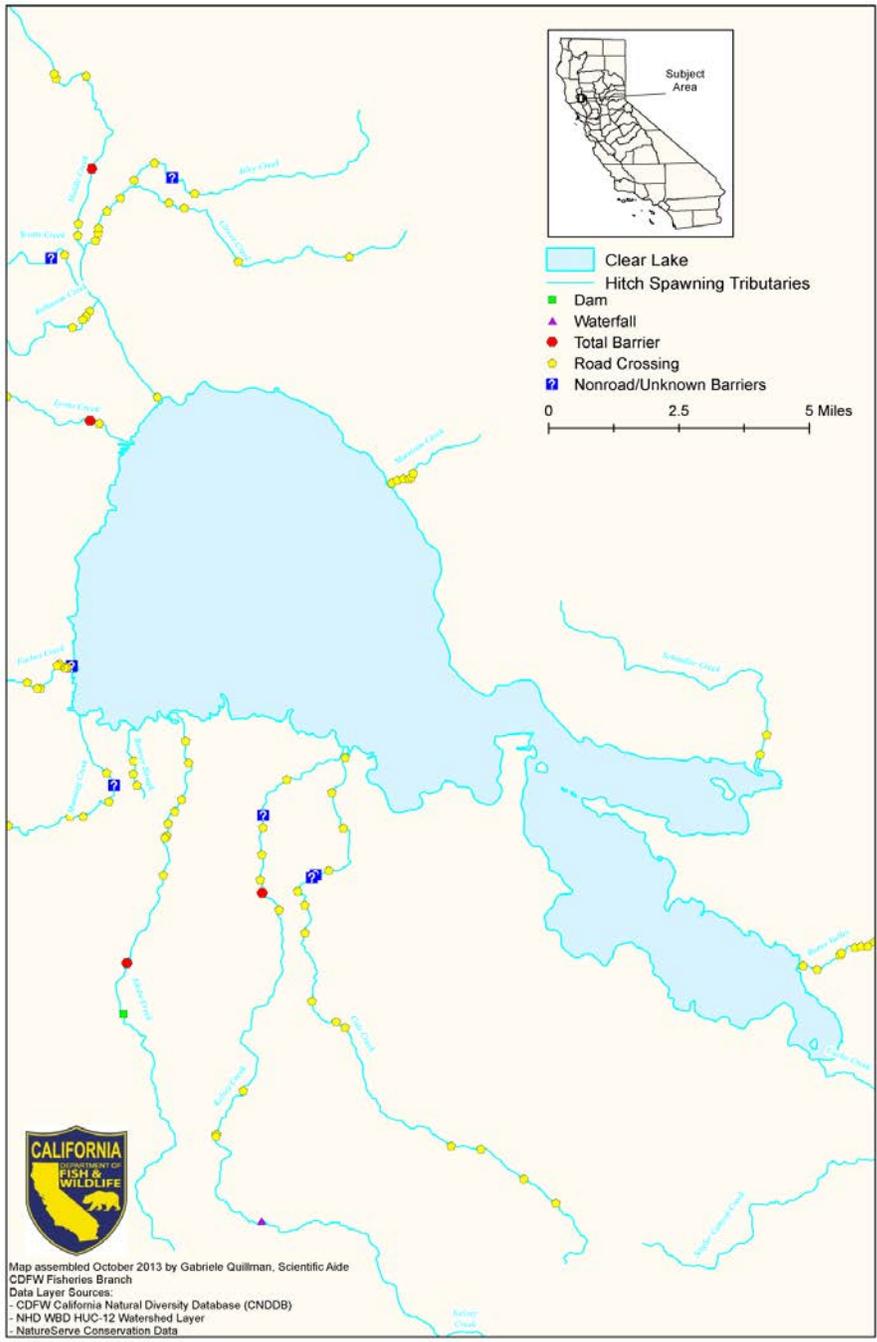
35
36 CLH spawn in low-gradient tributary streams to Clear Lake. All of the tributary streams
37 to Clear Lake have been altered (Appendix C) to various degrees by dams, barriers,
38 and diversions. Stream alterations can block migratory routes and decrease stream
39 flows necessary for spawning. The result can be loss of spawning and rearing habitat,
40 loss of nursery areas, increases in predation, competition from non-native aquatic
41 species, and decreased water quality (Murphy 1948 and 1951; Moyle 2002;). A limited
42 physical habitat analysis survey was conducted in 2013 on Adobe, Kelsey, Manning,
43 Middle, and Scotts creeks. Results of the survey indicate all of the creeks had low
44 Index of Biological Integrity (IBI) scores and are either partially or not supportive of
45 aquatic life (Mosley 2013). Examples of alterations to Clear Lake tributaries that have

1 impacted CLH include agricultural irrigation pumps and diversions, aggregate mining
2 activity, flood control structures, road crossings, bridge aprons, and off-highway vehicle
3 (OHV) use (McGinnis and Ringelberg 2008).
4

5 Adobe Creek, Highland Creek, Middle Creek, Clover Creek, and Kelsey Creek have
6 experienced a reduction in fish spawning habitat since the installation of dams and
7 increased irrigation (Murphy 1951; Macedo 1994; McGinnis and Ringelberg 2006). A
8 barrier assessment was completed in 2006 for Middle Creek and the Kelsey Creek fish
9 ladder (McGinnis and Ringelberg 2006). The assessment found physical barriers to fish
10 migration were associated with bridge aprons and weirs as well as habitat barriers from
11 historical gravel operations (McGinnis and Ringelberg 2006). The Kelsey Creek fish
12 ladder was found unsuitable for passage of CLH. The jump heights and velocities at the
13 ladder were determined to be too great for CLH (McGinnis and Ringelberg 2006).
14 Spawning observations by CCCLH from 2005 to 2013 witnessed fish stranded below
15 multiple barriers within the watershed (CCCLH 2013).
16

17 Many Clear Lake tributaries are no longer used for spawning or have reduced spawning
18 runs as a result of artificial structures that continue to impede spawning migrations
19 (Figure 7). While some operational and physical modifications to these structures have
20 been implemented over the years, they continue to adversely impact spawning CLH,
21 especially during dry years when spring stream flows are low.
22

23 In preparation of this report, the Department estimated the loss of CLH spawning and
24 rearing habitat due to constructed barriers and impediments within the tributaries to
25 Clear Lake (Figure 7). The barrier assessment determined the approximate locations of
26 barriers and estimated miles of stream habitat as determined from the California Native
27 Diversity Database, CDFW Geographic Information System, CDFW Fish Passage
28 Assessment Database, California GIS street layer, and Google Earth Maps. Using that
29 data, the Department estimated 180 river miles were historically available to spawning
30 CLH and that barriers have eliminated or reduced access to greater than 92% of the
31 historically available spawning habitat. Physical barriers, such as the footings of
32 bridges, low water crossings, dams, pipes, culverts, and water diversions in Kelsey,
33 Scotts, Middle, Clover, and other creeks interrupt or eliminate migration to spawning
34 areas (McGinnis and Ringelberg 2008). Appendix C contains a list of several tributaries
35 and some of their associated barriers.
36
37



1
2
3

Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed.

1
2 Water is frequently diverted from Clear Lake tributaries, during the CLH spawning
3 season, under riparian rights associated with land ownership in the watershed. These
4 water diversions consist of direct diversion from surface water intake pumps and from
5 shallow off-channel wells that capture groundwater flows. The primary purpose of water
6 diversions from Clear Lake tributaries is for agricultural production and frost protection.
7 Water diversions for frost protection have been shown to temporarily reduce in-stream
8 flow by as much as 95% (Deitch et al. 2009). Natural flow regimes are thought to favor
9 the success of native fishes over non-native fishes (Marchetti and Moyle 2001). The
10 impact of diversion on CLH spawning tributaries is poorly understood. In some
11 tributaries, water diversion has contributed to early drying of stream reaches and
12 desiccation of CLH eggs masses and newly hatched juveniles (Macedo, R., personal
13 communication, November 25, 2013, unreferenced). Additionally, significant flow
14 reductions can lead to increased water temperatures, reduced available aquatic habitat,
15 altered or decreased biodiversity, increases in non-native species, and alterations to
16 fish assemblages (Marchetti and Moyle 2001; Bunn and Arthington 2002; Bellucci et al.
17 2011).

Comment [GG17]: The County of Lake Special Districts diverts water from Kelsey Creek as the primary source of water for the town of Kelseyville. I think this statement may not identify all of the diversions equally. I know that ball field irrigation has caused a complete draw down on Cole Creek.....more than once.

18
19 The impacts of spawning habitat alterations to CLH may be inferred by the fate of
20 another native Clear Lake fish that required tributaries for spawning; the Clear Lake
21 splittail was last recorded in 1972 (Puckett 1972). The Clear Lake splittail formerly
22 spawned later in the season than did CLH, and the drying up of tributaries contributed to
23 their demise (Moyle 2002). All stream spawners had “declined precipitously” by 1944
24 (Murphy 1951). Therefore, earlier drying of tributaries by both natural and
25 anthropogenic processes likely impacts the CLH population.
26

27 ***Dredging and Mining***

28
29 Since the first European settlers arrived at Clear Lake and began gravel mining and
30 dredging operations, there have been documented deleterious effects on the watershed
31 (Suchanek et al. 2002). Field notes from CDFG personnel conducting stocking
32 assessments documented Kelsey Creek so loaded with silt from gravel operations that
33 creek visibility was zero (CDFG 1955). Smaller scale mining and dredging in tributary
34 streams has occurred since early settlement and has altered the amount and
35 distribution of stream gravels (Thompson et al. 2013). In some tributaries, gravel
36 extraction has resulted in the incising and channelizing of the streams and stream level
37 changes by as much as 15 feet (Suchanek et al. 2002; Eutenier, D. April 17, 2013
38 comment letter). After 1965 about one million metric tons of gravel products per year
39 were removed from the watershed until the partial moratorium on aggregate mining in
40 1981 (Richerson et al. 1994). Gravel was removed from Clear Lake tributaries to
41 provide road base for new roads created to accommodate the expanding population of
42 the area (Suchanek et al. 2002). Currently, approximately 58 acres in the Clear Lake
43 watershed are used for mining purposes (Forsgren Associates Inc. 2012).
44

45 Many areas along the tributaries to Clear Lake were channelized in response to
46 frequent flooding during the late winter and early spring (Maclanahan et al. 1972; U.S.
47 Army Corps of Engineers 1974). As a result of gravel extraction and channelization,

1 some areas were covered with riprap or confined by levees to prevent further erosion
2 and flooding. Erosion problems have contributed to sediment entering Clear Lake and
3 providing increased phosphorous loads that impair water quality (Richerson et al. 1994).
4 Gravel extraction results in channelization and down cutting of the stream bank, a
5 decrease in suitable spawning habitat, and increasing flow velocity and amount of
6 coarse material that passes through the system (Brown et al. 1998).

7 **Water Quality Impacts**

8
9 The Clear Lake watershed has seen a significant increase in the amount of
10 contaminants entering the lake over the past 75 years (Richerson et al. 1994). An
11 increase in agriculture and mining, and a shift to an urban environment, has resulted in
12 adverse water quality impacts in the lake (Mioni et al. 2011; California Environmental
13 Protection Agency [CEPA] 2012).

14
15 Erosion from construction, dredging, mining, agriculture, OHV use, grazing, [residential](#)
16 [development](#) and urbanization has resulted in increased sediment loads to the Clear
17 Lake watershed (Forsgren Associates Inc. 2012). Increased sediment loads transport
18 nutrient rich soil, particularly phosphorous, into Clear Lake and reduce spawning habitat
19 by increasing substrate “embeddedness” (Mosley 2013). During the late 1990s and
20 early 2000s soil erosion and sedimentation became an increasing problem as existing
21 agricultural lands were converted to vineyards (Forsgren Associates Inc. 2012). From
22 2002 to 2011 vineyard acreage in the Clear Lake watershed increased from
23 approximately 5,500 acres to 8,000 acres (Lake County Department of Agriculture
24 2011).

25
26 Development and expansion of extensive [and intensive](#) agriculture in the Clear Lake
27 watershed during the late 1890s until present day reclaimed the lake’s natural wetland
28 filtration system for agricultural use. An increase in agricultural production and a
29 decrease in wetland filtration increased nutrient flows into Clear Lake. Wetland
30 reclamation projects altered the transport of sediment and nutrients, particularly
31 phosphorous, into Clear Lake, resulting in an increase in noxious cyanobacteria blooms
32 that cover the lake in warmer months (Suchanek et al. 2002). As a result of continued
33 water quality issues, Clear Lake was added to the Clean Water Act Section 303(d) list of
34 impaired water bodies in 1988 (CEPA 2010 and 2012). In recent years, noxious
35 cyanobacteria blooms have at a minimum remained constant and may have increased
36 (CEPA 2012).

37
38 Cyanobacteria blooms have occurred at Clear Lake since the mid-1900s. Studies
39 indicate an increase in phosphorous was the driver behind water quality impairments
40 and noxious cyanobacteria blooms (Horne 1975; Richerson et al. 1994; CEPA 2012).
41 The blooms originally consisted primarily of *Microcystis*, but in recent years the blooms
42 have been attributed to both *Microcystis* and *Lyngbya*. These taxa represent both non-
43 nitrogen fixing (*Microcystis*) and nitrogen fixing (*Lyngbya*) cyanobacteria and raise
44 concerns that both phosphorous and nitrogen entering the lake need to be controlled
45 (Mioni et al. 2011; CEPA 2012). Cyanobacteria blooms have the ability to both directly
46 and indirectly impact CLH by direct interference with the growth of *Daphnia*, a limnetic
47 organism that is a food source for adult CLH, and interference with food web efficiency.

1 No studies have been conducted at Clear Lake to quantify the impact of cyanobacteria
2 blooms on the ecosystem, but studies conducted at other water bodies with varying
3 degrees of cyanobacteria blooms provide information on their impacts to the aquatic
4 environment. Cyanobacteria blooms reduce the amount of light penetration in the water
5 column and cause a reduction in producers that are unable to reposition themselves to
6 gain more light (Havens 2008). Organisms such as epiphyton, benthic algae, and
7 rooted vascular plants have a reduced ability to function in the ecosystem as a result of
8 cyanobacteria blooms. As the bacteria alter the nutrient cycle of the lake they replace
9 the producers in space and mass. The expanding bacteria begin to deplete CO₂ from
10 the water body, which increases pH and reduces growth of other producers (Havens
11 2008). The decreased CO₂ and increased pH can create surface scums and result in
12 mortality of fishes, including CLH. In the summer of 1969, a large fish die off, due to
13 heavy cyanobacteria growth and low oxygen levels, was reported at Clear Lake. An
14 estimated 170,000 fish died, consisting primarily of carp, CLH, and blackfish (CDFG
15 News Release 1969). Sub lethal and lethal effects of toxins released during
16 cyanobacteria blooms are also seen in fish and their associated food web (Havens
17 2008).

Comment [GG18]: This is true but in the case of CL the Lyngbya blooms have been attributed to the clarity of the water, and rooted vegetation has become problematic in the past ten years. Water clarity has been steadily increasing since 1969.

18
19 On September 19, 2007, the U.S. Environmental Protection Agency (EPA) approved a
20 control program as a nutrient Total Maximum Daily Load (TMDL) for Clear Lake with the
21 goal of reducing point and non-point source phosphorous entering the lake (CEPA
22 2012). Sources for phosphorous entering the lake include agricultural and urban runoff,
23 timber harvest, road maintenance, construction, gravel mining, dredging, and fire.
24 Additional amounts of nutrients from home fertilizers, marijuana grows, sewer, and
25 septic systems cannot be quantified.

Comment [GG19]: Again, this is very old data, I'm not sure it accurately reflects the current water quality conditions of the lake and I'm not sure of its relevance here.

26
27 To allow for increased yields on agricultural land and to prevent nuisance insect species
28 around the lake, pesticides became commonplace during the early and mid-1900s. For
29 many decades the Clear Lake gnat, a primary food source for CLH and CL splittail, was
30 targeted with pesticides to reduce its population. Between 1949 and 1957, the Clear
31 Lake gnat was targeted with the pesticide dichlorodiphenyldichloroethane (DDD).
32 During these years it is estimated that 99 percent of the gnat larvae in the lake were
33 killed. Concentrations of DDD were magnitudes higher in invertebrates, fish, and birds
34 than in the surrounding water in which they were found (Lindquist and Roth 1950; Rudd
35 1964). Sampling conducted during the late 1950s identified CLH, as well as other fish
36 species, contaminated with DDD (Hunt and Bischoff 1960). Contamination levels
37 ranged from 5.27 to 115 parts per million (ppm) for edible flesh of sampled fishes (Hunt
38 and Bischoff 1960). CLH were at the lower level of DDD contamination for Clear Lake
39 fishes at 10.9 to 28.1 ppm for edible flesh content (Hunt and Bischoff 1960). The results
40 of DDD in the Clear Lake watershed resulted in the first major ecological disaster at the
41 lake and the first records of pesticide bioaccumulation in the wildlife of the lake
42 (Suchanek et al. 2002).

43
44 Following the resurgence of gnat populations in response to growing resistance to DDD,
45 two additional measures were taken to reduce the gnat population. Gnat eggs were
46 targeted with a petroleum product, and adult gnats were targeted at roosting locations
47 with Malathion. Additional applications of methyl parathion were also made in 1962
48 (Suchanek et al. 2002). Clear Lake gnats are still present at the lake, but populations

1 are significantly reduced from historical levels. The likely cause of the reduced
2 population of gnats is introduced fishes, primarily inland silversides (Suchanek et al.
3 2002). In 2010 and 2012 Clear Lake gnat populations reached levels not seen in
4 decades. These gnat population booms appeared to coincide with years of low
5 population levels of inland silversides (Scott, J. 2013 personal communication, Aug 1,
6 2013, unreferenced). Qualitative sampling data on CLH does not allow for a direct
7 comparison of CLH numbers in years with increases in the gnat population.

8
9 In recent years, two herbicides, Komeen™ (copper sulfate) and SONAR™ (fluridone),
10 have been used extensively to manage the *Hydrilla verticillata* infestation at the lake.
11 Applied concentrations of Komeen™ do not kill fish directly; however, the impacts to
12 macroinvertebrates may indirectly impact CLH populations (Bairrington 1999). These
13 systemic herbicides also pose a threat to non-target vascular aquatic plants, such as
14 tules and submerged vegetation, which juvenile CLH require for rearing habitat. As
15 noted previously, there has already been a significant reduction in wetland habitat
16 around the lake, and any additional reductions would further limit the amount of habitat
17 available for CLH. Initial studies indicate a reduction in tule habitat following SONAR™
18 applications (Bairrington 1999). Environmental monitoring of eradication activities in
19 1996 and 1997 found that invertebrate species declined within the treatment area but
20 rebounded quickly following the toxicity decay of the herbicide (Bairrington 1999). Post-
21 treatment electrofishing surveys noted an increase in the number and abundance of fish
22 species (Bairrington 1999).

23
24 Mining operations within the watershed contributed to sulphur and mercury
25 contamination in Clear Lake. The Sulphur Bank Mercury Mine began operations in
26 1865 and ended in 1957 (Osleger et al. 2008; Giusti 2009) Originally the mine focused
27 on extracting sulphur, but as operations continued into the late 1920s and the sulphur
28 was found to be contaminated with mercury sulfide, operations switched to extracting
29 mercury from the large-scale open-pit mine (Giusti 2009). As a result of contamination,
30 the mine was classified as an EPA Superfund Site in 1990 (Suchanek et al. 1993). The
31 mine is thought to have contaminated the lake with both mercury and arsenic
32 (Suchanek et al. 1993). Studies have found the mercury concentrations in sediment to
33 be high (over 400 ppm) in the vicinity of the mine, decreasing as distance from the mine
34 increases (Suchanek et al. 2002). The mine continues to produce low pH acid mine
35 drainage that delivers sulfate to the lake. Over the past decade, the EPA has taken
36 several actions to remediate contamination from the mine. These include erosion
37 control measures, removal of contaminated soil, storm water diversion, and well
38 capping (U.S. Environmental Protection Agency 2012).

39
40 During the 1970s, elevated concentrations of mercury were found in the fish of the lake
41 (Curtis 1977). Mercury contamination can lead to significant impacts to the reproductive
42 success of fishes and can result in reduced brain function, altered size and function of
43 gonads and reduced gamete production (Sandheinrich and Miller 2006; Crump and
44 Trudeau 2009). In 2003, a mercury TMDL was developed for Clear Lake to reduce
45 methylmercury in fish by reducing overall mercury loads to Clear Lake (CEPA 2010).
46 Levels of mercury found in fish, including CLH, are between 0.06 and 0.32 µg/g (CEPA
47 2002). Concentrations of mercury present in Clear Lake fishes have resulted in health
48 advisories on their consumption, but are below acute toxicity thresholds (Harnly et al.

Comment [GG20]: I removed the word "extensively" as it is valued laden and subjective. It does not add to the discussion.

Comment [GG21]: I believe Komeen is a contact herbicide...check me on this.

Comment [GG22]: This is subjective. I know of no examples of tules being impacted. You need to include a reference if possible...at least in recent times.

1 1997). Mercury levels are close to or within the effect thresholds for reproduction and
2 growth for fathead minnow (0.32 to 0.62 µg/g) and rainbow trout (National Oceanic and
3 Atmospheric Administration [NOAA] 2011). Concentrations with no effect on rainbow
4 trout growth and development are 0.02 to 0.09 µg/g (NOAA 2011). Lacking specific
5 studies on CLH, based on surrogate effect levels for fathead minnows and rainbow
6 trout, it is reasonable to suspect that CLH may be experiencing sub lethal chronic and
7 reproductive effects from mercury contamination.
8

9 **Overexploitation**

10

11 **Commercial Harvest**

12

13 Commercial fish harvest at Clear Lake has been occurring since the early 1900s.
14 Harvested fish were distributed to fish markets in California for sale for human
15 consumption and animal feed. Prior to 1941, the majority of commercial operations
16 centered on harvesting catfish (*Ictalurus* or *Ameiurus* spp.) from the lake. Although
17 exact numbers are unavailable, it is likely that large numbers of catfish were taken
18 during this period (Bairrington 1999). In 1942 commercial harvest of catfish was
19 banned at Clear Lake. Beginning in the 1930s commercial harvest focused on
20 Sacramento blackfish (*Orthodon microlepidotus*), a native species, and common carp
21 (*Cyprinus carpio*), a non-native species. From 1932 to 1962 the annual average catch
22 rate was 295,000 pounds for the commercial fishery (Bairrington 1999). A ratio of
23 1.33:1 for blackfish to carp was the average during commercial fishing operations
24 (Bairrington 1999). In 1976 the only recorded capture and sale of CLH for commercial
25 purposes was submitted to the Department, a total of 1,550 pounds was reported
26 captured and sold at market that year (CDFW Commercial Fisheries Data). This is the
27 only instance in the records of CLH being captured for commercial sale, primarily due to
28 lack of interest and low sale price for the species (CDFW Commercial Fisheries Data).
29 By 1960 commercial fishing operators were required to count and release all by-catch
30 from commercial operations. CLH were found in large numbers some years and were
31 recorded and returned to the lake when captured (Figure 5; CDFW Commercial
32 Fisheries Data). The Department has received no commercial permit applications for
33 operations on Clear Lake over the past several years. The lack of permit applications
34 indicates that at this time commercial fishing operations at Clear Lake have ceased
35 (CDFW Commercial Fishing Permit Data).
36

37 **Cultural Harvest**

38

39 Clear Lake hitch are culturally significant to several Pomo tribes that inhabit the Clear
40 Lake watershed. Two Pomo tribes fought a war over Kelsey Creek and its important
41 CLH supply (Barrett 1906; Kniffen 1939). Historically, large runs of CLH provided a
42 staple food source for the local tribes (RREC 2011). During spawning runs, CLH were
43 captured by constructing a series of dams in the creeks from which the fish were then
44 scooped with baskets. The fish were cured to provide a food source throughout the year
45 (Kniffen 1939). Historical accounts from tribal members speak of CLH being easy to
46 find as they spawned in large numbers in the tributaries to the lake (Scotts Valley Band

1 of Pomo Indians historical accounts 2013). There are no estimates of the number of
2 CLH that were taken for cultural harvest during any specific timeframe. However, an
3 account from a tribal member indicates that, historically, a single family may have taken
4 a couple thousand fish during the spawning runs (Big Valley EPA 2013). Tribal
5 accounts indicate the harvest of CLH continued until the decline in spawning runs in the
6 mid-1980s (Big Valley EPA 2013). Prior to designation of CLH as a candidate species
7 for listing, regulations in the Clear Lake watershed allowed for the harvest of CLH in
8 spawning tributaries by hand or hand-held dip net. In 2013 the Department issued
9 CESA Memoranda of Understanding (Fish and Game Code, § 2081(a)) to three tribes
10 to authorize collection of CLH for scientific research and public education (Kratville, D.
11 personal communication, October 7, 2013, unreferenced).
12

13 **Predation and Competition**

14

15 Non-native fish introductions into Clear Lake date back as far as the late 1800s (Dill and
16 Cordone 1997). Prior to the introduction of non-native fish species, between 12 and 14
17 native fish species occupied Clear Lake (Bairrington 1999; Moyle 2002; Thompson et al.
18 2013). Currently, approximately ten native species and 20 non-native species inhabit
19 the lake (Bairrington 1999; Thompson et al. 2013). Over the past 100 years one native
20 species, thicketail chub (*Gila crassicauda*), has gone extinct and two native species,
21 hardhead (*Mylopharodon conocephalus*), and Clear Lake splittail, have been extirpated
22 from the lake. Sacramento perch (*Archoplites interruptus*), has not been captured in
23 sampling efforts since 1996 (Bairrington 1999; CDFW Commercial Fisheries Data;
24 Thompson et al. 2013). Tule perch (*Hysterothorax traski*) are accidentally caught or
25 incidentally observed as recently as 2014 (Giusti, pers. communication) but quantified
26 estimates of their populations do not exist. The majority of non-native species
27 introductions have been conducted by the Department, various local agencies, and
28 angling groups in an effort to increase sport fishing opportunities. Introductions of fish
29 at Clear Lake have been warm water sport fish (black bass, sunfish (*Lepomis* spp.),
30 catfish, etc.) or forage species for piscivorous sport fish. The Department has not
31 stocked fish in Clear Lake in the past decade. The four fish species listed below were
32 introduced without authorization from the Department (Bairrington 1999; Rowan J.
33 personal communication, October 10, 2013, unreferenced). Inland silverside, threadfin
34 shad, smallmouth bass (*Micropterus dolomieu*), and pumpkinseed (*Lepomis gibbosus*)
35 were introduced to provide forage for other game fishes, provide Clear Lake gnat
36 control, or as part of a new sport fishery (Anderson et al. 1986; Dill and Cordone 1997;
37 Bairrington 1999). Non-native game fishes comprise nearly 100 percent of the sport
38 catch from the lake. Incidental captures of native species occur infrequently and are
39 rarely recorded during creel and tournament surveys (Rowan J. personal
40 communication, October 10, 2013, unreferenced).
41

42 Non-native fish introductions can have significant impacts on native fish species. Inland
43 silverside and threadfin shad are thought to compete directly with CLH for food
44 resources (Geary and Moyle 1980; Anderson et al. 1986; Bairrington 1999). All three
45 species are limnetic foragers that rely on macroinvertebrates for food. There are no
46 direct comparisons, but years with declines in threadfin shad and inland silverside are
47 thought to coincide with increases in CLH numbers, and years with decreased threadfin

Formatted: Font: Italic

Comment [GG23]: Introduced yes, but I'm not sure if the introduction was successful.

Comment [GG24]: Is this the reference were Moyle goes so far to suggest that silverside may have played a role in the final demise of CL splittail?

1 shad and inland silverside result in increased young of year recruitment for other native
2 and non-native species (Rowan J. personal communication, October 10, 2013,
3 unreferenced). Competition for juvenile rearing habitat has increased with the reduction
4 in wetland habitat and increase in non-native fish species. Rearing habitat is essential
5 for CLH recruitment to any year class. A reduction in recruitment leads to a decrease
6 in spawning adults in the following years. A species with highly fluctuating population
7 trends, such as CLH, is particularly vulnerable to population level impacts in years with
8 reduced recruitment. Piscivorous fish species such as largemouth bass (*Micropterus*
9 *salmoides*) prey directly on both juvenile and adult CLH. Although no comprehensive
10 diet studies have been done, incidental data indicate that CLH are found in the
11 stomachs of piscivorous species in the lake (Moyle et al. in progress). Omnivorous
12 species such as catfish (*Ameiurus* spp.) are known to prey on various life stages of
13 native fishes. It is suggested that the introduction of catfish to Clear Lake may have
14 played a role in the decline of native fish species (Dill and Cordone 1997). The
15 introduction of catfish was described, by Captain J.D. Dondero of the Division of Fish
16 and Game, as having solved the problem of large spawning runs of fish dying in
17 tributaries to Clear Lake and that the population of nongame fish diminished following
18 their introduction (Dill and Cordone 1997). Jordan and Gilbert (1894) also describe
19 catfish as being destructive to the spawn of other species. The rates at which CLH are
20 consumed in relation to other prey species and the amount of CLH consumed are
21 unknown. It is likely that during years when alternative prey abundance is low, CLH
22 predation increases (Eagles-Smith et al. 2008).

23

24 **Disease and Parasites**

25

26 Disease outbreaks in fishes have been known to occur at Clear Lake. The outbreaks
27 are primarily koi herpes virus (KHV) and it affects introduced carp and goldfish. Native
28 minnows, including CLH, show no effects from KHV. Fish fungi (*Saprolegnia* spp.) have
29 been observed on fishes captured in Clear Lake and results from physical injury or
30 infection. CLH are susceptible to fish fungi but it is not readily observed in captured
31 fish. All fish in Clear Lake are susceptible to anchor worms (*Lernaea* spp.) and heavy
32 infestations can lead to mortality. No CLH with heavy anchor worm infestations have
33 been observed during CDFW fishery surveys at Clear Lake (Rowan J. personal
34 communication, October 10, 2013, unreferenced). The Big Valley Rancheria Band of
35 Pomo Indians has documented light loads of anchor worms occurring on CLH (Big
36 Valley Rancheria 2012 and 2013).

37

38 **Other Natural Occurrences or Human Related Activities**

39 **Climate Change**

40

41 It is likely that native fishes in California will be vulnerable to physical and chemical
42 changes as a result of climate change (Moyle et al. 2012). Research has shown that
43 the annual mean temperature in North America has increased between 1955 and 2005
44 and is predicted to continue increasing in the future (Field et al. 1999; Hayhoe et al.
45 2004); however, it varies across North America, is more pronounced in spring and
46 winter, and has affected daily minimum temperatures more than daily maximum

1 temperatures (Field et al. 2007). In general, climate change models for California
2 indicate an increase in overall air temperature, decreased and warmer rainfall, and an
3 increase in overall water temperatures (California Climate Change Center [CCCC]
4 2012). Cold storms are expected to decrease, giving way to warmer storms that create
5 earlier run-off and less water storage capabilities (Field et al. 1999; Hayhoe et al. 2004;
6 CCCC 2012). Climate change in the Clear Lake watershed is likely to cause some
7 changes to the interannual variability in rainfall. The change in rainfall variability would
8 likely increase the occurrence of drought and flood years (Clear Lake Integrated
9 Watershed Management Plan [CLIWMP] 2010). Expected climate change impacts to
10 California and the Clear Lake watershed will be significant during annual CLH spawning
11 cycles. CLH require winter and spring storms that provide suitable spawning flows in
12 the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff could
13 significantly impact the ability of CLH to successfully spawn. A climate driven change in
14 the Clear Lake watershed could result in the loss of spawning habitat, reduced access
15 to spawning habitat, stranding of spawning and juvenile fish, and egg desiccation.

16
17 A report on the projected effects of climate on California freshwater fishes, prepared for
18 the California Energy Commission's California Climate Change Center, determined CLH
19 to be critically vulnerable to impacts from climate change (Moyle et al. 2012). The
20 report evaluated criteria such as population size, population trends, range, lifespan, and
21 vulnerability to stochastic events to identify the degree of vulnerability of each fish
22 species. The Intergovernmental Panel on Climate Change has stated that of all
23 ecosystems, freshwater ecosystems will have the highest proportion of species
24 threatened with extinction due to climate change (Kundzewicz et al. 2007). Freshwater
25 lake species are more susceptible to extirpation because they are unable to emigrate
26 should habitat changes occur (CA Natural Resources Agency 2009).

28 **Recreational Activities**

29
30 The natural resources of the Clear Lake watershed are a tremendous recreational
31 resource for residents and visitors to Lake County. As the largest freshwater lake
32 wholly in California, with opportunities for multiple aquatic recreational activities, the
33 lake receives tens thousands of visitors per year. According to 2008 data acquired from
34 Lake County quagga mussel (*Dreissena rostriformis*) inspection sticker application
35 forms; there were 11,230 boats that visited the lake that year. Jet skis and pleasure
36 boats accounted for 41 percent of the boating activity at the lake (CLIWMP 2010).

37
38 Permanent structures, associated with boat docks, boat ramps, and swimming beaches,
39 have reduced littoral zone habitat around the lake. These structures require clearing of
40 littoral zone habitat to maintain access for recreational boaters and swimmers. It is
41 estimated that there are over 600 private boat docks and boat ramps on the lake
42 shoreline. In addition to reducing littoral zone habitat these structures provide additional
43 habitat for non-native sport fish, such as largemouth bass, that prey on CLH.

44
45 Recreational and tournament angling generate a significant amount of the activity in the
46 Clear Lake aquatic environment. In 2008, 18 percent of all boats entering the lake
47 identified their recreational activity as angling (CLIWMP 2010). In a single year creel

1 survey conducted in 1988 by the Department, CLH comprised two percent of the
2 recreational sport catch (Macedo 1991).

Comment [GG25]: I would like to encourage the Dept to re-engage with anglers and conduct annual or even bi-annual creel surveys to address this data gap.

3
4 The number of angling tournaments, primarily targeting largemouth bass, has drastically
5 increased over the last three decades in response to Clear Lake's reputation as a
6 premiere sport fishery. Between 2001 and 2008 the number of angling tournaments
7 increased from 98 to 208 per year (Rowan J. personal communication, October 10,
8 2013, unreferenced). The number of tournaments per year is a function of the economy
9 and has decreased since the recession that began in 2008. It is generally anticipated
10 tournament numbers will increase again as the economy continues to improve. It is
11 believed that recreational and tournament anglers' capture CLH incidentally while
12 angling. The impact to CLH from the increase in angling tournaments is unknown, but
13 is likely negligible because tournament anglers do not target CLH and by-catch would
14 be an inadvertent snagging on an artificial lure, a rare occurrence.

15 REGULATORY AND LISTING STATUS

16 Federal

17
18 On September 25, 2012 the Center for Biological Diversity petitioned the U.S. Fish and
19 Wildlife Service (USFWS) to list CLH as endangered or threatened under the federal
20 Endangered Species Act (ESA). As of the publication of this status review there has
21 been no action taken on the petition by USFWS.

22
23 The U.S. Forest Service (USFS) lists CLH as a sensitive species. USFS sensitive
24 species are those plant and animal species identified by a regional forester that are not
25 listed or proposed for listing under the federal ESA for which population viability is a
26 concern.

27 State

28
29 The Department designated CLH as a Species of Special Concern (SSC) in 1994. A
30 SSC is a species, subspecies, or distinct population of an animal native to California
31 that currently satisfies one or more of the following (not necessarily mutually exclusive)
32 criteria:

- 33 • Is extirpated from the State or, in the case of birds, in its primary seasonal or
34 breeding role;
- 35 • Is listed as Federally, but not State, threatened or endangered;
- 36 • Is experiencing, or formerly experienced, serious (nonscyclical) population
37 declines or range restrictions (not reversed) that, if continued or resumed, could
38 qualify it for State threatened or endangered status;
- 39 • Has naturally small populations exhibiting high susceptibility to risk from any
40 factor(s) that if realized, could lead to declines that would qualify it for State
41 threatened or endangered status.

42
43 The intent of designating a species as a SSC is to:

- 1 • Focus attention on animals at conservation risk by the Department, other State,
2 local and Federal government entities, regulators, land managers, planners,
3 consulting biologists, and others;
 - 4 • Stimulate research on poorly known species;
 - 5 • Achieve conservation and recovery of these animals before they meet California
6 Endangered Species Act criteria for listing as threatened or endangered.
- 7 There are no provisions in the Fish and Game Code that specifically prohibit take of
8 CLH or protect its habitat.
9

10 **Other Rankings**

11
12 The American Fisheries Society ranks CLH as vulnerable, meaning the taxon is in
13 imminent danger of becoming threatened throughout all or a significant portion of its
14 range (Jelks et al. 2011).

15 **EXISTING MANAGEMENT EFFORTS**

17 **Resource Management Plans**

18
19 An increase in resource management efforts throughout the Clear Lake watershed has
20 benefitted CLH, and several plans and strategies are in place to assist in reducing the
21 threats to CLH.
22

23 The Clear Lake Integrated Watershed Management Plan (2010) was prepared by two
24 resource conservation districts and provides details of past and current resource
25 management within the Clear Lake watershed. The plan seeks to identify opportunities
26 to improve and protect the health and function of the watershed and identifies specific
27 implementation actions to improve and protect watershed resources. Recommended
28 actions are prioritized on a timeline. As funding allows, implementation of these actions
29 will be undertaken by various non-governmental organizations (NGO) and local, state,
30 and federal agencies that share an interest in promoting the health and function of the
31 watershed. Multiple action items listed in the plan would benefit CLH and their habitats.
32 Several tributaries to Clear Lake have completed Watershed Assessment plans as well.
33 These include Kelsey Creek Watershed Assessment (2010), Middle Creek Watershed
34 Assessment (2010), and Scotts Creek Watershed Assessment (2010). These plans
35 were all completed by Lake County Water Resources Division for West and East Lake
36 Resource Conservation Districts.
37

38 With adoption of the TMDL for Clear Lake, several projects are in process or have been
39 completed to reduce the amount of phosphorous entering the lake. Specifically, the
40 Middle Creek Flood Damage Reduction and Ecosystem Restoration Project seeks to
41 reduce the amount of phosphorous entering the lake by 40 percent (CEPA 2012). Lake
42 County and the California Department of Transportation have implemented several best
43 management practices (BMPs) for managing storm water runoff to reduce the amount
44 of phosphorous and other contaminants that enter the lake. Both the USFS and Bureau
45 of Land Management (BLM) have undertaken projects to reduce nutrients entering the

Comment [GG26]: Should the tribes be included here?

1 lake as a result of off-highway vehicles and other land uses. BLM, in coordination with
2 Scotts Valley Band of Pomo Indians, received a grant to implement the Eightmile Valley
3 Sediment Reduction and Habitat Enhancement Project Design. Controlling sediment
4 from Eightmile Valley is crucial to controlling the amount of nutrients entering the lake.
5 Many of these projects are still in design or early implementation and it will be several
6 years before changes in nutrient loads within the lake can be observed and studied.

7
8 The adverse effects from an increase in sedimentation as a result of conversion of
9 various types of agricultural land to vineyard resulted in the formation of the Erosion
10 Prevention and Education Committee (EPEC). The EPEC ~~was~~ is a group of county
11 agencies and private entities that provide educational outreach regarding erosion
12 control and water quality protection. In addition, the Lake County Grading Ordinance
13 was approved in 2007 and requires grading permits and Erosion Control and Sediment
14 Detention Plans for projects with the probability of resulting in increased sedimentation
15 (Forsgren Associates, Inc. 2012).

Comment [GG27]: "was" past tense as the committee is no longer functioning as the mass increase of vineyard expansion has waned.

16
17 Concerns over the reduction in habitat quality resulting from gravel mining prompted
18 Lake County to adopt an Aggregate Resources Management Plan in 1994. The plan
19 called for a moratorium on gravel mining in several tributaries to Clear Lake. The
20 implementation of gravel mining regulations has resulted in reduced in-stream and bank
21 erosion and increased riparian habitat along the creeks (CEPA 2008).

22
23 To prevent further destruction of wetland habitat along the lake shoreline, in 2000 and
24 2003 amendments, Lake County adopted Section 23-15 of the Clear Lake Shoreline
25 Ordinance that prohibits the destruction of woody species and tules. In addition to the
26 ordinance, there is a no net-loss requirement for commercial, resort, and public
27 properties that seek to clear vegetation from areas along the shoreline (CLIWMP 2010).

28
29 RREC produced an Adaptive Management Plan (HAMP) for the Clear Lake Hitch,
30 *Lavinia exilicauda chi* (RREC 2011). The HAMP describes the current status of CLH
31 habitat and problems for habitat recovery. The habitat assessments are included in a
32 management plan that identifies action items, issues of uncertainty, stakeholder
33 involvement, sustainability, and plan amendment procedures. The RREC is currently in
34 the process of revising the HAMP.

Comment [GG28]: ???? What is this?

Comment [GG29]: What does the "H" stand for?

35
36 The Department has created or approved two Conceptual Area Protection Plans
37 (CAPP) for the Clear Lake Watershed. The creation of a CAPP for an area allows the
38 Department, as well as local and federal agencies, and NGOs, to apply for land
39 acquisition funding from the Wildlife Conservation Board. The first, the Clear Lake
40 CAPP, was approved in 2002 and addresses land acquisition needs in the area of
41 Middle Creek. The plan focuses on protecting wetland and riparian habitat for the
42 benefit of natural resources. The second CAPP, Big Valley Wetlands, is currently in
43 development with possible approval in 2014. The Big Valley Wetlands CAPP focuses
44 on land acquisitions in the western portion of the Clear Lake watershed for the purpose
45 of protecting wetland and riparian habitat. Both CAPP's will benefit CLH in the
46 protection of riparian and wetland habitat critical for spawning and rearing CLH. Land
47 acquisitions that seek to protect and restore existing CLH habitat should create a stable
48 environment for CLH populations.

1
2 The Department published a Clear Lake Fishery Management Plan in 1999 (Bairrington
3 1999). The plan provides a review of past and present biological information for Clear
4 Lake. The primary focus of the plan is to maintain fishery resources of the lake and
5 enhance recreational fishing opportunities. The plan identifies areas of controversy
6 between various stakeholder groups in the watershed, and states that “adapting to the
7 biological and social settings at Clear Lake involves a variety of compromises between
8 these groups and the non-angling groups who wish to ensure the well-being of Clear
9 Lake’s native fish species.” The plan identifies the decline in native fish species at
10 Clear Lake as being detrimental both socially and biologically. No specific guidelines
11 are given for addressing impacts to native species, but restoration of spawning habitat
12 and natural flow regimes are discussed as critical for native species survival.
13

14 **Monitoring and Research**

15
16 In 2013 the Department attempted to conduct a status assessment of the CLH
17 population present in Cole and Kelsey creeks. Sampling produced too few fish to
18 facilitate a statistically valid mark and recapture study. As a result, a population
19 estimate was not completed. The Department has proposed additional funding in 2014
20 to begin a multi-year mark-recapture study to determine a statistically valid population
21 estimate or index of CLH.
22

23 The CCCLH has been conducting annual spawning observations since 2005. A simple
24 protocol is followed that identifies the time, observer, and number of CLH observed.
25 Volunteers have put in hundreds of hours monitoring CLH spawning runs during this
26 time period. Although not quantitative, the surveys provide a glimpse into the number of
27 spawning CLH and how successful spawning is in a particular season. Results of these
28 surveys are included in Appendices A and B and summarized in Section 4.1 and 4.2
29 above.

30 **Habitat Restoration Projects**

31
32 In recent years, local, state, and federal agencies have begun implementing actions to
33 aid in the protection and restoration of Clear Lake wetland habitat. The Middle Creek
34 Flood Damage Reduction and Ecosystem Restoration Project will restore up to 1,400
35 acres of wetland habitat around Middle Creek and Rodman Slough, essentially doubling
36 the amount of existing wetland habitat in the watershed (CLIWMP 2010).
37

Comment [GG30]: Just so that you know, this “idea” has been in the works the entire time I have been in Lake County. Nearly 25 years.

38 **Impacts of Existing Management Efforts**

39
40 To date, existing management efforts have focused on CLH habitat restoration in the
41 watershed. Wetland restoration projects that would significantly benefit CLH have been
42 proposed and have been or will be implemented through the Middle Creek Flood
43 Damage Reduction and Ecosystem Restoration Project and the two CAPPs that cover
44 portions of the watershed. Wetland restoration is expected to aid in increasing
45 spawning success and juvenile recruitment into the population. Increased wetland
46 acreage would enhance filtration of tributary waters resulting in decreased amounts of

1 nutrients entering the lake and an increase in the water table. The increased water
2 table will help maintain surface flow in tributaries, resulting in suitable spawning habitat
3 being maintained throughout the spawning season. The Clear Lake Shoreline
4 Ordinance has resulted in a “no net loss” of shoreline wetland habitat around the lake
5 since its enactment. However, because these wetland restoration projects are either
6 recent or yet to be implemented, a thorough assessment of direct and indirect impacts
7 to CLH populations cannot be included in this status review.

8
9 Establishment of TMDLs for mercury and nutrients has led to a reduction in inputs and
10 an increase in monitoring efforts in the Clear Lake watershed. Past and future steps by
11 the federal government will reduce mercury contamination resulting from the Sulphur
12 Bank Mercury Mine. Most of the identified initial actions for cleanup have been
13 implemented. The focus will now be on two long-term projects to address waste pile
14 and lake sediment cleanup, which should result in significant reductions in mercury
15 contamination in the watershed. Nutrient loads entering Clear Lake have been
16 addressed by several measures including wetland restoration, BMPs for storm water
17 runoff, and erosion control measures. Many of these projects are in the early stages of
18 implementation, and a thorough assessment of impacts to CLH is yet to be been
19 completed. It is likely that reduced mercury and nutrient loads in Clear Lake will result
20 in a significant benefit to CLH.

Comment [GG31]: We can hope the results would be “significant” but I think it is speculative at this time. I would omit this adjective.

21 **SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE** 22 **HITCH IN CALIFORNIA**

23
24 CESA directs the Department to prepare this report regarding the status of CLH based
25 upon the best scientific information available to the Department. CESA’s implementing
26 regulations identify key factors that are relevant to the Department’s analyses.
27 Specifically, a “species shall be listed as endangered or threatened ... if the Commission
28 determines that its continued existence is in serious danger or is threatened by any one
29 or any combination of the following factors: (1) present or threatened modification or
30 destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease;
31 or (6) other natural occurrences or human-related activities.” (Cal. Code Regs., tit. 14, §
32 670.1 (i)(1)(A)).

33
34 The definitions of endangered and threatened species in the Fish and Game Code
35 provide guidance to the Department’s scientific determination. An endangered species
36 under CESA is one “which is in serious danger of becoming extinct throughout all, or a
37 significant portion, of its range due to one or more causes, including loss of habitat,
38 change in habitat, over exploitation, predation, competition, or disease.” (Fish & G.
39 Code, § 2062). A threatened species under CESA is one “that, although not presently
40 threatened with extinction, is likely to become an endangered species in the foreseeable
41 future in the absence of special protection and management efforts required by
42 [CESA].” (*Id.*, § 2067).

43
44 The preceding sections of this status review report describe the best scientific
45 information available to the Department, with respect to the key factors identified in the

1 regulations. The Department's scientific determinations regarding these factors as peer
2 review begins are summarized below.
3

4 **Present or Threatened Modification or Destruction of Habitat**

5
6 Beginning with the arrival of European settlers in the mid-1800s, alterations to habitats
7 in the watershed have directly impacted the ability of CLH to survive. Habitats
8 necessary for both spawning and rearing have been reduced or severely decreased in
9 suitability in the past century resulting in an observable decrease in the overall
10 abundance of CLH and its habitat. Spawning tributaries have been physically altered by
11 a combination of dams, diversions, and mining operations that have altered the course
12 and timing of spring flows and the amount and quality of spawning habitat available for
13 CLH. Dams create barriers to CLH passage that reduce the amount of available
14 spawning habitat while altering the natural flow regime of tributaries. Water diversions
15 in tributaries have resulted in decreased flows during critical spawning migrations for
16 CLH. Loss of eggs, juvenile, and adult fish due to desiccation and stranding from water
17 diversions are likely a significant impact on CLH populations. Gravel mining removed
18 large amounts of spawning substrate during peak operations in the mid-1900s.
19 Spawning substrate has been restored slowly after gravel mining was discontinued in
20 the majority of the watershed. Water quality impacts to the watershed have resulted in
21 Clear Lake being listed as an impaired water body and led to the establishment of
22 TMDLs for both mercury and nutrients for the lake. It is unclear to what extent the water
23 quality impacts are affecting CLH populations. **The Department considers modification
24 and destruction of habitat a significant threat to the continued existence of CLH.**

Formatted: Highlight

25 **Overexploitation**

26
27 Harvest of CLH has occurred by both Pomo tribes and commercial fishery operators at
28 Clear Lake. Historic accounts from tribal members indicate that significant amounts of
29 CLH were harvested during spawning runs. In recent years, the amount of harvest by
30 the Pomo has been minimal, and the CLH are used strictly for educational and cultural
31 reasons. Since the early 1990s commercial fishery operations have been required to
32 return all CLH captured to the lake. Prior to that, CLH had not been regularly harvested
33 for sale. It is likely that incidental catch during commercial harvest operations resulted
34 in mortality of some CLH. **However, there is no information indicating that
35 overexploitation threatens the continued existence of CLH.**

Formatted: Highlight

36 **Predation**

37
38 Direct predation of CLH by fish, birds, and mammals is known to occur in suitable
39 habitats within the watershed. Spawning runs are vulnerable to predation from birds
40 and mammals as fish migrate upstream and become stranded at various locations.
41 Stranding occurs both naturally and as a result of habitat modifications described
42 above. Non-native fishes prey directly on different life stages of CLH in all occupied
43 habitats. CLH have been found during stomach content analyses of largemouth bass.
44 Incidental observations indicate that largemouth bass may target CLH as the CLH stage
45 at the entrance to ascend spawning tributaries in early spring. Other introduced fishes,
46 such as catfish species, also prey on CLH. A detailed diet study on introduced fishes is

1 necessary to determine the extent of predation from introduced fishes. **There is**
2 **scientific information suggesting that predation by introduced fishes threatens the**
3 **continued existence of CLH.**

Formatted: Highlight

4 **Competition**

5
6 The extent of impacts on CLH from competition with other aquatic species is poorly
7 understood. Studies conducted on diet analysis of CLH indicate that there is
8 competition between CLH and other macroinvertebrate consuming fish species,
9 primarily inland silversides and threadfin shad. Observations by Department biologists
10 and others indicate that CLH populations fluctuate on alternating cycles with inland
11 silverside populations. CLH directly compete with other native and non-native fishes for
12 juvenile rearing habitat. The majority of fishes in Clear Lake utilize near shore wetland
13 habitat for juvenile rearing. With the decrease in wetland habitat over the past century,
14 there is increased competition for the remaining habitat. Although no formal studies
15 have been completed, it is likely that competition for resources threatens the continued
16 existence of **CLH.**

Comment [GG32]: Though I agree with the premise, and undoubtedly predation from introductions is real, both LMB and catfish have co-existed with CLH for nearly 100 years. I'm not sure taken by themselves, we can make the argument that predation "threatens" their existence. Certainly a key factor affecting current population.

Formatted: Highlight

17 **Disease**

18 There are no known diseases that are significant threats to the continued existence of
19 CLH.

Comment [GG33]: I think Moyle has identified silversides as a causative agent for the extirpation of splittail (last straw if you will). I think if you look at creel data pre and post introduction of SS you will see a dramatic shift in species abundance.

20 **Other Natural Occurrences or Human-related Activities**

21
22 **If projected Expected** climate change **models prove to be accurate potential** impacts to
23 California and the Clear Lake watershed **could will** be significant during annual CLH
24 spawning cycles. CLH require winter and spring storms that provide suitable spawning
25 flows in the tributaries of Clear Lake. A shift in timing, temperature, and amount of
26 runoff could **have negative significantly** impacts on the ability of CLH to successfully
27 spawn. A report on the projected effects of climate on California freshwater fishes
28 determined CLH to be critically vulnerable to impacts from climate **change.**

Comment [GG34]: Citation?

Comment [GG35]: I agree however the conclusions are speculative at this time. I wasn't comfortable with the number of time the word "significantly" was used in the paragraph. Climate change may indeed be a huge factor, but individual weather events can provide the necessary water for spawning. I know I'm playing with words here but I think it better reflects how the debate for climate is evolving.

Formatted: Highlight

29
30 Numerous recreational activities take place in Clear Lake each year. The majority of
31 recreational activities pose no significant threat to the survival of CLH. However, **though**
32 it is believed that recreational and tournament anglers' capture CLH incidentally, **the**
33 **occurrence is consider rare. at a low rate.** **The extent of impacts to CLH from angling is**
34 **unknown, but likely do not threaten the continued existence of CLH.**

35 **SUMMARY OF KEY FINDINGS**

36
37 At present time, the species can be found in portions of its historic habitat and
38 qualitative surveys indicate a variable interannual population. Based on qualitative
39 survey efforts to date a population estimate or index of CLH is not attainable. Without a
40 current population or index for CLH it is necessary to estimate impacts not based on a
41 set baseline but rather against trends seen in abundance and distribution in sampling
42 efforts over the past half century.
43

1 It will be imperative for the Department and the conservation community to study and
2 monitor the population of CLH over the next decade. A review of the scientific
3 determinations regarding the status of CLH indicates there are significant threats to the
4 continued existence of the species, particularly related to historical and ongoing habitat
5 modification, predation from introduced species, and competition. Many of these
6 threats are currently or in the near future being addressed by existing management
7 efforts. Monitoring impacts from existing management efforts will be imperative to
8 assessing the future status of CLH.

9 **RECOMMENDATION FOR PETITIONED ACTION**

10 CESA directs the Department to prepare this report regarding the status of CLH in
11 California based upon the best scientific information available. CESA also directs the
12 Department based on its analysis to indicate in the status report whether the petitioned
13 action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd.
14 (f)). The Department includes and makes its recommendation in its status report as
15 submitted to the Commission in an advisory capacity based on the best available
16 science.
17

18 Based on the criteria described above, the scientific information available to the
19 Department does/does not indicate that CLH are threatened with extinction and likely to
20 become an endangered species in the foreseeable future. The listing recommendation
21 will be provided in this report after the Department receives, evaluates, and incorporates
22 peer-review comments as appropriate.
23

24 **PROTECTION AFFORDED BY LISTING**

25
26 It is the policy of the State to conserve, protect, restore and enhance any endangered or
27 any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an
28 endangered or threatened species, unauthorized “take” of CLH will be prohibited,
29 making the conservation, protection, and enhancement of the species and its habitat an
30 issue of statewide concern. As noted earlier, CESA defines “take” as hunt, pursue,
31 catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any
32 person violating the take prohibition would be punishable under State law. The Fish and
33 Game Code provides the Department with related authority to authorize “take” under
34 certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) As authorized
35 through an incidental take permit, however, impacts of the taking on CLH caused by the
36 activity must be minimized and fully mitigated according to State standards.
37

38 Additional protection of CLH following listing would also occur with required public
39 agency environmental review under CEQA and its federal counter-part, the National
40 Environmental Policy Act (NEPA). CEQA and NEPA both require affected public
41 agencies to analyze and disclose project-related environmental effects, including
42 potentially significant impacts on endangered, rare, and threatened special status
43 species. Under CEQA’s “substantive mandate,” for example, state and local agencies
44 in California must avoid or substantially lessen significant environmental effects of their
45 projects to the extent feasible. With that mandate and the Department’s regulatory

1 jurisdiction generally, the Department expects related CEQA and NEPA review will likely
2 result in increased information regarding the status of CLH in California as a result of,
3 among other things, updated occurrence and abundance information for individual
4 projects. Where significant impacts are identified under CEQA, the Department expects
5 project-specific required avoidance, minimization, and mitigation measures will also
6 benefit the species. State listing, in this respect, and required consultation with the
7 Department during state and local agency environmental review under CEQA, is also
8 expected to benefit the species in terms of related impacts for individual projects that
9 might otherwise occur absent listing.

10
11 If CLH are listed under CESA, it may increase the likelihood that State and federal land
12 and resource management agencies will allocate additional funds towards protection
13 and recovery actions. However, funding for species recovery and management is
14 limited, and there is a growing list of threatened and endangered species.

15 **MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES**

16
17 Current data on CLH suffers from being largely anecdotal and qualitative in nature.
18 Studies designed to provide quantitative data on CLH populations and the factors that
19 affect the ability of CLH to survive and reproduce are necessary for species
20 management. The following management recommendations were generated by
21 Department staff with considerations from local agencies, non-profits, and interested
22 parties.

- 23
- 24 • Derive a statistically valid population estimate or index allowing assessment of
25 impacts to the overall population and provide a baseline to maintain a
26 sustainable population level.
- 27 • Conduct a thorough assessment of barriers to fish movement on primary
28 spawning streams and provide recommendations for restoration actions on
29 substantial barriers.
- 30 • Complete a detailed analysis of spawning habitat in primary spawning streams
31 and provide recommendations for restoration actions.
- 32 • Implement identified restoration activities to increase available spawning habitat
33 for CLH.
- 34 • Conduct a review of reservoir operations at Highland Springs, Adobe Creek, and
35 Kelsey Creek detention dams to assess water release operations that may be
36 impacting CLH, development and implementation of guidelines for minimizing
37 impacts.
- 38 • Conduct an in stream flow analysis of primary spawning tributaries to determine
39 impacts of water diversions on stream flows, particularly during spawning
40 season.
- 41 • Coordinate with landowners, stakeholders, and permitting agencies on
42 developing strategies for reducing in stream diversions during spawning season.
- 43 • Determine the value of wetland habitat in the watershed pertaining to
44 survivorship of juvenile CLH and make appropriate recommendations on
45 restoration or modification.

- 1 • Analyze food web interactions of CLH and non-native fish to determine potential
2 impacts to CLH.
- 3 • Conduct a diet analysis of predatory fish species to determine the extent of their
4 impact on CLH.
- 5 • Conduct creel surveys to gain a better understanding of CLH capture rates
6 during both recreational and tournament angling.
- 7 • Develop a comprehensive monitoring program to assess both native and non-
8 native fish populations and their distribution in the watershed.
- 9 • Identify habitats within the watershed that may be suitable for CLH
10 translocations.
- 11 • Coordinate the above research and restoration efforts with interested
12 stakeholders in the watershed.
- 13 • Develop an outreach program to provide updates to stakeholders on recovery
14 and management efforts.

15 **PUBLIC RESPONSE**

16
17 *Note to Reviewer.* Public response will be finalized after the Department receives,
18 evaluates, and incorporates peer-review comments as appropriate.

19 **PEER REVIEW**

20
21 *Note to Reviewer.* Peer review will be finalized after the Department receives,
22 evaluates, and incorporates peer-review comments as appropriate.
23
24

25

26

27

28

29

30

31

32

1
2
3

4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

LITERATURE CITED

Aguilar, A. and J. Jones. 2009. Nuclear and Mitochondrial Diversification in two Native California Minnows: Insights into Taxonomic Identity and Regional Phylogeography. *Molecular Phylogenetics and Evolution* 51 (2): 373-381.

Anderson, N.L., D.L. Woodward and A.E. Colwell. 1986. Pestiferous dipterans and two recently introduced aquatic species at Clear Lake. *Proceedings of the California Mosquito Vector Control Association*. 54:163-167.

Anderson, N.L., 1989. Letter to Rick Macedo containing notes and data from LCVCD sampling efforts.

Avise, J.C. and F.J. Ayala. 1976. Genetic differentiation in speciose versus depauperate phylads: Evidence from the California minnows. *Evolution* 30:46-58.

Barrett, S.A., 1906. The Ethno-Geography of the Pomo and Neighboring Indians. University of California Publications in American Archeology and Ethnology. Vol 6 No. 1.

Bairrington, P., 1999. CDFG Clear Lake Fishery Management Plan.

Bellucci, C. J., Becker, M., & Beauchene, M. (2011). Characteristics of macroinvertebrate and fish communities from 30 least disturbed small streams in Connecticut. *Northeastern Naturalist*, 18(4), 411-444.

Big Valley EPA, 2013. Hitch interview notes with families of Big Valley Rancheria and Elem Indian Colony.

Big Valley Rancheria, 2012. Hitch *Lavinia exilicauda* Chi Hopkirk ecology and water quality studies in Big Valley sub-basin creeks in 2012.

Big Valley Rancheria, 2013. Big Valley sub-basin creek water quality, quantity, and Hitch *Lavinia exilicauda* Chi Hopkirk ecology program. Spring, 2013.

Brown, A.V., M.M. Little, and K.B. Brown, 1998. Impacts of gravel mining on gravel bed streams. *Transactions of the American Fisheries Society*. 127:979-994.

Bunn, S.E., and A.H. Arthington, 2002. Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol. 30:4. Pp 492-507.

California Climate Change Center, 2012. Our Changing Climate 2012 Vulnerability and Adaptation to the Increasing Risks from Climate Change in California.

1
2 California Department of Fish and Game, 1955-1956. Field notes on Kelsey and Seigler
3 Creeks.
4
5 California Department of Fish and Game, 1961-2001. Commercial Catch data for Clear
6 Lake
7
8 California Department of Fish and Game, 1969. News Release on Fish Dieoffs at Clear
9 Lake.
10
11 California Department of Fish and Game, 1988. Clear Lake Electrofishing Survey, April
12 2, 1987 Memorandum.
13
14 California Department of Fish and Game, 2012. Electrofishing data, Memorandum in
15 progress.
16
17 California Department of Fish and Wildlife, 2013. Report to the Fish and Game
18 Commission Evaluation of the Petition from the Center for Biological Diversity to List
19 Clear Lake Hitch (*Lavinia exilicauda chi*) as a Threatened Species under the California
20 Endangered Species Act.
21
22 California Department of Fish and Wildlife, 2013. Commercial Fisheries Data from catch
23 records.
24
25 California Department of Fish and Wildlife, 2013. Commercial Operators permit
26 applications.
27
28 California Department of Fish and Wildlife, April 24, 2013. Press Release – CDFW
29 Seeks Public Comment and Data Regarding Clear Lake Hitch.
30
31 California Department of Water Resources. 1975. Clear Lake Water Quality Data.
32
33 California Natural Resources Agency, 2009. California Climate Adaptation Strategy
34 Discussion Draft.
35
36 California Environmental Protection Agency RWQCBCVR, 2002. Clear Lake TMDL for
37 Mercury Staff Report.
38
39 California Environmental Protection Agency RWQCBCVR, 2008, Monitoring and
40 Implementation Plan Clear Lake Mercury and Nutrient TMDL's.
41
42 California Environmental Protection Agency RWQCBCVR, 2010. Clear Lake Mercury
43 Total Maximum Daily Load Update.
44
45 California Environmental Protection Agency RWQCBCVR, 2012. Clear Lake Nutrient
46 Total Maximum Daily Load Control Program 5-year Update.
47
48 California Regulatory Notice Register, 2012. No. 41-Z. p.1501

1
2 California Regulatory Notice Register, 2013. No. 12-Z. p.488
3
4 Center for Biological Diversity, 2012. Petition to List Clear Lake Hitch (*Lavinia exilicauda*
5 *chi*) as Threatened under the California Endangered Species Act. 58 pp.
6
7 Chi Council for the Clear Lake Hitch (CCCLH). 2013. Hitch spawning survey results,
8 2005-2013. Available at <http://lakelive.info/chicouncil/>
9
10 Clear Lake Integrated Watershed Management Plan, February 2010. Prepared for West
11 Lake and East Lake Resource Conservation Districts.
12
13 Coleman, G.A. 1930. A biological survey of Clear Lake, Lake County. *Calif. Fish and*
14 *Game* 16: 221-227.
15
16 Converse, Y.A., C.P. Hawkins and R. A. VALDEZ, 1998. Habitat Relationships of
17 Subadult Humpback Chub in the Colorado River through Grand Canyon: Spatial
18 Variability and Implications of Flow Regulation. *REGULATED RIVERS: RESEARCH &*
19 *MANAGEMENT* 14: 267–284
20
21 Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1964. The impact of the fishery on the
22 midges of Clear Lake, Lake County, CA, *Annals of the Entomological Society of*
23 *America*, Vol. 57, pp. 701-707.
24
25 Cott, P. A., Sibley, P. K., Somers, W. M., Lilly, M. R., & Gordon, A. M. (2008). A
26 REVIEW OF WATER LEVEL FLUCTUATIONS ON AQUATIC BIOTA WITH AN
27 EMPHASIS ON FISHES IN ICE-COVERED LAKES¹. *Journal of the American Water*
28 *Resources Association*, 44(2), 343-359.
29
30 Cox, B., 2007. CDFG Clear Lake Fishery Surveys Summary Report.
31
32 Curtis T.C. 1977. Pesticide Laboratory report. California Department of Fish and Game,
33 E.P. No. P-133. 3pp.
34
35 Crump, KL and VL Trudeau, 2009. Mercury-induced reproductive impairment in fish.
36 *Environmental Toxicology and Chemistry*. 28(5):895-907.
37
38 Deitch, M.J., G.M. Kondolf, and A.M. Merenlender. 2009. Hydrologic impacts of
39 smallscale instream diversions for frost and heat protection in the California wine
40 country. *River Research and Applications*, Volume 25, Issue 2, pages 118-134.
41
42 Dill, W. A., and A. J. Cordone. 1997. Fish Bulletin 178. History and Status of Introduced
43 Fishes in California 1871-1996. California. Fish and Game. 414 pp.
44
45 Eagles-Smith, C.A., T.H. Suchanek, A.E. Colwell, N.L. Anderson, and P.B. Moyle. 2008.
46 Changes in fish diets and food web mercury bioaccumulation induced by an invasive
47 planktivorous fish. *Ecological Applications* 18(Supplement): A213–A226.
48

- 1 Ewing, B., 2013. Summary of the Clear Lake Hitch Population Estimate for Cole and
2 Kelsey Creeks, Lake County.
3
- 4 Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller,
5 1999. *Confronting Climate Change in California: Ecological Impacts on the Golden*
6 *State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of
7 America, Washington, DC.
8
- 9 Field, C.B., L.D. Mortsch,, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W.
10 Running and M.J. Scott, 2007: North America. *Climate Change 2007: Impacts,*
11 *Adaptation and Vulnerability. Contribution of Working Group II to the Fourth*
12 *Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry,
13 O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge
14 University Press, Cambridge, UK, 617-652.
15
- 16 Forsgren Associates Inc, 2012. Clear Lake Watershed Sanitary Survey 2012 Update
17 Final.
18
- 19 Franson, S. 2013. Summary of Spring 20-13 Field Monitoring with Locations chosen for
20 observing egg and larval development of Clear Lake Hitch (*Lavinia exilicauda chi*).
21
- 22 Gafny, S., A. Gasith, and M. Goren 2006. Effect of water level fluctuation on shore
23 spawning of *Mirogrex terraesanctae* (Steinitz), (Cyprinidae) in Lake Kinneret,
24 Israel. *Journal of Fish Biology* vol 41:6 pages 863-871
25
- 26 Geary, R.E. 1978. Life history of the Clear Lake hitch (*Lavinia exilicauda chi*).
27 Unpublished Master's Thesis, University of California, Davis. 27 pp.
28
- 29 Geary, R.E. and P.B. Moyle. 1980. Aspects of the ecology of the hitch, *Lavinia*
30 *exilicauda* (Cyprinidae), a persistent native cyprinid in Clear Lake, California.
31 *Southwest. Nat.* 25:385-390.
32
- 33 Giusti, G. 2009. Human Influences to Clear Lake, California A 20th Century History.
34
- 35 Harnly, M., S. Seidel, P. Rojas, R. Fornes, P. Flessel, D. Smith, R. Kreutzer, and L.
36 Goldman. 1996. Biological monitoring for mercury within a community with soil and fish
37 contamination. *Environmental Health Perspectives*, Vol. 105:4, 424-429.
38
- 39 Havens, K.E. 2008. Cyanobacterial Harmful Algal Blooms: State of the Science and
40 Research Needs. Chapter 33: Cyanobacteria blooms: effects on aquatic ecosystems.
41 Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser,
42 S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S.
43 Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004.
44 Emissions pathways, climate change, and impacts on California. *Proceedings of the*
45 *National Academy of Science* 101:12422-12427.
46
- 47 Hopkirk, J.D. 1973. Endemism in fishes of the Clear Lake region of central California.
48 *University of California Publications in Zoology* 96: 160 pp.

1
2 Horne, A.J. 1975. The Effects of Copper, Major and Minor Nutrient Element
3 Additions, and Lake Water Movements on Blue-Green Algal Bloom Development in
4 Clear Lake.
5
6 Hudon, C., Armellin, A., Gagnon, P., & Patoine, A. (2010). Variations in water
7 temperatures and levels in the St. Lawrence River (quebec, canada) and potential
8 implications for three common fish species. *Hydrobiologia*, 647(1), 145-161.
9
10 Hunt, E.G. and A.I. Bischoff. 1960. Inimical effects on wildlife or periodic DDD
11 applications to Clear Lake. *California Fish and Game* 46:91-106.
12
13 Jelks, H L., Stephen J. Walsh, Noel M. Burkhead, Salvador Contreras-Balderas,
14 Edmundo
15 Diaz-Pardo, Dean A. Hendrickson, John Lyons, Nicholas E. Mandrak, Frank
16 McCormick, Joseph S. Nelson, Steven P. Platania, Brady A. Porter, Claude B. Renaud,
17 Juan Jacobo Schmitter-Soto, Eric B. Taylor & Melvin L. Warren Jr. (2008): Conservation
18 Status of Imperiled North American Freshwater and Diadromous Fishes, *Fisheries*,
19 33:8, 372-407.
20
21 Jordan, D.S., and C.H. Gilbert. 1894. List of Fishes Inhabiting Clear Lake, California.
22 *Bulletin of the United States Fish Commission*, Vol. XIV.
23
24 Kelsey Creek Watershed Assessment, February 2010. Prepared for East Lake and
25 West Lake Resource Conservation Districts.
26
27 Kimsey, J.B. and L.O. Fisk. 1960. Keys to the freshwater and anadromous fishes of
28 California. *Calif. Fish Game* 46:453-79.
29
30 Kniffen, F.B. 1939. Pomo Geography. University of California Publications in American
31 Archaeology and Ethnology. Vol. 36 No. 6 pp. 353-400.
32
33 Kratville, D. October 7, 2013. Email correspondence on CESA MOU's issued for CLH.
34
35 Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T.
36 Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management.
37 *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working*
38 *Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate*
39 *Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.
40 Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.
41
42 Lake County Department of Agriculture, 2011. Crop Report
43
44 Lake County Department of Public Works Water Resources Division, 2003. Clear Lake
45 Wetlands Geographic Information Systems Data User Manual.
46
47 Lake County Vector Control District, 2013. Copy of verified Beach Seine 1987-2010 CL
48 Hitch with notes.

1
2 Lindquist, A.W., C.D. Deonier, and J.E. Hanley. 1943. The relationship of fish to the
3 Clear Lake gnat, in Clear Lake, California. Calif. Fish Game 29:196-202.
4
5 Lindquist, A.W. and A.R. Roth. 1950. Effect of dichlorodiphenyl dichloroethane on larva
6 of the Clear Lake gnat in California. *Journal of Economic Entomology* 43:328-332.
7
8 Macclanahan, J., E. W. Danley, H. F. Dewitt, and W. Wolber. 1972[app]. Flood control
9 project maintenance and repair, 1971 inspection report. California Department of Water
10 Resources Bulletin 149-71.
11
12 Macedo, R., 1991. Creel Survey at Clear Lake, California March – June, 1988. CDFG
13 Administrative Report No. 91-3.
14
15 Macedo, R. 1994. Swimming Upstream Without a Hitch. *Outdoor California*:
16 January/February 1994.
17
18 Marchetti, M.P. and P.B. Moyle, 2001. Effects of flow regime on fish assemblages in a
19 regulated California stream. *Ecological Applications*. 11(2). Pp. 530-539.
20
21 McGinnis, D. and E. Ringelberg. 2006. Lake County Fish Barrier Assessment. Technical
22 Memo.
23
24 Middle Creek Watershed Assessment, February 2010. Prepared for West Lake
25 Resource Conservation District.
26
27 Miller, R.R. 1945. A new cyprinid fish from Southern Arizona, and Sonora, Mexico, with
28 description of a new subgenus of *Gila* and a review of related species. *Copeia*
29 1945:104-110.
30
31 Miller, R.R. 1963. Synonymy, characters and variation of *Gila crassicauda*, a rare
32 California minnow, with an account of its hybridization with *Lavinia exilicauda*. *California*
33 *Fish and Game* 49 (1): 20-29.
34
35 Mioni, C., R. Kudela, and D. Baxter. 2011. Harmful cyanobacteria blooms and their
36 toxins in Clear Lake and the Sacramento-San Joaquin delta (California). *Central Valley*
37 *Regional Water Quality Control Board*: 10-058-150.
38
39 Moyle, P.B. and M. Massingill. 1981. Hybridization between hitch, *Lavinia exilicauda*,
40 and Sacramento blackfish, *Orthodon microlepidotus*, in San Luis Reservoir, California.
41 *California Fish Game* 67:196-198.
42
43 Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. *Fish*
44 *Species of Special Concern in California*, 2nd edition.
45
46 Moyle, P.B. and T. Light, 1996. Fish Invasions in California: Do Abiotic Factors
47 Determine Success? *Ecology* 77:1666-1670.
48

1 Moyle, P. B. 2002. Inland Fishes of California. Berkeley: University of California Press.
2
3 Moyle, P.B., JD Kiernam, PK Crain and RM Quinones, 2012. Projected Effects of Future
4 Climates on Freshwater Fishes of California. A White Paper from the California Energy
5 Commission's California Climate Change Center.
6
7 Moyle P.B., J.V Katz, and R.M. Quinones. In review. Fish Species of Special Concern
8 for California. Prepared for California Department of Fish and Game, Sacramento
9
10 Murphy, G.I. 1948. Notes on the biology of the Sacramento hitch (*Lavinia e. exilicauda*)
11 of Clear Lake, Lake County, California. Calif. Fish Game 34:101-110.
12
13 Murphy, G.I. 1951. The fishery of Clear Lake, Lake County, California. *Calif. Fish and*
14 *Game* 37: 439-484.
15
16 National Oceanic and Atmospheric Administration, 2011. Table 2. Toxicity associated
17 with mercury in tissues (ug/g) wet weight.
18
19 Nicola, S.J. 1974. The life history of the hitch, *Lavinia exilicauda* Baird and Girard, in
20 Beardsley Reservoir, California. Inland Fish. Admin. Rep. 74-6:1-16.
21
22 Osleger, D.A., R.A. Zierenberg, T.H. Suchanek, J.S. Stoner, S. Morgan, and D.P.
23 Adam. 2008. Clear Lake sediments: anthropogenic changes in physical sedimentology
24 and magnetic response. Ecological Applications 18 (Supplement): A239-A256.
25
26 Puckett, L., 1972. CDFG Memorandum-Fisheries Survey Clear Lake, Lake County.
27
28 Richerson P.J., T.H. Suchanek, and S.J. Why. 1994. The Causes and Control of Algal
29 Blooms in Clear Lake, Clean Lakes Diagnostic/Feasibility Study for Clear Lake,
30 California. Prepared for USEPA Region IX.
31
32 Ridout, W.L. 1899. A Fish Jam on Kelsey Creek. *Overland Monthly and Out West*
33 *Magazine*. Volume 34, Issue 202. p. 333.
34
35 Robinson Rancheria Environmental Center (RREC). 2011. Draft Adaptive Management
36 Plan for the Clear Lake Hitch, *Lavinia exilicauda chi*. Available
37 at <http://www.robinsonrancheria.org/environmental/water.htm>.
38
39 Rowan, J., 2008. CDFG Clear Lake, Lake County Memorandum.
40
41 Rudd, R.L. 1964. *Pesticides and the Living Landscape*. University of Wisconsin Press,
42 Madison, WI.
43
44 Sandheinrich, MB. And KM Miller, 2006. Effects of dietary methylmercury on
45 reproductive behavior of fathead minnows (*Pimephales promelas*). *Environmental*
46 *Toxicology and Chemistry*. 25(11):3053-3057.
47

1 Scotts Creek Watershed Assessment, February 2010. Prepared for West Lake
2 Conservation District.
3

4 Scotts Valley Band of Pomo Indians, 2013. Historical accounts provided to CDFW by
5 Steve Elliott and Wanda Quitquit.
6

7 State of California Fish and Game Commission, March 11, 2013. California Fish and
8 Game Commission Notice of Findings
9

10 State of California Fish and Game Commission, October 2, 2012. California Fish and
11 Game Commission Notice of Receipt of Petition
12

13 Suchanek, T.H., P.J. Richerson, L.A. Woodward, D.G. Slotton, L.J. Holts and C.E.
14 Woodmansee. 1993. Ecological Assessment of the Sulphur Bank Mercury Mine
15 Superfund Site, Clear Lake, California: A Survey and Evaluation of Mercury In:
16 Sediment, Water, Plankton, Periphyton, Benthic Invertebrates and Fishes Within the
17 Aquatic Ecosystem of Clear Lake, California. Phase 1- Preliminary Lake Study Report.
18 Prepared for EPA-Region IX, Superfund Program. 113 pp., plus 2 attachments.
19

20 Suchanek, T.H., P.J. Richerson, D.C. Nelson, C.A. Eagles-Smith, D.W. Anderson, J.J.
21 Cech, Jr., G. Schladow, R. Zierenberg, J.F. Mount, S.C. McHatton, D.G. Slotton, L.B.
22 Webber, A.L. Bern and B.J. Swisher. 2002. Evaluating and managing a multiply-
23 stressed ecosystem at Clear Lake, California: A holistic ecosystem approach.
24 "Managing For Healthy Ecosystems: Case Studies," CRC/Lewis Press. pp. 1233-1265.
25

26 Swift, C. 1965. Early development of the hitch, *Lavinia exilicauda*, of Clear Lake,
27 California. Calif. Fish Game 51:74-80.
28

29 Thompson, L.C., G.A. Giusti, K.L. Weber, and R.F. Keiffer. 2013. The native and
30 introduced fishes of Clear Lake: a review of the past to assist with decisions of the
31 future. California Fish and Game 99(1):7-41.
32

33 U.S. Army Corps of Engineers. 1974[app]. Flood plain information: Big Valley streams
34 (Manning, Adobe, Kelsey, and Cole Creeks), Kelseyville, California. Department of
35 the Army, Sacramento District, Corps of Engineers, Sacramento, California, USA.
36

37 U.S. Environmental Protection Agency, 2012. Sulphur Bank Mercury Mine News
38 Release – EPA to Begin Construction of Test Covers in Clear Lake.
39

40 Week, L., 1982. Habitat Selectivity of Littoral Zone Fishes at Clear Lake, CDFG
41 California. Administrative Report No. 82-7.
42

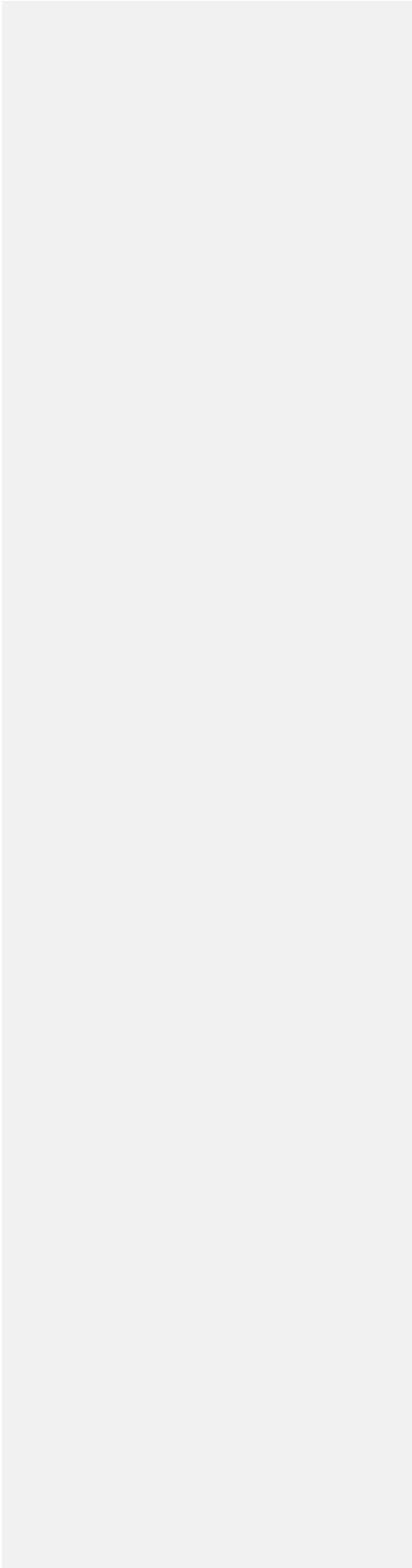
43 Wetzel, R.G., 2001. Limnology lake and River Ecosystems, 3rd ed. Pg. 834.
44

45 Winder, M., J. Reuter and G. Schladow, 2010. Clear Lake Report: Clear Lake Historical
46 Data Analysis.
47
48

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

Appendix A. Summary graphs of spawning observations between 2005 and 2013

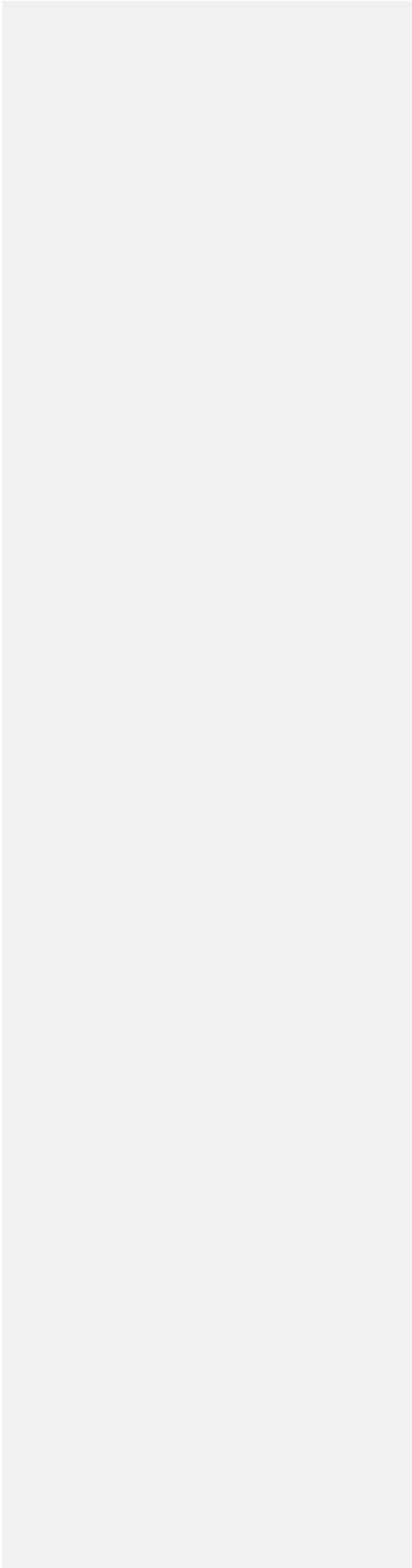
DRAFT



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

Appendix B. Figures depicting CLH observations on spawning tributaries

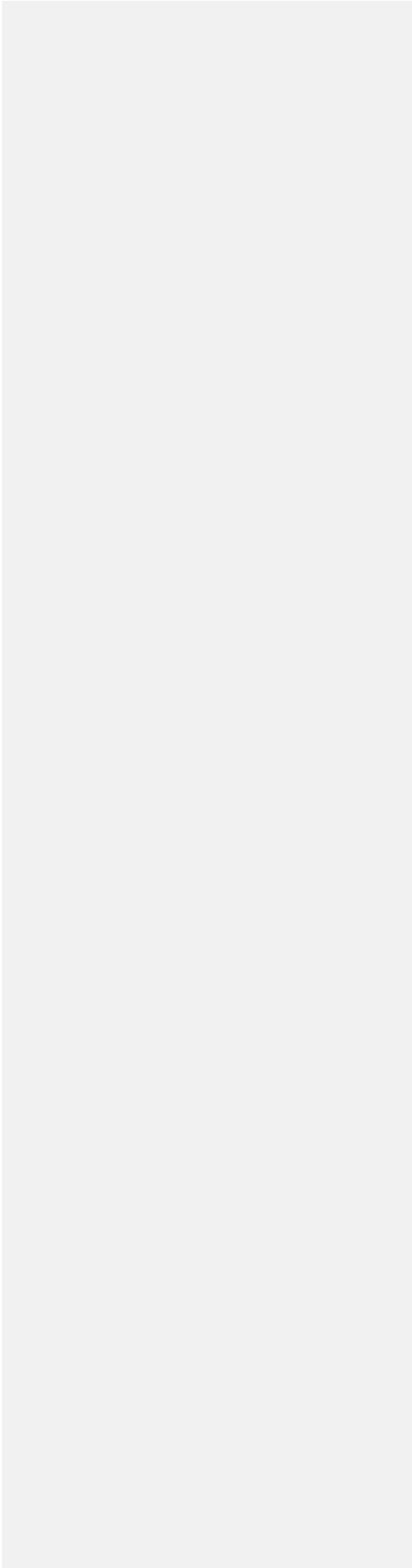
DRAFT



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

Appendix C. Description of barriers associated with CLH spawning tributaries

DRAFT



1
2 Highland Springs Creek: There is a flood control dam on Highland Springs Creek, a
3 tributary to Adobe Creek, which is impassable to CLH.
4
5 Adobe Creek: There is a flood control dam on Adobe Creek above Bell Hill Road that is
6 impassable to CLH. There are two culverts on Adobe Creek that are mitigation barriers
7 to spawning CLH when the water flows and velocity are not too great, but these culverts
8 block CLH migration.
9
10 Alley Creek: Alley Creek has been channeled and diverted into Clover Creek. Alley
11 Creek historically supported CLH runs. During some time and under certain conditions
12 migrating CLH can access Alley Creek via the Clover channel bypass, but not when the
13 diversion has silt or sand obstructing it.
14
15 Clover Creek: There was a diversion barrier on Clover Creek, a tributary of Middle
16 Creek, which prevented fish passage into Clover Creek and Alley Creek. In 2004 the
17 Robinson Rancheria received a Tribal Wildlife Grant to mitigate the diversion barrier.
18 The work has been completed and the barrier has been modified and no longer
19 obstructs fish passage. However, CLH must pass a concrete diversion structure at the
20 junction with Alley Creek to the northwest of Upper Lake to gain the upper reaches of
21 Clover Creek. This diversion structure usually becomes a complete barrier when filled
22 with gravel and sediment.
23
24 Forbes Creek: Forbes Creek has a concrete storm water diversion structure that
25 impedes and at times blocks CLH passage.
26
27 Kelsey Creek: On Kelsey Creek, the main barriers to CLH migration are a detention
28 dam 2 to 3 miles upstream of Clear Lake, and the Main Street Bridge in Kelseyville. The
29 rock and concrete weir constructed at the base of the Main Street Bridge is a barrier to
30 the passage of CLH (Peter Windrem, personnel communication, 2012). The structure
31 has a fish ladder which is nonfunctional and the site is nonetheless a total barrier to
32 CLH (McGinnis and Ringelberg, 2008). The Kelsey Creek detention structure below
33 Dorn Crossing has retractable gates which can be opened during the CLH spawning
34 season. However, altered flow patterns and slight increases in the slope of the
35 streambed have been enough to reduce the number of spawning CLH that can pass
36 through the detention structure and move upstream. Also, rock riprap situated below the
37 retention dam seems to have impeded the upstream migration of CLH and needs to be
38 modified to provide a clear channel for fish transit. A number of drop-structures in
39 Kelsey Creek intended for gravel aggradation impede migration. Some of these do not
40 seem to impede CLH passage under current conditions, but CLH navigate them with
41 difficulty especially on the downstream passage. Further upstream, culverts that once
42 tended to clog with debris and block fish migration at the Merritt Road crossing have
43 been removed and replaced by a bridge that poses no impediment to CLH passage.
44
45 Lyons Creek: A high culvert on Lyons Creek at Lakeshore Drive prevents CLH from
46 moving upstream. Lyons Creek also has a concrete barrier at the County's Juvenile Hall
47 facility that completely prevents fish passage.
48

1 Manning Creek: A dam upstream of known CLH spawning areas in the lower reaches
2 of Manning Creek may prevent CLH from spawning further upstream.
3

4 Middle Creek: On Middle Creek, a rock and concrete weir at the Rancheria Road
5 Bridge has been a total fish passage barrier for CLH. Remedial work has been done
6 downstream, with more weirs installed in an effort to elevate the gradient so that CLH
7 could surmount the barrier and work was done to improve their stability after high flows,
8 but it remains to be seen if this will allow CLH passage. Similar weirs to capture and
9 hold gravel were installed many years ago in Adobe Creek and Kelsey Creek that do
10 not impede CLH passage, but there is concern the installed weirs on Middle Creek may
11 be potential barriers to CLH. A downstream weir at Rancheria Road is a partial barrier
12 and improperly sized rip rap at this location acts as partial migration barrier (McGinnis
13 and Ringelberg 2008). CLH were seen recently at Middle Creek Bridge and Highway 20
14 and although there are no obvious barriers, they did not appear to be able to navigate
15 the swift currents there due to the lack of resting pools. If CLH could surmount
16 Rancheria Bridge, many additional miles of spawning grounds would be accessible to
17 CLH up to areas south of Hunter Bridge, where habitat suitability ends because the
18 channel is braided and shallow due to gravel mining.
19

20 Scotts Creek: On Scotts Creek, a rock and concrete weir at the Decker Bridge is a total
21 barrier to the passage of CLH. As water levels have been lower, a barrier at the lower
22 end of Tule Lake is problematic for fish passage to Tule Lake and its tributary
23 Mendenhall Creek, Scotts Creek and tributaries, Bachelor Valley/Witter Springs area
24 tributaries, and Blue Lakes and tributaries. There is a one-way flow gate on the Blue
25 Lakes outlet at Scotts Creek that prevents CLH from entering Blue Lakes.
26

27 Seigler Canyon Creek: There are two barriers to CLH migration into Seigler Canyon
28 Creek, an exposed sewer pipe and a road crossing. The sewer pipeline which crosses
29 Seigler Canyon Creek for Anderson Marsh State Park was modified in the 1990s and
30 completely blocks CLH access to that creek, once a major spawning tributary.

Page	Line	Reviewer Comment	Department Response
7	18	Hopkirk felt that the compressed body differentiated the lake ssp. from riverine ssp. You may want to identify that point as well.	No Change-difference is noted in next paragraph of document.
7	26	You just addressed my previous point.	Noted.
7	30	Do you have a citation for this?	No Change- sentence is referenced and the Department accepted Clear Lake hitch as a distinct subspecies in the Fish Species of Special Concern in California document from 1995.
9	24-25	suggested edit "all have of low gradients prior to entering the lake"	Accepted- sentence reworded.
9	26	I'm not sure about this. This may be true in the headwater regions of Kelsey Creek, Cole Creek and possibility others, but I believe surface water is found beyond the reach of hitch.	Accepted- sentence reworded.
9	29-30	suggested edit "resemble salmonid runs"	Accepted- sentence reworded.
10	28	Should we list other fish species e.g. catfish, other centrarchids?	Noted- sentence was removed based on other peer review comments.
11	9	I think you should spell this out the first time.	No Change- Chi Council for Clear Lake Hitch (CCCLH) is spelled out previously in the Life History section.
11	20	I know what your intention is here but we really don't have "spawning success" data i.e. fecundity numbers. Maybe "reduced number of adults observed" or something similar. None of the counts include night time observations	Accepted- sentence reworded.
11	35	You might want to consider a line that identifies turbidity following a rain can affect observation data collection. Simply to identify another variable.	Accepted- additional info added to paragraph describing Chi Council spawning observations.
13	14-16	Good point.	Noted.
13	25-27	More than fish numbers, I think this is a salient point. Trend analysis is more important that a single year data point due to the lack of flow in many historic spawning tribs in 2013.	Noted- Figure 3 Illustrates the number of spawning tributaries between 2005-2013.
13	27-29	Does this identify a need to better quantify and standardize a protocol to estimate annual fish migration numbers?	Noted- The Department is working with observers to create a more rigorous and scientifically valid survey protocol.
16	6-26	I know this is the information that is available but each anecdotal point is qualified that CLH would have been incidental to the effort. What is one to deduce from this?	Noted- The goal of the status review is to evaluate all existing data on CLH. Not all data allows for a specific conclusion to be drawn.
17	1-3	This last paragraph is good information.	Noted.
17	13	There is some local discrepancy about this picture. The image is certainly of cyprinids, but there is some dispute as to the species.	Accepted- sentence reworded.
17	5-23	This is all good information. It strikes me as out of place. Might it be better placed earlier in the document to provide a historical perspective followed by the information provided by Chi Council and Vector Control?	Noted- The format of the document is consistent with the requirements for a status review.
18	12	Not all of these acres represent converted wetlands, though some operations could potentially impact "wetland function".	Accepted- sentence reworded.
21	5	The County of Lake Special Districts diverts water from Kelsey Creek as the primary source of water for the town of Kelseyville. I think this statement may not identify all of the diversions equally. I know that ball field irrigation has caused a complete draw down on Cole Creek.....more than once	Accepted- Additional information added on diversions.
22	15-16	suggested edit "Erosion from construction, dredging, mining, agriculture, OHV use, grazing, residential development and urbanization"	No Change- This information was found in Forsgren Associates Inc. 2012. Residential development was not specifically mentioned.
22	26	suggested edit "Development and expansion of extensive and intensive agriculture in the Clear Lake"	No Change- extensive and intensive removed for lack of reference
23	4-8	This is true but in the case of CL the Lyngbya blooms have been attributed to the clarity of the water, and rooted vegetation has become problematic in the past ten years. Water clarity has been steadily increasing since 1969.	Noted- No references were cited by reviewer on increase in water clarity or rooted vegetation.
23	12-17	Again, this is very old data, I'm not sure it accurately reflects the current water quality conditions of the lake and I'm not sure of its relevance here.	No Change- The paragraph describes direct impacts to CLH resulting from water Cyanobacteria.
23	29	suggested edit "a primary food source for CLH and CL splittail"	No Change- The status review is addressing impacts to CLH.
24	10	I removed the word "extensively" as it is valued laden and subjective. It does not add to the discussion.	Accepted- sentence reworded.
24	13	I believe Komeen is a contact herbicide...check me on this.	Accepted- sentence reworded.
24	12-17	This is subjective. I know of no examples of tules being impacted. You need to include a reference if possible...at least in recent times.	No Change- The two herbicides are non selective and will impact any vascular plant they come in contact with. There is no claim that they impact a specific amount of tules just that they can.
26	24	suggested addition "Tule perch (Hysteroecarpus traski) are accidentally caught or incidentally observed as recently as 2014 (Giusti, pers. communication) but quantified estimates of their populations do not exist.	No Change- The previous sentences are describing species that are extinct, extirpated, or possible extirpated from the lake. Tule perch do not fit in this group.
26	34	Introduced yes, but I'm not sure if the introduction was successful.	Noted- It is documented an introduction occurred but the species did not establish in the lake. A clarifying sentence has been added.
26	44	Is this the reference were Moyle goes so far to suggest that silversides may have played a role in the final demise of CL splittail?	Noted- Geary and Moyle 1980 does not suggest silversides played a role in the demise of Clear Lake splittail.
29	1-2	I would like to encourage the Dept to re-engage with anglers and conduct annual or even bi-annual creel surveys to address this data gap	Accepted- As part of the Management Recommendations and Recovery Measures the Department included angler surveys.
29	8	suggested edit "The number of tournaments per year is a function of the economy and has decreased since the recession that began in 2008. It is generally anticipated tournament numbers will increase again as the economy continues to improve."	Accepted premise- Information was added stating the decline in permitted tournaments between 2008-2013. Information on the function of the economy was omitted.
30	30	Should the tribes be included here?	Accepted-Sentence reworded
31	10	"was" past tense as the committee is no longer functioning as the mass increase of vineyard expansion has waned	Accepted- sentence reworded.

31	29	???? What is this?	RREC is defined in the Species Status and Population Trends section as Robinson Rancheria Ecological Center
31	29	What does the "H" stand for?	Accepted- HAMP changed to AMP throughout document.
32	32-36	25 years	Noted.
33	20	We can hope the results would be "significant" but I think it is speculative at this time. I would omit this adjective.	Accepted- sentence reworded.
35	1-3	Though I agree with the premise, and undoubtedly predation from introductions is real, both LMB and catfish have co-existed with CLH for nearly 100 years. I'm not sure taken by themselves, we can make the argument that predation "threatens" their existence. Certainly a key factor affecting current population. I think Moyle has identified silversides as a causative agent for the extirpation of splittail (last straw if you will). I think if you look at creel data pre and post introduction of SS you will see a dramatic shift in species abundance.	No Change- The language is consistent with the requirements of the status review under Fish and Game Code and Title 14.
35	6-16		Accepted- Information has been added on Mississippi silverside, threadfin shad, and CLH abundance.
35	22-24	suggested edit "If projected climate change models prove to be accurate potential impacts to California and the Clear Lake watershed could be significant during annual CLH spawning cycles.	Accepted - sentence reworded except for change to projected and from will to could be.
35	26	suggested edit "runoff could have negative impacts on the ability of CLH to successfully"	No Change- spawning impacts would be significant.
35	27-28	Citation?	No Change- These are summary sections the citations are in the more detailed impacts sections.
35	27-28	I agree however the conclusions are speculative at this time. I wasn't comfortable with the number of time the word "significantly" was used in the paragraph. Climate change may indeed be a huge factor, but individual weather events can provide the necessary water for spawning. I know I'm playing with words here but I think it better reflects how the debate for climate is evolving.	No Change- The language is consistent with the requirements of the status review under Fish and Game Code and Title 14.
35	31-33	suggested edit "However, though it is believed that recreational and tournament anglers' capture CLH incidentally, the occurrence is consider rare.	Accepted- sentence reworded.
General	none	You might want to review the Annotated Bibliography published by Weber, K. et.al. 2011 as it contains over 300 references to both Clear Lake and its fishes. Particularly you may find some useful and informative "gray literature" to assist you with historical perspectives.	Noted.



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
Sacramento, CA 95811
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director



January 13, 2014

Jerry J. Smith
Biological Sciences Department
San Jose State University
One Washington Square
San Jose, CA 95192

Dear Dr. Smith

CLEAR LAKE HITCH (*LAVINIA EXILICAUDA CHI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife (Department) Draft Status Report of the Clear Lake hitch (*Lavinia exilicauda chi*). A copy of the Department's peer review draft status report, dated January 2014, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of Clear Lake hitch in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). The Department would appreciate receiving your peer review input on or before February 10, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened. The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission.

The Commission first received the petition to list Clear Lake hitch as threatened on September 25, 2012. The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on March 22, 2013 following publication of regulatory notice by the Office of Administrative Law. The Clear Lake hitch is currently protected under CESA in California in that capacity.

The peer review Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the best scientific information available regarding the status of Clear Lake hitch in California. Headed into peer review, the Department believes the best available science indicates that listing the species as threatened under CESA is warranted at this time. To be clear, we ask that you focus

Conserving California's Wildlife Since 1870

Name, Title
Business
Date
Page 2

your review on the scientific information and the Department's related assessment of the required population and life history elements prescribed in CESA rather than focusing on the tentative conclusion we share as a matter of professional courtesy. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the best scientific information available regarding the status of Clear Lake hitch in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA (*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important as well as whether they indicate, in your opinion, that Clear Lake hitch is likely to become, in the foreseeable future, at serious risk of becoming extinct throughout all or a significant portion of its range in California.

We ask that you assess our work for quality and conduct a thorough and proper review. As with all peer review processes, the reviewer is not the final arbiter, but your comments will inform our final decision-making. Also, please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Kevin Thomas at kevin.thomas@wildlife.ca.gov, or he may be reached by telephone at (916) 358-2845.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Stafford Lehr
Chief, Fisheries Branch

Enclosure(s)

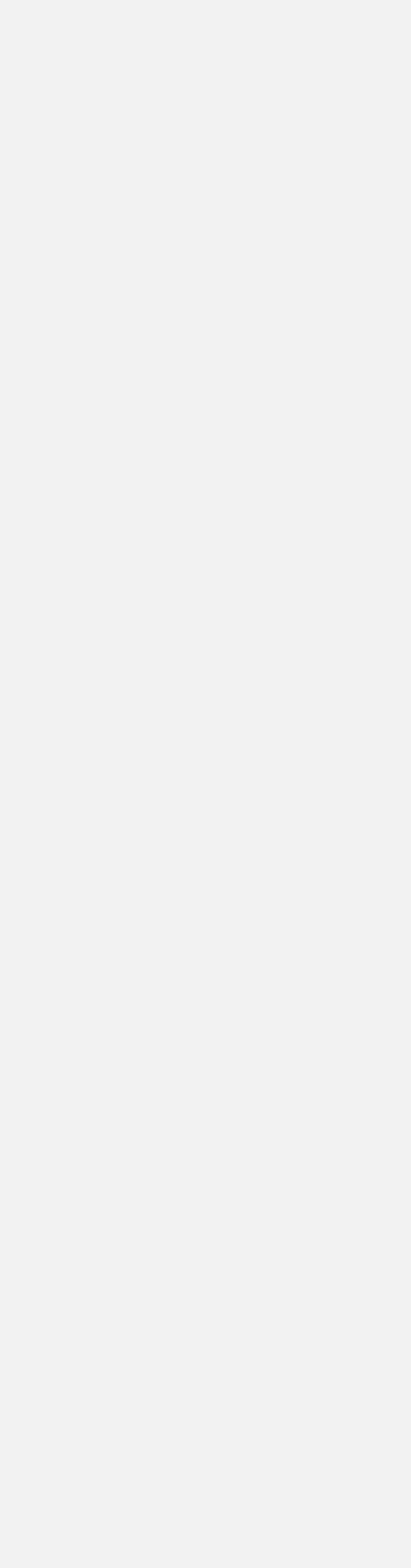
cc: Tina Bartlett
CDFW-NCR

Name, Title
Business
Date
Page 3

Thomas Gibson
CDFW-OGC

Katherine Hill
CDFW-NCR

Kevin Thomas
CDFW-NCR



1
2
3 **State of California**
4 **Natural Resources Agency**
5 **Department of Fish and Wildlife**
6
7

8
9 **REPORT TO THE FISH AND GAME COMMISSION**
10

11
12
13
14 **A STATUS REVIEW OF CLEAR LAKE HITCH (*Lavinia exilicauda* ch)**
15

16
17 **January 2014 Preliminary Draft for Peer Review**
18
19
20



21
22 Clear Lake hitch adult. Photo courtesy of Rick Macedo
23

24
25
26 **Charlton H. Bonham, Director**
27 **Department of Fish and Wildlife**
28

29
30
31
32 **Report to the Fish and Game Commission**
33 **A STATUS REVIEW OF CLEAR LAKE HITCH**
34

Contents

1

2 LIST OF FIGURES..... 3

3 LIST OF APPENDICES 4

4 EXECUTIVE SUMMARY 4

5 Background 5

6 Summary of Findings..... 5

7 Status 5

8 Threats 5

9 Petitioned Action 5

10 Management and Recovery Recommendations..... 5

11 INTRODUCTION 5

12 Petition History 6

13 Department Review 6

14 BIOLOGY 7

15 Species Description 7

16 Taxonomy..... 7

17 Range and Distribution 7

18 Life History 7

19 Habitat that May be Essential to the Continued Existence of the Species..... 9

20 SPECIES STATUS AND POPULATION TRENDS..... 9

21 FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE 15

22 Present or Threatened Modification or Destruction of Habitat 15

23 Wetland Habitat Loss 15

24 Spawning Habitat Exclusion and Loss 15

25 Water Quality Impacts 18

26 Overexploitation 21

27 Commercial Harvest..... 21

28 Cultural Harvest 21

29 Predation and Competition 22

30 Disease and Parasites..... 23

31 Other Natural Occurrences or Human Related Activities 23

32 Climate Change 23

33 Recreational Activities 24

1	REGULATORY AND LISTING STATUS.....	25
2	Federal	25
3	State	25
4	Other Rankings.....	26
5	EXISTING MANAGEMENT EFFORTS.....	26
6	Resource Management Plans	26
7	Monitoring and Research.....	28
8	Habitat Restoration Projects.....	28
9	Impacts of Existing Management Efforts.....	28
10	SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE HITCH IN CALIFORNIA.....	29
11	Present or Threatened Modification or Destruction of Habitat	29
12	Overexploitation	30
13	Predation.....	30
14	Competition	30
15	Disease	31
16	There are no known diseases that are significant threats to the continued existence of CLH.	31
17	Other Natural Occurrences or Human-related Activities	31
18	SUMMARY OF KEY FINDINGS.....	31
19	RECOMMENDATION FOR PETITIONED ACTION.....	32
20	PROTECTION AFFORDED BY LISTING	32
21	MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES	33
22	PUBLIC RESPONSE.....	34
23	PEER REVIEW.....	34
24	LITERATURE CITED.....	34

25
26
27

28

29 **LIST OF FIGURES**

30		
31	Figure 1. Map depicting the Clear Lake watershed.	7
32	Figure 2. Clear Lake hitch population trends over the past 52 years as measured by	
33	three methods of qualitative sampling and spawning season rainfall totals as recorded	

1 at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall
2 gauges. Data in blue tones corresponds to the primary y axis and data in red tones
3 corresponds to the secondary y axis. 11
4 **Figure 3.** Number of occupied Clear Lake hitch spawning tributaries documented by
5 CCCLH observers between 2005 and 2013. 13
6 **Figure 4.** Summary of Clear Lake hitch captured during Lake County Vector Control
7 District beach seine surveys conducted from 1987 to 2010. 13
8 **Figure 5.** Number of Clear Lake hitch captured incidentally during commercial harvest
9 operations between 1961 and 2001. 13
10 **Figure 6.** Photo from 1890s depicting spawning CLH being stranded in Kelsey Creek.15
11 **Figure 7.** Clear Lake hitch spawning barriers located on tributaries throughout the
12 watershed. 16
13

14

15 **LIST OF APPENDICES**

16
17 **Appendix A.** Summary graphs of spawning observations between 2005 and 2013
18 **Appendix B.** Figures depicting CLH observations on spawning tributaries
19 **Appendix C.** Description of barriers associated with CLH spawning tributaries
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

35 **EXECUTIVE SUMMARY**

36
37 This status review report describes the current status of Clear Lake hitch (*Lavinia*
38 *exilicauda chi*) (CLH) in California as informed by the scientific information available to
39 the California Department of Fish and Wildlife (Department, CDFW, CDFG).
40

1 **Background**

- 2 • September 25, 2012: The Fish and Game Commission (Commission) received a
3 petition from the Center for Biological Diversity to list CLH as threatened under
4 the California Endangered Species Act (CESA) (Center for Biological Diversity
5 2012).
- 6 • September 26, 2012: The Commission sent a memorandum to the Department,
7 referring the petition to the Department for its evaluation.
- 8 • October 12, 2012: The Commission provided notice of the received petition from
9 the Center for Biological Diversity to list CLH as threatened under CESA (Cal.
10 Reg. Notice Register 2012, Vol. 41-Z, p.1502).
- 11 • December 12, 2012 the Commission granted a 30-day extension on the
12 submission date for the Department's Initial Review of Petition to List the Clear
13 Lake Hitch as threatened under CESA.
- 14 • January 31, 2013: The Department provided the Commission with an Initial
15 Review of Petition to List the Clear Lake Hitch as Threatened under the
16 California Endangered Species Act pursuant to Fish and Game Code, section
17 2073.5. The Department's review recommended that the petition provided
18 sufficient information to indicate the petitioned action may be warranted, and the
19 petition should be accepted and considered (CDFW 2013).
- 20 • March 6, 2013: At its scheduled public meeting in Mt. Shasta, California, the
21 Commission considered the petition, the Department's petition evaluation and
22 recommendation, and comments received by the Commission and found that the
23 petition provided sufficient information to indicate the petitioned action may be
24 warranted.
- 25 • March 22, 2013: The Commission published its Notice of Findings in the
26 California Regulatory Notice Register (CA Reg. Notice Register 2013, Vol. 12-Z
27 p. 488), stating the petition was accepted for consideration, and designated CLH
28 as a candidate species.

29 **Summary of Findings**

30
31 *Note to Reviewer:* This Summary of Findings will be finalized after the Department
32 receives, evaluates, and incorporates peer-review comments as appropriate.

33 **Status**

34 **Threats**

35 **Petitioned Action**

36
37 **Management and Recovery Recommendations**

38 **INTRODUCTION**

39
40 This status review report addresses the Clear Lake hitch (*Lavinia exilicauda chi*) (CLH),
41 the subject of a petition to list the species as threatened under the California
42 Endangered Species Act (CESA) (Fish & G. Code § 2050 *et seq.*).

1 **Petition History**

2
3 On September 25, 2012, the Fish and Game Commission (Commission) received a
4 petition from the Center for Biological Diversity (Petitioner) to list the CLH as a
5 threatened species under CESA.
6
7 On September 26, 2012 the Commission sent a memorandum to the California
8 Department of Fish and Wildlife (Department, CDFW, and CDFG) referring the petition
9 to the Department for its evaluation.
10
11 On October 12, 2012, as required by Fish and Game Code, section 2073.3, notice of
12 the petition was published in the California Notice Register (Cal. Reg. Notice Register
13 2012, Vol. 41-Z, p.1502).
14
15 On December 12, 2012 the Commission granted a 30-day extension on the submission
16 date for the Department's Initial Review of Petition to List the CLH as threatened under
17 CESA.
18
19 On January 31, 2013, the Department provided the Commission with its Initial Review of
20 Petition to List the CLH as threatened under CESA. Pursuant to Fish and Game Code,
21 section 2073.5, subdivision (a) (2), the Department recommended that the petition
22 provided sufficient information to indicate the petitioned action may be warranted.
23
24 On March 6, 2013 at its scheduled public meeting in Mt. Shasta, California, the
25 Commission considered the petition, the Department's petition evaluation and
26 recommendation, and comments received, and found that sufficient information existed
27 to indicate the petition may be warranted and accepted the petition for consideration.
28
29 Subsequently, on March 22, 2013 the Commission published its Notice of Findings for
30 CLH in the California Regulatory Notice Register, designating the CLH as a candidate
31 species (CA Reg. Notice Register 2013, Vol. 12-Z p. 488).

32 **Department Review**

33
34 Following the Commission's action to designate CLH as a candidate species, the
35 Department notified affected and interested parties and solicited data and comments on
36 the petitioned action, pursuant to Fish and Game Code, section 2074.4 (see also Cal.
37 Code Regs., Title 14, § 670.1(f)(2)) (CDFW 2013). All comments received are included
38 in Appendix D to this report. The Department commenced its review of the status of the
39 species as required by Fish and Game Code section 2074.6.
40
41 This report reflects the Department's scientific assessment to date of the status of CLH
42 in California. At this point, the report will undergo independent and competent peer
43 review by scientists with acknowledged expertise relevant to the status of CLH. Once
44 peer review is completed Appendix E will contain the specific input provided to the
45 Department by the individual peer reviewers (Cal. Code Regs., Title 14, § 670.1(f) (2)).

1 **BIOLOGY**

2 **Species Description**

3
4 Clear Lake hitch is a member of the cyprinid family (Cyprinidae), growing to 35
5 centimeters (cm) standard length (SL), and with laterally compressed bodies, small
6 heads and upward pointing mouths (Moyle et al. 1995). They are separated from other
7 California minnows by their long anal fin consisting of 11 to 14 rays. The dorsal fin (10
8 to 12 rays) originates behind the origin of the pelvic fins. Juvenile CLH have a silver
9 coloration with a black spot at the base of the tail. As CLH grow older the spot is lost
10 and they appear yellow-brown to silvery-white on the back. The body becomes deeper
11 in color as the length increases (Hopkirk 1973; Moyle 2002). CLH show little change in
12 pigmentation during the breeding season (Hopkirk 1973). The deep, compressed body,
13 small upturned mouth, and numerous long slender gill rakers (26 to 32) reflect the
14 zooplankton-feeding strategy of a limnetic forager (Moyle 2002). This lake adapted
15 subspecies also has larger eyes and larger scales than other hitch subspecies.

16 **Taxonomy**

17
18 Hopkirk (1973) described CLH as a lake-adapted subspecies based primarily on the
19 greater number of fine gill rakers. CLH are distinguished from other subspecies of hitch
20 by their deeper body, larger eyes, larger scales and more gill rakers (Hopkirk 1973).
21 Recent research on 10 microsatellite loci supports Hopkirk’s description of CLH as a
22 distinct subspecies (Aguilar et al. 2009). However, mitochondrial DNA analysis has not
23 been able to distinguish CLH as a distinct subspecies from other hitch in California.
24 Yet, based upon the morphological and microsatellite analysis there is sufficient
25 evidence to warrant the designation of CLH as a distinct subspecies of hitch (Hopkirk
26 1973; Moyle et al. 1995; Aguilar et al. 2009).

27
28 CLH can hybridize with other Cyprinidae species and hybridization is known to occur
29 with the genetically similar California roach (*Lavinia symmetricus*) (Miller 1945b; Avise
30 and Ayala 1976; Moyle and Massingill 1981; Moyle et al. *in review*). However, there is
31 no documentation of these hybrids in Clear Lake. CLH were known to hybridize in
32 Clear Lake with the now extinct thickettail chub (*Gila crassicauda*) (Moyle et al. *in review*).

33 **Range and Distribution**

34
35 The entire CLH population is confined to Clear Lake, Lake County, California, and to
36 associated lakes and ponds within the Clear Lake watershed such as Thurston Lake
37 and Lampson Pond (Figure 1). Populations previously identified in the Blue Lakes, west
38 of Clear Lake, have apparently been extirpated (Macedo 1994).

39
40 **Figure 1.** Map depicting the Clear Lake watershed.

41
42
43
44 **Life History**

45

Comment [JS1]: Blue Lakes, Thurston Lake, and Lampson Pond are small and not a substitute for the Clear Lake population. However, their ecology and status may give insight into factors involved in Clear Lake. Why was the Blue Lakes population extirpated?
Comment [JS2]: Can Blue Lakes be included in the map?

1 Physical adaptations to lake conditions allow CLH greater than 50 millimeters (mm) SL
2 to feed almost exclusively on water fleas (*Daphnia* spp.) (Geary 1978; Geary and Moyle
3 1980; Moyle 2002). Stomach analysis indicates that CLH feed primarily in the day
4 rather than at night (Geary 1978). Juveniles less than 50 mm SL are found in shallow,
5 littoral zone (near-shore) waters and feed primarily on the larvae and pupae of
6 chironomidae; planktonic crustaceans including the genera *Bosnia* and *Daphnia*; and
7 historically on the eggs, larvae, and adults of Clear Lake gnat (*Chaoborus astictopus*)
8 (Lindquist et al. 1943; Geary 1978; Geary and Moyle 1980). Growth in CLH is faster
9 and total size greater than that of other hitch subspecies (Nicola 1974). By three
10 months CLH have reached 44 mm SL and will continue to grow to between 80 to 120
11 mm by the end of their first year (Geary and Moyle 1980). Females become mature by
12 their second or third year, whereas males tend to mature in their first or second year
13 (Kimsey 1960). Females grow faster and are larger at maturity than males (Hopkirk
14 1973; Geary 1978; Ringelberg and McGinnis 2009). The larger size of CLH in
15 comparison to hitch from other locations translates to greater fecundity. Accordingly,
16 spawning females in Clear Lake average 36,000 eggs each year (Geary and Moyle
17 1980) compared to an average of 26,000 eggs for hitch in Beardsley Reservoir (Nicola
18 1974).

19
20 Clear Lake tributaries are numerous and located around the lake basin (Figure 1). Most
21 streams have headwaters at higher elevations in the surrounding foothills; others have
22 headwaters in lower elevations of the basin, and nearly all have low gradients. Some
23 streams are more substantial than others with flowing water year round. Most are
24 seasonal with remnant pools occurring by late spring, and subsequently dry during
25 summer months. Those that retain water year round often have long stream reaches
26 that are ephemeral. CLH spawn in these low-gradient tributary streams and form
27 spawning migrations that resemble small scale salmon runs. Spawning migrations
28 usually occur in response to heavy spring rains, from mid-February through May and
29 occasionally into June (Murphy 1948b; Kimsey 1960; Swift 1965; Chi Council for Clear
30 Lake Hitch (CCCLH) 2013 (unpublished data)). During wet years, CLH spawning
31 migrations may also opportunistically extend into the upper reaches of various small
32 tributaries, drainage ditches, and even flooded meadows (Moyle et al. *in review*). CLH
33 have also been observed spawning along the shores of Clear Lake, over clean gravel in
34 water 1 to 10 cm deep where wave action cleans the gravel of silt (Kimsey 1960). The
35 success of these atypical spawning areas is not clearly understood and may be limited
36 due to losses from egg desiccation and juvenile predation (Kimsey 1960; Rowan, J.
37 personal communication, October 10, 2013, unreferenced).

38
39 CLH spawn at water temperatures of 14 to 18°C in the lower reaches of tributaries. Egg
40 deposition occurs along the margins of streams in very shallow riffles over clean, fine-
41 to-medium sized gravel (Murphy 1948b; Kimsey 1960). Eggs are fertilized by one to
42 five males as they are released from the females (Murphy 1948b; Moyle 2002). Eggs
43 are non-adhesive and sink to the bottom after fertilization, where they become lodged
44 among the interstices in the gravel. The eggs immediately begin to absorb water and
45 swell to more than double their original size. This rapid expansion provides a protective
46 cushion of water between the outer membrane and the developing embryo (Swift 1965)
47 and may help to secure eggs in gravel interstices. The embryos hatch after
48 approximately 7 days, and larvae become free-swimming after another 7 days (Swift

Comment [JS3]: Longevity may be an important issue. Longevity based upon scales appears to be 4-6 years (Geary 1978, Moyle 2002), but the periodically relatively high population sizes are often spaced farther apart than that. Have otoliths been examined to determine if hitch in Clear Lake live much longer than scales indicate (due to little growth in old fish), as has been demonstrated in a number of lake fishes, such as Tui chubs, Cui ui, tahoe suckers, etc. This may explain how hitch have managed to persist despite infrequent good reproductive success.

1 1965). Larvae must then move downstream to the lake before stream flows become
2 ephemeral (Moyle 2002).

3
4 Within Clear Lake, larvae remain near shore and are thought to depend upon stands of
5 tules (*Schoenoplectus acutus*) and submerged weeds for cover until they assume a
6 limnetic lifestyle (CDFG 2012). Juvenile CLH require rearing habitat with water
7 temperatures of 15° C or greater for survival (Moyle 2002; Franson 2012 and 2013).
8 Juveniles are found in littoral shallow-water habitats and move into deeper offshore
9 areas after approximately 80 days, when they are between 40 to 50 mm SL (Geary
10 1978; CDFG 2012). Adult CLH are usually found in the limnetic zone (well-lit, surface
11 waters away from shore) of Clear Lake. The limnetic feeding behavior of adult fish is
12 supported by stomach analysis of CLH where very little content of benthic midges was
13 found, even though the fish were collected in the profundal (deep-water) habitat during
14 the survey (Cook et al. 1964). Additional data collected by the Department during the
15 early 1980s indicates CLH are present in the littoral zone from April to July and are
16 absent from this habitat during other months (Week 1982).

17
18 Adult CLH are vulnerable to predation during their spawning migration by mergansers
19 (*Mergus* spp.), herons (*Ardea* spp.), bald eagles (*Haliaeetus leucocephalus*), and other
20 birds, river otter (*Lontra canadensis*), northern raccoon (*Procyon lotor*), and striped
21 skunk (*Mephitis mephitis*) (Bairrington 1999). In addition, CLH have been recovered
22 from the stomachs of black bass (*Micropterus* spp.) caught in the lake (Bairrington
23 1999). Most predation by black bass likely occurs during spring staging periods as CLH
24 congregate and begin to ascend tributaries to spawn (Rowan, J. personal
25 communication, October 10, 2013, unreferenced).

26 **Habitat that May be Essential to the Continued Existence of the Species**

27
28 At various life stages CLH utilize stream and lacustrine (lake) habitat present in the
29 watershed (Figure 1). Adult fish spawn in the tributaries of the lake during the spring
30 and juvenile fish emerge from the tributaries and utilize near shore habitats to continue
31 growth and seek refuge from predators. As juveniles mature into adults they move to
32 the main body of the lake and assume a limnetic lifestyle until returning to spawn in the
33 tributaries the following spring.

Comment [JS4]: Based upon habitat uses by most hitch compared to inland silverside and largemouth bass, is the limnetic zone a relative refuge; are spawning success and survival of juveniles in tule beds and other shoreline habitats the major potential problems. Are data available to answer this question?

34 **SPECIES STATUS AND POPULATION TRENDS**

35
36 An assessment of the status of CLH should include statistically valid population
37 estimates conducted over time, to provide population data and trends. CLH studies to
38 date have consisted primarily of qualitative sampling and are not suitable for deriving
39 population estimates; however, these study results can provide insight into the current
40 status of the species.

41
42 The population trends for this status review focus on three sets of data available to the
43 Department for analysis. First, commercial catch records, submitted to the department
44 by operators on Clear Lake, contain incidental catch information on CLH dating back to
45 1961. Operators were required to keep records of CLH caught incidentally while

1 operations focused on other species in the lake. Second, the Lake County Vector
2 Control District (LCVCD) has been conducting sampling efforts along the shoreline of
3 Clear Lake since 1987. Although sampling efforts are not specific to CLH, LCVCD
4 recorded incidental data on CLH captured during each sampling. Third, spawning
5 observation data have been collected by volunteers with the CCCLH since 2005.
6 Spawning observation data provide an estimate of the number of CLH in any given
7 spawning tributary during the observation period. Results are summarized by the
8 CCCLH each year following the completion of the spawning season. Information on
9 population trends prior to 1961 is focused on small sampling efforts, published articles,
10 and traditional ecological knowledge from tribal members. Although not quantifiable,
11 this data provides an idea of the status and distribution of CLH prior to larger qualitative
12 sampling efforts.

Comment [JS5]: Is the commercial fishing effort that supplies important incidental catch numbers quantifiable or was it reasonably similar among years. You are using number of days commercial operations occurred—is that a good measure of effort among years? The incidental catch numbers may be very misleading if effort was substantially different among years; can the incidental catch be converted to catch per unit effort to provide a more useful index?

13
14 Environmental conditions required for successful spawning and biological impacts to the
15 survivorship of CLH are highly variable from year to year and often result in multiple
16 years with reduced spawning success or reduced recruitment into the population. The
17 information presented in Figure 2 comes from the three qualitative sampling efforts
18 conducted at Clear Lake and measured rainfall totals during the past 52 years in the
19 watershed. Trend data in commercial catch records were represented for a given year
20 by totaling the number of CLH captured per year and dividing by the number of days
21 commercial operations occurred. Commercial catch data are comprised primarily of
22 adult CLH. The CLH spawning trend data were calculated by totaling the number of
23 CLH observed and dividing by the number of observation periods. LCVCD data on CLH
24 captures represent the total number of CLH captured per year. LCVCD data is
25 comprised primarily of juvenile CLH. The data represented from Table 6 of CDFG
26 (1999) were calculated by using 20,000 as a total catch baseline for percent of total
27 catch for CLH. Total rainfall data for January to June of each year was measured at the
28 Clear Lake Highlands and U.S. Geological Survey rainfall gauges. Figure 2 does not
29 reflect population numbers but rather trends in the abundance of CLH in any given year.
30 As a proxy for changes in an established population size, biologists often use qualitative
31 information as an indicator of population trends.

Comment [JS6]: Rainfall totals or January – June totals (figure 2) are not a good index of stream runoff conditions during the mid-February to May period when hatch are spawning and fry are moving down to the lake (they certainly don't match my experience with streamflow conditions in the central coast for the last 1- 2 decades). A better proxy would be runoff totals (or days over 10 cfs?) at the USGS gage on Kelsey Creek or other available stream gages (Adobe Cr?).

32
33 The trends of all data show a highly variable population that responds both positively
34 and negatively to environmental parameters and varies significantly from year to year.
35 Rainfall totals do not appear to be significantly correlated to the abundance of CLH
36 during the timeframe. It is likely that a combination of environmental factors is
37 impacting the CLH population. The fluctuating abundance trend has continued
38 throughout the duration of the qualitative sampling efforts and indicates CLH
39 populations have at times been extremely low and at other times relatively robust.
40

Comment [JS7]: See comment above

Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis.

Comment [JS8]: See rainfall comment above

DRAFT

1 In 2013 the Department conducted a mark-and-recapture study to gain a better
2 understanding of the CLH spawning population in Cole and Kelsey creeks.
3 Unfortunately, too few individuals were marked and recaptured to give a statistically
4 valid population estimate (Ewing 2013). Electrofishing surveys in June 2012 identified
5 thousands of young of year CLH in near shore habitats along the southwestern
6 shoreline of Clear Lake (CDFG 2012). Volunteers with the CCCLH conducted direct
7 observations of CLH in spawning tributaries of Clear Lake in 2013, and spawning
8 observations identified less than 500 CLH present (CCCLH 2013). Of those fish, 300 to
9 400 were found below the Kelsey Creek detention dam. No single day count totaled
10 more than 70 fish in any spawning tributary in 2013 (CCCLH 2013).
11

12 CCCLH qualitative spawning observations between 2005 and 2013 indicated peak
13 single day CLH spawning runs of 1,000 to 5,000 fish (CCCLH 2013), and daily
14 observation averages ranged from 3.5 to 183.1 fish (Figure 2). However, these
15 observations make no distinction between previously counted fish, and it may be more
16 prudent to look at fixed location single day counts from this time period. The highest
17 number of CLH observations recorded was approximately 5,000 during 2005;
18 concurring with beach seine data that demonstrate a higher than average number of
19 CLH caught in 2005 as well (CCCLH 2013; LCVCD 2013). The increased number of
20 juvenile CLH captured in the 2005 beach seine sampling is the likely reason for the
21 increase in adult spawning observations between 2007 and 2009. Appendix A contains
22 summary graphs and figures, prepared by CCCLH, for observations made between
23 2005 and 2013.
24

25 There is sufficient information from these spawning observations to suggest the number
26 of spawning tributaries being used by CLH decreased in 2013 compared to the average
27 from 2005 to 2012 (Figure 3) (CCCLH 2013). However, the data limitations do not allow
28 for quantification of observation time on each creek (survey effort) compared with the
29 number of fish observed to aid in understanding the extent of use in each tributary.
30 Appendix B contains figures depicting the decline in annual spawning runs in Clear
31 Lake tributaries between 2005 and 2013 (CCCLH 2013). Historic accounts and habitat
32 suitability predications suggest that CLH originally spawned, to some degree, in all the
33 tributaries to Clear Lake (Robinson Rancheria Ecological Center (RREC) 2011).
34 However, reports on Pomo geography speak of Pomo tribes in the area travelling to
35 Kelsey Creek to capture CLH and even of war when a tribe tried to divert Kelsey Creek
36 to gain control of the important CLH supply (Barrett 1906; Kniffen 1939). Based on the
37 reports it is unclear to what extent CLH spawned in other tributaries to Clear Lake. It
38 can be surmised the majority of CLH spawning occurred in Kelsey Creek during this
39 period. Over the past eight years the number of occupied spawning tributaries has
40 decreased from a high of 12 in 2006 to three in 2013 (CCCLH 2013). Currently, Adobe
41 Creek seems to have the largest spawning run in the Clear Lake watershed while
42 Kelsey and Cole creeks support smaller spawning runs. Based on historical accounts
43 the primary spawning tributary has shifted from Kelsey Creek to Adobe Creek (Kniffen
44 1939; CCCLH 2013).
45
46
47

1 **Figure 3.** Number of occupied Clear Lake hitch spawning tributaries documented by
2 CCCLH observers between 2005 and 2013.

Comment [JS9]: The number of occupied spawning tributaries seems to track pretty closely with runoff during March through May. 2005 and 2006 and 2010 and 2011 were the et years for spring runoff and hitch access. 2007 and 2013 were the dry years with winter/spring stream flow dropping quickly. 2012 was relatively dry, but the majority of stream flow was late (March and April).

This chart would benefit by graphing both the number of streams and the mid-February to May rainfall total or number of days above a threshold flow.

3
4 LCVCD has been collecting beach seine data at various sites around the lake for more
5 than two decades. The sampling is designed to measure abundance of threadfin shad
6 (*Dorosoma petenense*) and inland silversides (*Menidia beryllina*) as part of a Clear Lake
7 gnat (*Chaoborus astictopus*) surveillance program. Incidental captures of CLH are
8 recorded during these surveys; however, the data collected are not appropriate for a
9 statistically valid evaluation of CLH populations as the sample design varies significantly
10 in timing, water quality conditions, and lake depth during surveys. Additionally, sample
11 locations are in areas that contain open unvegetated beaches that are not preferred
12 habitat for CLH. Although surveys were not conducted to assess CLH, capture data for
13 these surveys is consistent with other data sources in demonstrating a population that
14 has poor recruitment in many years interspersed with few years of high levels of
15 recruitment (Figure 4) (LCVCD 2013). In most years less than 100 CLH are captured
16 during the surveys (17 of 24 years). Four of the six years when more than 100 CLH
17 were captured were between 2005 and 2010. The greatest numbers of CLH were
18 captured in 1991, a year that was described by the Department as a boom for juvenile
19 fish in the lake (Bairrington 1999). Commercial fisheries data from 1991 also indicate
20 an increase in CLH numbers captured during operations; over 6,000 CLH were
21 captured and released by commercial fishery operators between March and May in
22 1991 (CDFW Commercial Fisheries Data). Data from the early 1990s also indicate an
23 increase in zooplankton and macroinvertebrate numbers resulting in increased available
24 forage for CLH (Winder et al. 2010).

25
26
27 **Figure 4.** Summary of Clear Lake hitch captured during Lake County Vector Control
28 District beach seine surveys conducted from 1987 to 2010.

29
30 The data available to the Department that cover the greatest timeframe come from
31 commercial harvest records for Clear Lake. These data, 1961 to 2001, provide
32 estimates of CLH numbers captured incidentally during operations (Figure 5). Multiple
33 times throughout the past 50 years the number of CLH captured has surpassed 10,000
34 fish. There are also several years where CLH were almost or entirely absent from
35 sample collections. These data suggest that CLH can sustain a population through
36 multiple years of suppressed spawning or recruitment or both.

Comment [JS10]: Too bad the commercial harvest had not continued soo that we would have recent data.

37
38
39 **Figure 5.** Number of Clear Lake hitch captured incidentally during commercial
40 harvest operations between 1961 and 2001.

41
42
43 In the 1980s, the Department began sampling Clear Lake fishes to assess native and
44 sport fish populations in the lake. Surveys found CLH occupying littoral habitats
45 between April and July each year (Week 1982). The surveys were directed towards
46 littoral zone use and provide no information on CLH outside of those months (Week
47 1982). An electrofishing survey was completed in April of 1987, and CLH was the most
48 abundant fish sampled at locations around Rattlesnake Island and Clearlake Oaks

1 subdivision; however, only a total of 52 CLH were captured during the survey (CDFG
2 1988). It must be noted that this sampling was on a very small scale, targeted black
3 crappie (*Pomoxis nigromaculatus*), and occurred in habitats where CLH would likely be
4 found during this time period. Additional spring and fall sampling between 1995 and
5 2006 found CLH to be the most abundant native fish, but the overall capture numbers
6 were relatively low with a peak catch per unit effort (CPUE) of only 0.087 for juvenile
7 fish in the fall of 2000 and 0.169 for adult fish in the spring of 1999. CPUE's were based
8 on the number of fish caught per minute of electrofishing (Cox 2007). Electrofishing
9 surveys conducted during late June 2007 reported low numbers of CLH recorded during
10 the survey (Rowan 2008). The low numbers of CLH may be attributed to the sampling
11 timeframe in late June. As noted in Cook et al. 1964, CLH were absent from littoral zone
12 sampling following the start of summer. In an effort to reduce impacts to CLH while
13 sampling, the Department's Clear Lake surveys between 2008 and 2012 were all
14 confined to the timeframe of late June and July when CLH numbers are greatly reduced
15 in the littoral zone.

Comment [JS11]: Most abundant, but only 52 CLH captured? Electrofishing the small juveniles may not be an effective sampling technique. Trap nets?

16
17 As late as 1972, CLH and other nongame fish were described as comprising the bulk of
18 the Clear Lake fishery (Puckett 1972). The Lake County Mosquito Abatement District
19 conducted surveys between 1961 and 1963 examining the relationship between fish
20 and midges. These surveys identified CLH as the third most abundant fish in the lake.
21 The majority of CLH were captured in the littoral and profundal zones using gill nets.
22 However, the limnetic zone was not sampled since midges do not occur in this area. A
23 total of 1,229 fish was taken during these surveys (Cook et al. 1964).

Comment [JS12]: It appears to concerns about mortality eliminated sampling during the crucial period of CLH juvenile use of the littoral zone, so you did not get the necessary data. Isn't the data worth some incidental mortality?

If the species is listed, such an approach in collecting permits and monitoring may cripple effective monitoring needed to track population status. Similarly, it seems that the incidental catch data in the commercial harvest was extremely valuable data; can a resumption of carp and blackfish commercial harvest be encouraged to produce hitch data?

24
25 Field notes from CDFG biologists in 1955 note CLH runs with large numbers in Kelsey
26 Creek (CDFG 1955). Similar notes from 1956 indicate spawning CLH in Kelsey Creek
27 as numbering in the hundreds and Seigler Creek containing 400 CLH for every 100 feet
28 of stream above the Anderson Brothers ford (CDFG 1956). CLH were the second most
29 abundant fish caught during various gill net surveys in the lake at that time (Lindquist et
30 al. 1943). Surveys conducted between 1938 and 1941, for examination of fish and gnat
31 interactions, describe the runs of Sacramento splittail (*Pogonichthys ciscooides*) and
32 CLH as numbering in the tens of thousands (Lindquist et al. 1943). A photograph from
33 1890 depicts a spawning run so thick that CLH formed a blanket across the creek
34 (Figure 6). Early stories from the area describe fish runs so thick that streams were
35 difficult to ford by horses and wagons, and residents shoveled spawning fish to bring
36 home for hog feed (Rideout 1899). The volume of dead fish found during spawning
37 runs on Clear Lake tributaries created a stench that was intolerable to lakeshore
38 residents (Dill and Cordone 1997). It is not entirely clear if spawning runs such as those
39 depicted in Figure 6 occurred every year or fluctuated based on tributary flows, but it is
40 likely they fluctuated in a similar fashion to what was observed during the past decade
41 of CCCLH spawning surveys. Regardless, the body of evidence lends support for
42 claims of CLH as common and the most abundant fish in Clear Lake during the late
43 nineteenth and early twentieth centuries (Coleman 1930; Jordan and Gilbert 1894).

1 **Figure 6.** Photo from 1890s depicting spawning CLH being stranded in Kelsey
2 Creek.
3

4 **FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE**

5

6 **Present or Threatened Modification or Destruction of Habitat**

7

8 **Wetland Habitat Loss**

9

10 Wetlands provide critical rearing habitat for juvenile fishes native to Clear Lake (Geary
11 1978; CDFG 2012). Prior to the arrival of European settlers in the mid-1800s, Clear
12 Lake was surrounded by large tracts of wetlands. Throughout the expansion of
13 European settlements around the lake, the wetland habitat was drained and filled to
14 provide urban and agricultural lands. Currently, the Clear Lake watershed contains over
15 16,000 acres of land dedicated to agricultural production (Lake County Department of
16 Agriculture 2011; Forsgen Associates Inc. 2012). Comparisons of historical versus
17 current wetland habitat reveal a loss of approximately 85%, from 9,000 acres in 1840 to
18 1,500 acres by 1977 (Week 1982; Bairrington 1999; Suchanek et al. 2002; ; Lake
19 County Department of Public Works 2003; Giusti 2009; CEPA 2012). Loss of wetland
20 habitat coupled with competition for existing habitat with introduced fishes has led to a
21 decline in available rearing habitat for juvenile CLH (Week 1982).

22 **Spawning Habitat Exclusion and Loss**

23

24 ***Dams, Barriers, and Diversions***

25

26 Cache Creek Dam was constructed at the outlet of Clear Lake in 1915, and Yolo County
27 Flood Control and Water Conservation District (YCFCWCD) manipulates the lake water
28 level several feet seasonally to allow for diversions for irrigation (CDWR 1975). Clear
29 Lake is allowed to fluctuate on a yearly basis, a maximum of 7.56 feet above a mean
30 level plane referred to as the "Rumsey gage" (CDWR 1975). The effects of lake water
31 manipulations on CLH populations have not been quantified. Manipulation of water
32 levels in the Clear Lake watershed likely results in decreased water quality, a reduction
33 in spawning and rearing habitat, and increased risk of predation (Converse et al. 1998;
34 Wetzel 2001; Gafny et al. 2006; Cott et al. 2008; Hudon et al 2009). All of these
35 impacts can lead to the extinction of native species that evolved in lakes free of habitat
36 modifications resulting from impoundment structures (Wetzel 2001). Impounded
37 systems also tend to be dominated by non-native species (Moyle and Light 1996).

38
39 CLH spawn in low-gradient tributary streams to Clear Lake. All of the tributary streams
40 to Clear Lake have been altered (Appendix C) to various degrees by dams, barriers,
41 and diversions. Stream alterations can block migratory routes and decrease stream
42 flows necessary for spawning. The result can be loss of spawning and rearing habitat,
43 loss of nursery areas, increases in predation, competition from non-native aquatic

1 species, and decreased water quality (Murphy 1948 and 1951; Moyle 2002;). A limited
2 physical habitat analysis survey was conducted in 2013 on Adobe, Kelsey, Manning,
3 Middle, and Scotts creeks. Results of the survey indicate all of the creeks had low
4 Index of Biological Integrity (IBI) scores and are either partially or not supportive of
5 aquatic life (Mosley 2013). Examples of alterations to Clear Lake tributaries that have
6 impacted CLH include agricultural irrigation pumps and diversions, aggregate mining
7 activity, flood control structures, road crossings, bridge aprons, and off-highway vehicle
8 (OHV) use (McGinnis and Ringelberg 2008).

Comment [JS13]: Not in references

9
10 Adobe Creek, Highland Creek, Middle Creek, Clover Creek, and Kelsey Creek have
11 experienced a reduction in fish spawning habitat since the installation of dams and
12 increased irrigation (Murphy 1951; Macedo 1994; McGinnis and Ringelberg 2006). A
13 barrier assessment was completed in 2006 for Middle Creek and the Kelsey Creek fish
14 ladder (McGinnis and Ringelberg 2006). The assessment found physical barriers to fish
15 migration were associated with bridge aprons and weirs as well as habitat barriers from
16 historical gravel operations (McGinnis and Ringelberg 2006). The Kelsey Creek fish
17 ladder was found unsuitable for passage of CLH. The jump heights and velocities at the
18 ladder were determined to be too great for CLH (McGinnis and Ringelberg 2006).
19 Spawning observations by CCCLH from 2005 to 2013 witnessed fish stranded below
20 multiple barriers within the watershed (CCCLH 2013).

21
22 Many Clear Lake tributaries are no longer used for spawning or have reduced spawning
23 runs as a result of artificial structures that continue to impede spawning migrations
24 (Figure 7). While some operational and physical modifications to these structures have
25 been implemented over the years, they continue to adversely impact spawning CLH,
26 especially during dry years when spring stream flows are low.

27
28 In preparation of this report, the Department estimated the loss of CLH spawning and
29 rearing habitat due to constructed barriers and impediments within the tributaries to
30 Clear Lake (Figure 7). The barrier assessment determined the approximate locations of
31 barriers and estimated miles of stream habitat as determined from the California Native
32 Diversity Database, CDFW Geographic Information System, CDFW Fish Passage
33 Assessment Database, California GIS street layer, and Google Earth Maps. Using that
34 data, the Department estimated 180 river miles were historically available to spawning
35 CLH and that barriers have eliminated or reduced access to greater than 92% of the
36 historically available spawning habitat. Physical barriers, such as the footings of
37 bridges, low water crossings, dams, pipes, culverts, and water diversions in Kelsey,
38 Scotts, Middle, Clover, and other creeks interrupt or eliminate migration to spawning
39 areas (McGinnis and Ringelberg 2008). Appendix C contains a list of several tributaries
40 and some of their associated barriers.

41
42
43
44 **Figure 7.** Clear Lake hitch spawning barriers located on tributaries throughout
45 the watershed.

46
47 Water is frequently diverted from Clear Lake tributaries, during the CLH spawning
48 season, under riparian rights associated with land ownership in the watershed. These

1 water diversions consist of direct diversion from surface water intake pumps and from
2 shallow off-channel wells that capture groundwater flows. The primary purpose of water
3 diversions from Clear Lake tributaries is for agricultural production and frost protection.
4 Water diversions for frost protection have been shown to temporarily reduce in-stream
5 flow by as much as 95% (Deitch et al. 2009). Natural flow regimes are thought to favor
6 the success of native fishes over non-native fishes (Marchetti and Moyle 2001). The
7 impact of diversion on CLH spawning tributaries is poorly understood. In some
8 tributaries, water diversion has contributed to early drying of stream reaches and
9 desiccation of CLH eggs masses and newly hatched juveniles (Macedo, R., personal
10 communication, November 25, 2013, unreferenced). Additionally, significant flow
11 reductions can lead to increased water temperatures, reduced available aquatic habitat,
12 altered or decreased biodiversity, increases in non-native species, and alterations to
13 fish assemblages (Marchetti and Moyle 2001; Bunn and Arthington 2002; Bellucci et al.
14 2011).

15
16 The impacts of spawning habitat alterations to CLH may be inferred by the fate of
17 another native Clear Lake fish that required tributaries for spawning; the Clear Lake
18 splittail was last recorded in 1972 (Puckett 1972). The Clear Lake splittail formerly
19 spawned later in the season than did CLH, and the drying up of tributaries contributed to
20 their demise (Moyle 2002). All stream spawners had “declined precipitously” by 1944
21 (Murphy 1951). Therefore, earlier drying of tributaries by both natural and
22 anthropogenic processes likely impacts the CLH population.
23

24 ***Dredging and Mining***

25
26 Since the first European settlers arrived at Clear Lake and began gravel mining and
27 dredging operations, there have been documented deleterious effects on the watershed
28 (Suchanek et al. 2002). Field notes from CDFG personnel conducting stocking
29 assessments documented Kelsey Creek so loaded with silt from gravel operations that
30 creek visibility was zero (CDFG 1955). Smaller scale mining and dredging in tributary
31 streams has occurred since early settlement and has altered the amount and
32 distribution of stream gravels (Thompson et al. 2013). In some tributaries, gravel
33 extraction has resulted in the incising and channelizing of the streams and stream level
34 changes by as much as 15 feet (Suchanek et al. 2002; Eutenier, D. April 17, 2013
35 comment letter). After 1965 about one million metric tons of gravel products per year
36 were removed from the watershed until the partial moratorium on aggregate mining in
37 1981 (Richerson et al. 1994). Gravel was removed from Clear Lake tributaries to
38 provide road base for new roads created to accommodate the expanding population of
39 the area (Suchanek et al. 2002). Currently, approximately 58 acres in the Clear Lake
40 watershed are used for mining purposes (Forsgren Associates Inc. 2012).
41

42 Many areas along the tributaries to Clear Lake were channelized in response to
43 frequent flooding during the late winter and early spring (Maclanahan et al. 1972; U.S.
44 Army Corps of Engineers 1974). As a result of gravel extraction and channelization,
45 some areas were covered with riprap or confined by levees to prevent further erosion
46 and flooding. Erosion problems have contributed to sediment entering Clear Lake and
47 providing increased phosphorous loads that impair water quality (Richerson et al. 1994).

1 Gravel extraction results in channelization and down cutting of the stream bank, a
2 decrease in suitable spawning habitat, and increasing flow velocity and amount of
3 coarse material that passes through the system (Brown et al. 1998).

4 **Water Quality Impacts**

5
6 The Clear Lake watershed has seen a significant increase in the amount of
7 contaminants entering the lake over the past 75 years (Richerson et al. 1994). An
8 increase in agriculture and mining, and a shift to an urban environment, has resulted in
9 adverse water quality impacts in the lake (Mioni et al. 2011; California Environmental
10 Protection Agency [CEPA] 2012).

11
12 Erosion from construction, dredging, mining, agriculture, OHV use, grazing, and
13 urbanization has resulted in increased sediment loads to the Clear Lake watershed
14 (Forsgren Associates Inc. 2012). Increased sediment loads transport nutrient rich soil,
15 particularly phosphorous, into Clear Lake and reduce spawning habitat by increasing
16 substrate “embeddedness” (Mosley 2013). During the late 1990s and early 2000s soil
17 erosion and sedimentation became an increasing problem as existing agricultural lands
18 were converted to vineyards (Forsgren Associates Inc. 2012). From 2002 to 2011
19 vineyard acreage in the Clear Lake watershed increased from approximately 5,500
20 acres to 8,000 acres (Lake County Department of Agriculture 2011).

21
22 Development and expansion of extensive agriculture in the Clear Lake watershed
23 during the late 1890s until present day reclaimed the lake’s natural wetland filtration
24 system for agricultural use. An increase in agricultural production and a decrease in
25 wetland filtration increased nutrient flows into Clear Lake. Wetland reclamation projects
26 altered the transport of sediment and nutrients, particularly phosphorous, into Clear
27 Lake, resulting in an increase in noxious cyanobacteria blooms that cover the lake in
28 warmer months (Suchanek et al. 2002). As a result of continued water quality issues,
29 Clear Lake was added to the Clean Water Act Section 303(d) list of impaired water
30 bodies in 1988 (CEPA 2010 and 2012). In recent years, noxious cyanobacteria blooms
31 have at a minimum remained constant and may have increased (CEPA 2012).

32
33 Cyanobacteria blooms have occurred at Clear Lake since the mid-1900s. Studies
34 indicate an increase in phosphorous was the driver behind water quality impairments
35 and noxious cyanobacteria blooms (Horne 1975; Richerson et al. 1994; CEPA 2012).
36 The blooms originally consisted primarily of *Microcystis*, but in recent years the blooms
37 have been attributed to both *Microcystis* and *Lyngbya*. These taxa represent both non-
38 nitrogen fixing (*Microcystis*) and nitrogen fixing (*Lyngbya*) cyanobacteria and raise
39 concerns that both phosphorous and nitrogen entering the lake need to be controlled
40 (Mioni et al. 2011; CEPA 2012). Cyanobacteria blooms have the ability to both directly
41 and indirectly impact CLH by direct interference with the growth of *Daphnia*, a limnetic
42 organism that is a food source for adult CLH, and interference with food web efficiency.
43 No studies have been conducted at Clear Lake to quantify the impact of cyanobacteria
44 blooms on the ecosystem, but studies conducted at other water bodies with varying
45 degrees of cyanobacteria blooms provide information on their impacts to the aquatic
46 environment. Cyanobacteria blooms reduce the amount of light penetration in the water
47 column and cause a reduction in producers that are unable to reposition themselves to

1 gain more light (Havens 2008). Organisms such as epiphyton, benthic algae, and
2 rooted vascular plants have a reduced ability to function in the ecosystem as a result of
3 cyanobacteria blooms. As the bacteria alter the nutrient cycle of the lake they replace
4 the producers in space and mass. The expanding bacteria begin to deplete CO₂ from
5 the water body, which increases pH and reduces growth of other producers (Havens
6 2008). The decreased CO₂ and increased pH can create surface scums and result in
7 mortality of fishes, including CLH. In the summer of 1969, a large fish die off, due to
8 heavy cyanobacteria growth and low oxygen levels, was reported at Clear Lake. An
9 estimated 170,000 fish died, consisting primarily of carp, CLH, and blackfish (CDFG
10 News Release 1969). Sub lethal and lethal effects of toxins released during
11 cyanobacteria blooms are also seen in fish and their associated food web (Havens
12 2008).

13
14 On September 19, 2007, the U.S. Environmental Protection Agency (EPA) approved a
15 control program as a nutrient Total Maximum Daily Load (TMDL) for Clear Lake with the
16 goal of reducing point and non-point source phosphorous entering the lake (CEPA
17 2012). Sources for phosphorous entering the lake include agricultural and urban runoff,
18 timber harvest, road maintenance, construction, gravel mining, dredging, and fire.
19 Additional amounts of nutrients from home fertilizers, marijuana grows, sewer, and
20 septic systems cannot be quantified.

21
22 To allow for increased yields on agricultural land and to prevent nuisance insect species
23 around the lake, pesticides became commonplace during the early and mid-1900s. For
24 many decades the Clear Lake gnat, a primary food source for CLH, was targeted with
25 pesticides to reduce its population. Between 1949 and 1957, the Clear Lake gnat was
26 targeted with the pesticide dichlorodiphenyldichloroethane (DDD). During these years it
27 is estimated that 99 percent of the gnat larvae in the lake were killed. Concentrations of
28 DDD were magnitudes higher in invertebrates, fish, and birds than in the surrounding
29 water in which they were found (Lindquist and Roth 1950; Rudd 1964). Sampling
30 conducted during the late 1950s identified CLH, as well as other fish species,
31 contaminated with DDD (Hunt and Bischoff 1960). Contamination levels ranged from
32 5.27 to 115 parts per million (ppm) for edible flesh of sampled fishes (Hunt and Bischoff
33 1960). CLH were at the lower level of DDD contamination for Clear Lake fishes at 10.9
34 to 28.1 ppm for edible flesh content (Hunt and Bischoff 1960). The results of DDD in
35 the Clear Lake watershed resulted in the first major ecological disaster at the lake and
36 the first records of pesticide bioaccumulation in the wildlife of the lake (Suchanek et al.
37 2002).

38
39 Following the resurgence of gnat populations in response to growing resistance to DDD,
40 two additional measures were taken to reduce the gnat population. Gnat eggs were
41 targeted with a petroleum product, and adult gnats were targeted at roosting locations
42 with Malathion. Additional applications of methyl parathion were also made in 1962
43 (Suchanek et al. 2002). Clear Lake gnats are still present at the lake, but populations
44 are significantly reduced from historical levels. The likely cause of the reduced
45 population of gnats is introduced fishes, primarily inland silversides (Suchanek et al.
46 2002). In 2010 and 2012 Clear Lake gnat populations reached levels not seen in
47 decades. These gnat population booms appeared to coincide with years of low
48 population levels of inland silversides (Scott, J. 2013 personal communication, Aug 1,

1 2013, unreferenced). Qualitative sampling data on CLH does not allow for a direct
2 comparison of CLH numbers in years with increases in the gnat population.
3

4 In recent years, two herbicides, Komeen™ (copper sulfate) and SONAR™ (fluridone),
5 have been used extensively to manage the *Hydrilla verticillata* infestation at the lake.
6 Applied concentrations of Komeen™ do not kill fish directly; however, the impacts to
7 macroinvertebrates may indirectly impact CLH populations (Bairrington 1999). These
8 systemic herbicides also pose a threat to non-target vascular aquatic plants, such as
9 tules and submerged vegetation, which juvenile CLH require for rearing habitat. As
10 noted previously, there has already been a significant reduction in wetland habitat
11 around the lake, and any additional reductions would further limit the amount of habitat
12 available for CLH. Initial studies indicate a reduction in tule habitat following SONAR™
13 applications (Bairrington 1999). Environmental monitoring of eradication activities in
14 1996 and 1997 found that invertebrate species declined within the treatment area but
15 rebounded quickly following the toxicity decay of the herbicide (Bairrington 1999). Post-
16 treatment electrofishing surveys noted an increase in the number and abundance of fish
17 species (Bairrington 1999).
18

19 Mining operations within the watershed contributed to sulphur and mercury
20 contamination in Clear Lake. The Sulphur Bank Mercury Mine began operations in
21 1865 and ended in 1957 (Osleger et al. 2008; Giusti 2009). Originally the mine focused
22 on extracting sulphur, but as operations continued into the late 1920s and the sulphur
23 was found to be contaminated with mercury sulfide, operations switched to extracting
24 mercury from the large-scale open-pit mine (Giusti 2009). As a result of contamination,
25 the mine was classified as an EPA Superfund Site in 1990 (Suchanek et al. 1993). The
26 mine is thought to have contaminated the lake with both mercury and arsenic
27 (Suchanek et al. 1993). Studies have found the mercury concentrations in sediment to
28 be high (over 400 ppm) in the vicinity of the mine, decreasing as distance from the mine
29 increases (Suchanek et al. 2002). The mine continues to produce low pH acid mine
30 drainage that delivers sulfate to the lake. Over the past decade, the EPA has taken
31 several actions to remediate contamination from the mine. These include erosion
32 control measures, removal of contaminated soil, storm water diversion, and well
33 capping (U.S. Environmental Protection Agency 2012).
34

35 During the 1970s, elevated concentrations of mercury were found in the fish of the lake
36 (Curtis 1977). Mercury contamination can lead to significant impacts to the reproductive
37 success of fishes and can result in reduced brain function, altered size and function of
38 gonads and reduced gamete production (Sandheinrich and Miller 2006; Crump and
39 Trudeau 2009). In 2003, a mercury TMDL was developed for Clear Lake to reduce
40 methylmercury in fish by reducing overall mercury loads to Clear Lake (CEPA 2010).
41 Levels of mercury found in fish, including CLH, are between 0.06 and 0.32 µg/g (CEPA
42 2002). Concentrations of mercury present in Clear Lake fishes have resulted in health
43 advisories on their consumption, but are below acute toxicity thresholds (Harnly et al.
44 1997). Mercury levels are close to or within the effect thresholds for reproduction and
45 growth for fathead minnow (0.32 to 0.62 µg/g) and rainbow trout (National Oceanic and
46 Atmospheric Administration [NOAA] 2011). Concentrations with no effect on rainbow
47 trout growth and development are 0.02 to 0.09 µg/g (NOAA 2011). Lacking specific
48 studies on CLH, based on surrogate effect levels for fathead minnows and rainbow

1 trout, it is reasonable to suspect that CLH may be experiencing sub lethal chronic and
2 reproductive effects from mercury contamination.
3

4 **Overexploitation**

5

6 **Commercial Harvest**

7

8 Commercial fish harvest at Clear Lake has been occurring since the early 1900s.
9 Harvested fish were distributed to fish markets in California for sale for human
10 consumption and animal feed. Prior to 1941, the majority of commercial operations
11 centered on harvesting catfish (*Ictalurus* or *Ameiurus* spp.) from the lake. Although
12 exact numbers are unavailable, it is likely that large numbers of catfish were taken
13 during this period (Bairrington 1999). In 1942 commercial harvest of catfish was
14 banned at Clear Lake. Beginning in the 1930s commercial harvest focused on
15 Sacramento blackfish (*Orthodon microlepidotus*), a native species, and common carp
16 (*Cyprinus carpio*), a non-native species. From 1932 to 1962 the annual average catch
17 rate was 295,000 pounds for the commercial fishery (Bairrington 1999). A ratio of
18 1.33:1 for blackfish to carp was the average during commercial fishing operations
19 (Bairrington 1999). In 1976 the only recorded capture and sale of CLH for commercial
20 purposes was submitted to the Department, a total of 1,550 pounds was reported
21 captured and sold at market that year (CDFW Commercial Fisheries Data). This is the
22 only instance in the records of CLH being captured for commercial sale, primarily due to
23 lack of interest and low sale price for the species (CDFW Commercial Fisheries Data).
24 By 1960 commercial fishing operators were required to count and release all bycatch
25 from commercial operations. CLH were found in large numbers some years and were
26 recorded and returned to the lake when captured (Figure 5; CDFW Commercial
27 Fisheries Data). The Department has received no commercial permit applications for
28 operations on Clear Lake over the past several years. The lack of permit applications
29 indicates that at this time commercial fishing operations at Clear Lake have ceased
30 (CDFW Commercial Fishing Permit Data).
31

Comment [JS14]: It seems like a resumption of commercial harvest of catfish might subsidize the blackfish and carp fishery and restore the incidental capture data on hitch that have been missing for the last decade.

32 **Cultural Harvest**

33

34 Clear Lake hitch are culturally significant to several Pomo tribes that inhabit the Clear
35 Lake watershed. Two Pomo tribes fought a war over Kelsey Creek and its important
36 CLH supply (Barrett 1906; Kniffen 1939). Historically, large runs of CLH provided a
37 staple food source for the local tribes (RREC 2011). During spawning runs, CLH were
38 captured by constructing a series of dams in the creeks from which the fish were then
39 scooped with baskets. The fish were cured to provide a food source throughout the year
40 (Kniffen 1939). Historical accounts from tribal members speak of CLH being easy to
41 find as they spawned in large numbers in the tributaries to the lake (Scotts Valley Band
42 of Pomo Indians historical accounts 2013). There are no estimates of the number of
43 CLH that were taken for cultural harvest during any specific timeframe. However, an
44 account from a tribal member indicates that, historically, a single family may have taken
45 a couple thousand fish during the spawning runs (Big Valley EPA 2013). Tribal
46 accounts indicate the harvest of CLH continued until the decline in spawning runs in the

1 mid-1980s (Big Valley EPA 2013). Prior to designation of CLH as a candidate species
2 for listing, regulations in the Clear Lake watershed allowed for the harvest of CLH in
3 spawning tributaries by hand or hand-held dip net. In 2013 the Department issued
4 CESA Memoranda of Understanding (Fish and Game Code, § 2081(a)) to three tribes
5 to authorize collection of CLH for scientific research and public education (Kratville, D.
6 personal communication, October 7, 2013, unreferenced).
7

8 **Predation and Competition**

9
10 Non-native fish introductions into Clear Lake date back as far as the late 1800s (Dill and
11 Cordone 1997). Prior to the introduction of non-native fish species, between 12 and 14
12 native fish species occupied Clear Lake (Bairrington 1999; Moyle 2002; Thompson et al.
13 2013). Currently, approximately ten native species and 20 non-native species inhabit
14 the lake (Bairrington 1999; Thompson et al. 2013). Over the past 100 years one native
15 species, thicketail chub (*Gila crassicauda*), has gone extinct and two native species,
16 hardhead (*Mylopharodon conocephalus*), and Clear Lake splittail, have been extirpated
17 from the lake. Sacramento perch (*Archoplites interruptus*), has not been captured in
18 sampling efforts since 1996 (Bairrington 1999; CDFW Commercial Fisheries Data;
19 Thompson et al. 2013). The majority of non-native species introductions have been
20 conducted by the Department, various local agencies, and angling groups in an effort to
21 increase sport fishing opportunities. Introductions of fish at Clear Lake have been
22 warmwater sport fish (black bass, sunfish (*Lepomis* spp.), catfish, etc.) or forage
23 species for piscivorous sport fish. The Department has not stocked fish in Clear Lake in
24 the past decade. The four fish species listed below were introduced without
25 authorization from the Department (Bairrington 1999; Rowan J. personal
26 communication, October 10, 2013, unreferenced). Inland silverside, threadfin shad,
27 smallmouth bass (*Micropterus dolomieu*), and pumpkinseed (*Lepomis gibbosus*) were
28 introduced to provide forage for other game fishes, provide Clear Lake gnat control, or
29 as part of a new sport fishery (Anderson et al. 1986; Dill and Cordone 1997; Bairrington
30 1999). Non-native game fishes comprise nearly 100 percent of the sport catch from the
31 lake. Incidental captures of native species occur infrequently and are rarely recorded
32 during creel and tournament surveys (Rowan J. personal communication, October 10,
33 2013, unreferenced).
34

35 Non-native fish introductions can have significant impacts on native fish species. Inland
36 silverside and threadfin shad are thought to compete directly with CLH for food
37 resources (Geary and Moyle 1980; Anderson et al. 1986; Bairrington 1999). All three
38 species are limnetic foragers that rely on macroinvertebrates for food. There are no
39 direct comparisons, but years with declines in threadfin shad and inland silverside are
40 thought to coincide with increases in CLH numbers, and years with decreased threadfin
41 shad and inland silverside result in increased young of year recruitment for other native
42 and non-native species (Rowan J. personal communication, October 10, 2013,
43 unreferenced). Competition for juvenile rearing habitat has increased with the reduction
44 in wetland habitat and increase in non-native fish species. Rearing habitat is essential
45 for CLH recruitment to any year class. A reduction in recruitment leads to a decrease
46 in spawning adults in the following years. A species with highly fluctuating population
47 trends, such as CLH, is particularly vulnerable to population level impacts in years with

1 reduced recruitment. Piscivorous fish species such as largemouth bass (*Micropterus*
2 *salmoides*) prey directly on both juvenile and adult CLH. Although no comprehensive
3 diet studies have been done, incidental data indicate that CLH are found in the
4 stomachs of piscivorous species in the lake (Moyle et al. in progress). Omnivorous
5 species such as catfish (*Ameiurus* spp.) are known to prey on various life stages of
6 native fishes. It is suggested that the introduction of catfish to Clear Lake may have
7 played a role in the decline of native fish species (Dill and Cordone 1997). The
8 introduction of catfish was described, by Captain J.D. Dondero of the Division of Fish
9 and Game, as having solved the problem of large spawning runs of fish dying in
10 tributaries to Clear Lake and that the population of nongame fish diminished following
11 their introduction (Dill and Cordone 1997). Jordan and Gilbert (1894) also describe
12 catfish as being destructive to the spawn of other species. The rates at which CLH are
13 consumed in relation to other prey species and the amount of CLH consumed are
14 unknown. It is likely that during years when alternative prey abundance is low, CLH
15 predation increases (Eagles-Smith et al. 2008).
16

17 **Disease and Parasites**

18
19 Disease outbreaks in fishes have been known to occur at Clear Lake. The outbreaks
20 are primarily koi herpes virus (KHV) and it affects introduced carp and goldfish. Native
21 minnows, including CLH, show no effects from KHV. Fish fungi (*Saprolegnia* spp.) have
22 been observed on fishes captured in Clear Lake and results from physical injury or
23 infection. CLH are susceptible to fish fungi but it is not readily observed in captured
24 fish. All fish in Clear Lake are susceptible to anchor worms (*Lernaea* spp.) and heavy
25 infestations can lead to mortality. No CLH with heavy anchor worm infestations have
26 been observed during CDFW fishery surveys at Clear Lake (Rowan J. personal
27 communication, October 10, 2013, unreferenced). The Big Valley Rancheria Band of
28 Pomo Indians has documented light loads of anchor worms occurring on CLH (Big
29 Valley Rancheria 2012 and 2013).
30

31 **Other Natural Occurrences or Human Related Activities**

32 **Climate Change**

33
34 It is likely that native fishes in California will be vulnerable to physical and chemical
35 changes as a result of climate change (Moyle et al. 2012). Research has shown that
36 the annual mean temperature in North America has increased between 1955 and 2005
37 and is predicted to continue increasing in the future (Field et al. 1999; Hayhoe et al.
38 2004); however, it varies across North America, is more pronounced in spring and
39 winter, and has affected daily minimum temperatures more than daily maximum
40 temperatures (Field et al. 2007). In general, climate change models for California
41 indicate an increase in overall air temperature, decreased and warmer rainfall, and an
42 increase in overall water temperatures (California Climate Change Center [CCCC]
43 2012). Cold storms are expected to decrease, giving way to warmer storms that create
44 earlier run-off and less water storage capabilities (Field et al. 1999; Hayhoe et al. 2004;
45 CCCC 2012). Climate change in the Clear Lake watershed is likely to cause some
46 changes to the interannual variability in rainfall. The change in rainfall variability would

1 likely increase the occurrence of drought and flood years (Clear Lake Integrated
2 Watershed Management Plan [CLIWMP] 2010). Expected climate change impacts to
3 California and the Clear Lake watershed will be significant during annual CLH spawning
4 cycles. CLH require winter and spring storms that provide suitable spawning flows in
5 the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff could
6 significantly impact the ability of CLH to successfully spawn. A climate driven change in
7 the Clear Lake watershed could result in the loss of spawning habitat, reduced access
8 to spawning habitat, stranding of spawning and juvenile fish, and egg desiccation.

9
10 A report on the projected effects of climate on California freshwater fishes, prepared for
11 the California Energy Commission's California Climate Change Center, determined CLH
12 to be critically vulnerable to impacts from climate change (Moyle et al. 2012). The
13 report evaluated criteria such as population size, population trends, range, lifespan, and
14 vulnerability to stochastic events to identify the degree of vulnerability of each fish
15 species. The Intergovernmental Panel on Climate Change has stated that of all
16 ecosystems, freshwater ecosystems will have the highest proportion of species
17 threatened with extinction due to climate change (Kundzewicz et al. 2007). Freshwater
18 lake species are more susceptible to extirpation because they are unable to emigrate
19 should habitat changes occur (CA Natural Resources Agency 2009).

21 **Recreational Activities**

22
23 The natural resources of the Clear Lake watershed are a tremendous recreational
24 resource for residents and visitors to Lake County. As the largest freshwater lake
25 wholly in California, with opportunities for multiple aquatic recreational activities, the
26 lake receives tens thousands of visitors per year. According to 2008 data acquired from
27 Lake County quagga mussel (*Dreissena rostriformis*) inspection sticker application
28 forms; there were 11,230 boats that visited the lake that year. Jet skis and pleasure
29 boats accounted for 41 percent of the boating activity at the lake (CLIWMP 2010).

30
31 Permanent structures, associated with boat docks, boat ramps, and swimming beaches,
32 have reduced littoral zone habitat around the lake. These structures require clearing of
33 littoral zone habitat to maintain access for recreational boaters and swimmers. It is
34 estimated that there are over 600 private boat docks and boat ramps on the lake
35 shoreline. In addition to reducing littoral zone habitat these structures provide additional
36 habitat for non-native sport fish, such as largemouth bass, that prey on CLH.

37
38 Recreational and tournament angling generate a significant amount of the activity in the
39 Clear Lake aquatic environment. In 2008, 18 percent of all boats entering the lake
40 identified their recreational activity as angling (CLIWMP 2010). In a single year creel
41 survey conducted in 1988 by the Department, CLH comprised two percent of the
42 recreational sport catch (Macedo 1991).

43
44 The number of angling tournaments, primarily targeting largemouth bass, has drastically
45 increased over the last three decades in response to Clear Lake's reputation as a
46 premiere sport fishery. Between 2001 and 2008 the number of angling tournaments
47 increased from 98 to 208 per year (Rowan J. personal communication, October 10,

1 2013, unreferenced). It is believed that recreational and tournament anglers' capture
2 CLH incidentally while angling. The impact to CLH from the increase in angling
3 tournaments is unknown, but is likely negligible because tournament anglers do not
4 target CLH and bycatch would be an inadvertent snagging on an artificial lure, a rare
5 occurrence.

6 **REGULATORY AND LISTING STATUS**

7 **Federal**

8
9 On September 25, 2012 the Center for Biological Diversity petitioned the U.S. Fish and
10 Wildlife Service (USFWS) to list CLH as endangered or threatened under the federal
11 Endangered Species Act (ESA). As of the publication of this status review there has
12 been no action taken on the petition by USFWS.

13
14 The U.S. Forest Service (USFS) lists CLH as a sensitive species. USFS sensitive
15 species are those plant and animal species identified by a regional forester that are not
16 listed or proposed for listing under the federal ESA for which population viability is a
17 concern.

18 **State**

19
20 The Department designated CLH as a Species of Special Concern (SSC) in 1994. A
21 SSC is a species, subspecies, or distinct population of an animal native to California
22 that currently satisfies one or more of the following (not necessarily mutually exclusive)
23 criteria:

- 24 • Is extirpated from the State or, in the case of birds, in its primary seasonal or
25 breeding role;
- 26 • Is listed as Federally, but not State, threatened or endangered;
- 27 • Is experiencing, or formerly experienced, serious (noncyclical) population
28 declines or range restrictions (not reversed) that, if continued or resumed, could
29 qualify it for State threatened or endangered status;
- 30 • Has naturally small populations exhibiting high susceptibility to risk from any
31 factor(s) that if realized, could lead to declines that would qualify it for State
32 threatened or endangered status.

33
34 The intent of designating a species as a SSC is to:

- 35 • Focus attention on animals at conservation risk by the Department, other State,
36 local and Federal government entities, regulators, land managers, planners,
37 consulting biologists, and others;
- 38 • Stimulate research on poorly known species;
- 39 • Achieve conservation and recovery of these animals before they meet California
40 Endangered Species Act criteria for listing as threatened or endangered.

41 There are no provisions in the Fish and Game Code that specifically prohibit take of
42 CLH or protect its habitat.

43

1 **Other Rankings**

2
3 The American Fisheries Society ranks CLH as vulnerable, meaning the taxon is in
4 imminent danger of becoming threatened throughout all or a significant portion of its
5 range (Jelks et al. 2011).

6 **EXISTING MANAGEMENT EFFORTS**

7
8 **Resource Management Plans**

9
10 An increase in resource management efforts throughout the Clear Lake watershed has
11 benefitted CLH, and several plans and strategies are in place to assist in reducing the
12 threats to CLH.

13
14 The Clear Lake Integrated Watershed Management Plan (2010) was prepared by two
15 resource conservation districts and provides details of past and current resource
16 management within the Clear Lake watershed. The plan seeks to identify opportunities
17 to improve and protect the health and function of the watershed and identifies specific
18 implementation actions to improve and protect watershed resources. Recommended
19 actions are prioritized on a timeline. As funding allows, implementation of these actions
20 will be undertaken by various non-governmental organizations (NGO) and local, state,
21 and federal agencies that share an interest in promoting the health and function of the
22 watershed. Multiple action items listed in the plan would benefit CLH and their habitats.
23 Several tributaries to Clear Lake have completed Watershed Assessment plans as well.
24 These include Kelsey Creek Watershed Assessment (2010), Middle Creek Watershed
25 Assessment (2010), and Scotts Creek Watershed Assessment (2010). These plans
26 were all completed by Lake County Water Resources Division for West and East Lake
27 Resource Conservation Districts.

28
29 With adoption of the TMDL for Clear Lake, several projects are in process or have been
30 completed to reduce the amount of phosphorous entering the lake. Specifically, the
31 Middle Creek Flood Damage Reduction and Ecosystem Restoration Project seeks to
32 reduce the amount of phosphorous entering the lake by 40 percent (CEPA 2012). Lake
33 County and the California Department of Transportation have implemented several best
34 management practices (BMPs) for managing storm water runoff to reduce the amount
35 of phosphorous and other contaminants that enter the lake. Both the USFS and Bureau
36 of Land Management (BLM) have undertaken projects to reduce nutrients entering the
37 lake as a result of off-highway vehicles and other land uses. BLM, in coordination with
38 Scotts Valley Band of Pomo Indians, received a grant to implement the Eightmile Valley
39 Sediment Reduction and Habitat Enhancement Project Design. Controlling sediment
40 from Eightmile Valley is crucial to controlling the amount of nutrients entering the lake.
41 Many of these projects are still in design or early implementation and it will be several
42 years before changes in nutrient loads within the lake can be observed and studied.

43
44 The adverse effects from an increase in sedimentation as a result of conversion of
45 various types of agricultural land to vineyard resulted in the formation of the Erosion
46 Prevention and Education Committee (EPEC). The EPEC is a group of county

1 agencies and private entities that provide educational outreach regarding erosion
2 control and water quality protection. In addition, the Lake County Grading Ordinance
3 was approved in 2007 and requires grading permits and Erosion Control and Sediment
4 Detention Plans for projects with the probability of resulting in increased sedimentation
5 (Forsgren Associates, Inc. 2012).

6
7 Concerns over the reduction in habitat quality resulting from gravel mining prompted
8 Lake County to adopt an Aggregate Resources Management Plan in 1994. The plan
9 called for a moratorium on gravel mining in several tributaries to Clear Lake. The
10 implementation of gravel mining regulations has resulted in reduced in-stream and bank
11 erosion and increased riparian habitat along the creeks (CEPA 2008).

12
13 To prevent further destruction of wetland habitat along the lake shoreline, in 2000 and
14 2003 amendments, Lake County adopted Section 23-15 of the Clear Lake Shoreline
15 Ordinance that prohibits the destruction of woody species and tules. In addition to the
16 ordinance, there is a no net-loss requirement for commercial, resort, and public
17 properties that seek to clear vegetation from areas along the shoreline (CLIWMP 2010).

18
19 RREC produced an Adaptive Management Plan (HAMP) for the Clear Lake Hitch,
20 *Lavinia exilicauda chi* (RREC 2011). The HAMP describes the current status of CLH
21 habitat and problems for habitat recovery. The habitat assessments are included in a
22 management plan that identifies action items, issues of uncertainty, stakeholder
23 involvement, sustainability, and plan amendment procedures. The RREC is currently in
24 the process of revising the HAMP.

25
26 The Department has created or approved two Conceptual Area Protection Plans
27 (CAPP) for the Clear Lake Watershed. The creation of a CAPP for an area allows the
28 Department, as well as local and federal agencies, and NGOs, to apply for land
29 acquisition funding from the Wildlife Conservation Board. The first, the Clear Lake
30 CAPP, was approved in 2002 and addresses land acquisition needs in the area of
31 Middle Creek. The plan focuses on protecting wetland and riparian habitat for the
32 benefit of natural resources. The second CAPP, Big Valley Wetlands, is currently in
33 development with possible approval in 2014. The Big Valley Wetlands CAPP focuses
34 on land acquisitions in the western portion of the Clear Lake watershed for the purpose
35 of protecting wetland and riparian habitat. Both CAPP's will benefit CLH in the
36 protection of riparian and wetland habitat critical for spawning and rearing CLH. Land
37 acquisitions that seek to protect and restore existing CLH habitat should create a stable
38 environment for CLH populations.

39
40 The Department published a Clear Lake Fishery Management Plan in 1999 (Bairrington
41 1999). The plan provides a review of past and present biological information for Clear
42 Lake. The primary focus of the plan is to maintain fishery resources of the lake and
43 enhance recreational fishing opportunities. The plan identifies areas of controversy
44 between various stakeholder groups in the watershed, and states that "adapting to the
45 biological and social settings at Clear Lake involves a variety of compromises between
46 these groups and the non-angling groups who wish to ensure the well-being of Clear
47 Lake's native fish species." The plan identifies the decline in native fish species at
48 Clear Lake as being detrimental both socially and biologically. No specific guidelines

1 are given for addressing impacts to native species, but restoration of spawning habitat
2 and natural flow regimes are discussed as critical for native species survival.
3

4 **Monitoring and Research**

5
6 In 2013 the Department attempted to conduct a status assessment of the CLH
7 population present in Cole and Kelsey creeks. Sampling produced too few fish to
8 facilitate a statistically valid mark and recapture study. As a result, a population
9 estimate was not completed. The Department has proposed additional funding in 2014
10 to begin a multi-year mark-recapture study to determine a statistically valid population
11 estimate or index of CLH.
12

13 The CCCLH has been conducting annual spawning observations since 2005. A simple
14 protocol is followed that identifies the time, observer, and number of CLH observed.
15 Volunteers have put in hundreds of hours monitoring CLH spawning runs during this
16 time period. Although not quantitative, the surveys provide a glimpse into the number of
17 spawning CLH and how successful spawning is in a particular season. Results of these
18 surveys are included in Appendices A and B and summarized in Section 4.1 and 4.2
19 above.

20 **Habitat Restoration Projects**

21
22 In recent years, local, state, and federal agencies have begun implementing actions to
23 aid in the protection and restoration of Clear Lake wetland habitat. The Middle Creek
24 Flood Damage Reduction and Ecosystem Restoration Project will restore up to 1,400
25 acres of wetland habitat around Middle Creek and Rodman Slough, essentially doubling
26 the amount of existing wetland habitat in the watershed (CLIWMP 2010).
27

28 **Impacts of Existing Management Efforts**

29
30 To date, existing management efforts have focused on CLH habitat restoration in the
31 watershed. Wetland restoration projects that would significantly benefit CLH have been
32 proposed and have been or will be implemented through the Middle Creek Flood
33 Damage Reduction and Ecosystem Restoration Project and the two CAPPs that cover
34 portions of the watershed. Wetland restoration is expected to aid in increasing
35 spawning success and juvenile recruitment into the population. Increased wetland
36 acreage would enhance filtration of tributary waters resulting in decreased amounts of
37 nutrients entering the lake and an increase in the water table. The increased water
38 table will help maintain surface flow in tributaries, resulting in suitable spawning habitat
39 being maintained throughout the spawning season. The Clear Lake Shoreline
40 Ordinance has resulted in a “no net loss” of shoreline wetland habitat around the lake
41 since its enactment. However, because these wetland restoration projects are either
42 recent or yet to be implemented, a thorough assessment of direct and indirect impacts
43 to CLH populations cannot be included in this status review.
44

45 Establishment of TMDLs for mercury and nutrients has led to a reduction in inputs and
46 an increase in monitoring efforts in the Clear Lake watershed. Past and future steps by

Comment [JS15]: As indicated earlier, a study of hitch age structure using otoliths would be useful to determine longevity in the lake and resilience to infrequent good spawning success.

1 the federal government will reduce mercury contamination resulting from the Sulphur
2 Bank Mercury Mine. Most of the identified initial actions for cleanup have been
3 implemented. The focus will now be on two long-term projects to address waste pile
4 and lake sediment cleanup, which should result in significant reductions in mercury
5 contamination in the watershed. Nutrient loads entering Clear Lake have been
6 addressed by several measures including wetland restoration, BMPs for storm water
7 runoff, and erosion control measures. Many of these projects are in the early stages of
8 implementation, and a thorough assessment of impacts to CLH is yet to be been
9 completed. It is likely that reduced mercury and nutrient loads in Clear Lake will result
10 in a significant benefit to CLH.

11 **SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE** 12 **HITCH IN CALIFORNIA**

13
14 CESA directs the Department to prepare this report regarding the status of CLH based
15 upon the best scientific information available to the Department. CESA's implementing
16 regulations identify key factors that are relevant to the Department's analyses.
17 Specifically, a "species shall be listed as endangered or threatened ... if the Commission
18 determines that its continued existence is in serious danger or is threatened by any one
19 or any combination of the following factors: (1) present or threatened modification or
20 destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease;
21 or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, §
22 670.1 (i)(1)(A)).

23
24 The definitions of endangered and threatened species in the Fish and Game Code
25 provide guidance to the Department's scientific determination. An endangered species
26 under CESA is one "which is in serious danger of becoming extinct throughout all, or a
27 significant portion, of its range due to one or more causes, including loss of habitat,
28 change in habitat, over exploitation, predation, competition, or disease." (Fish & G.
29 Code, § 2062). A threatened species under CESA is one "that, although not presently
30 threatened with extinction, is likely to become an endangered species in the foreseeable
31 future in the absence of special protection and management efforts required by
32 [CESA]." (*Id.*, § 2067).

33
34 The preceding sections of this status review report describe the best scientific
35 information available to the Department, with respect to the key factors identified in the
36 regulations. The Department's scientific determinations regarding these factors as peer
37 review begins are summarized below.

38 39 **Present or Threatened Modification or Destruction of Habitat**

40
41 Beginning with the arrival of European settlers in the mid-1800s, alterations to habitats
42 in the watershed have directly impacted the ability of CLH to survive. Habitats
43 necessary for both spawning and rearing have been reduced or severely decreased in
44 suitability in the past century resulting in an observable decrease in the overall
45 abundance of CLH and its habitat. Spawning tributaries have been physically altered by
46 a combination of dams, diversions, and mining operations that have altered the course

1 and timing of spring flows and the amount and quality of spawning habitat available for
2 CLH. Dams create barriers to CLH passage that reduce the amount of available
3 spawning habitat while altering the natural flow regime of tributaries. Water diversions
4 in tributaries have resulted in decreased flows during critical spawning migrations for
5 CLH. Loss of eggs, juvenile, and adult fish due to desiccation and stranding from water
6 diversions are likely a significant impact on CLH populations. Gravel mining removed
7 large amounts of spawning substrate during peak operations in the mid-1900s.
8 Spawning substrate has been restored slowly after gravel mining was discontinued in
9 the majority of the watershed. Water quality impacts to the watershed have resulted in
10 Clear Lake being listed as an impaired water body and led to the establishment of
11 TMDLs for both mercury and nutrients for the lake. It is unclear to what extent the water
12 quality impacts are affecting CLH populations. The Department considers modification
13 and destruction of habitat a significant threat to the continued existence of CLH.

14 **Overexploitation**

15
16 Harvest of CLH has occurred by both Pomo tribes and commercial fishery operators at
17 Clear Lake. Historic accounts from tribal members indicate that significant amounts of
18 CLH were harvested during spawning runs. In recent years, the amount of harvest by
19 the Pomo has been minimal, and the CLH are used strictly for educational and cultural
20 reasons. Since the early 1990s commercial fishery operations have been required to
21 return all CLH captured to the lake. Prior to that, CLH had not been regularly harvested
22 for sale. It is likely that incidental catch during commercial harvest operations resulted
23 in mortality of some CLH. However, there is no information indicating that
24 overexploitation threatens the continued existence of CLH.

25 **Predation**

26
27 Direct predation of CLH by fish, birds, and mammals is known to occur in suitable
28 habitats within the watershed. Spawning runs are vulnerable to predation from birds
29 and mammals as fish migrate upstream and become stranded at various locations.
30 Stranding occurs both naturally and as a result of habitat modifications described
31 above. Non-native fishes prey directly on different life stages of CLH in all occupied
32 habitats. CLH have been found during stomach content analyses of largemouth bass.
33 Incidental observations indicate that largemouth bass may target CLH as the CLH stage
34 at the entrance to ascend spawning tributaries in early spring. Other introduced fishes,
35 such as catfish species, also prey on CLH. A detailed diet study on introduced fishes is
36 necessary to determine the extent of predation from introduced fishes. There is
37 scientific information suggesting that predation by introduced fishes threatens the
38 continued existence of CLH.

39 **Competition**

40
41 The extent of impacts on CLH from competition with other aquatic species is poorly
42 understood. Studies conducted on diet analysis of CLH indicate that there is
43 competition between CLH and other macroinvertebrate consuming fish species,
44 primarily inland silversides and threadfin shad. Observations by Department biologists
45 and others indicate that CLH populations fluctuate on alternating cycles with inland
46 silverside populations. CLH directly compete with other native and non-native fishes for

1 juvenile rearing habitat. The majority of fishes in Clear Lake utilize near shore wetland
2 habitat for juvenile rearing. With the decrease in wetland habitat over the past century,
3 there is increased competition for the remaining habitat. Although no formal studies
4 have been completed, it is likely that competition for resources threatens the continued
5 existence of CLH.

6 **Disease**

7 There are no known diseases that are significant threats to the continued existence of
8 CLH.

9 **Other Natural Occurrences or Human-related Activities**

10
11 Expected climate change impacts to California and the Clear Lake watershed will be
12 significant during annual CLH spawning cycles. CLH require winter and spring storms
13 that provide suitable spawning flows in the tributaries of Clear Lake. A shift in timing,
14 temperature, and amount of runoff could significantly impact the ability of CLH to
15 successfully spawn. A report on the projected effects of climate on California
16 freshwater fishes determined CLH to be critically vulnerable to impacts from climate
17 change.

18
19 Numerous recreational activities take place in Clear Lake each year. The majority of
20 recreational activities pose no significant threat to the survival of CLH. However, it is
21 believed that recreational and tournament anglers' capture CLH incidentally, at a low
22 rate. The extent of impacts to CLH from angling is unknown, but likely do not threaten
23 the continued existence of CLH.

24 **SUMMARY OF KEY FINDINGS**

25
26 At present time, the species can be found in portions of its historic habitat and
27 qualitative surveys indicate a variable interannual population. Based on qualitative
28 survey efforts to date a population estimate or index of CLH is not attainable. Without a
29 current population or index for CLH it is necessary to estimate impacts not based on a
30 set baseline but rather against trends seen in abundance and distribution in sampling
31 efforts over the past half century.

32
33 It will be imperative for the Department and the conservation community to study and
34 monitor the population of CLH over the next decade. A review of the scientific
35 determinations regarding the status of CLH indicates there are significant threats to the
36 continued existence of the species, particularly related to historical and ongoing habitat
37 modification, predation from introduced species, and competition. Many of these
38 threats are currently or in the near future being addressed by existing management
39 efforts. Monitoring impacts from existing management efforts will be imperative to
40 assessing the future status of CLH.

Comment [JS16]: It appears that the decline of hitch after introduction catfish and later inland silverside and the apparent inverse year-to-year relationship between silverside/threadfin shad and hitch support competition and predation as ongoing threats. The many barriers and diversion impacts on spawning have made successful (and widespread) spawning less likely and more subject to year to year runoff effects (now and with future climate change). However, the data on hitch abundance are limited but point to a boom or bust pattern in population abundance (with uncertain longevity of individual fish). The threats and the present pattern indicate that extinction is a real possibility without intervention to improve the amount and regularity of spawning success and juvenile survival in the littoral environment.

1 **RECOMMENDATION FOR PETITIONED ACTION**

2
3 CESA directs the Department to prepare this report regarding the status of CLH in
4 California based upon the best scientific information available. CESA also directs the
5 Department based on its analysis to indicate in the status report whether the petitioned
6 action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd.
7 (f)). The Department includes and makes its recommendation in its status report as
8 submitted to the Commission in an advisory capacity based on the best available
9 science.

10
11 Based on the criteria described above, the scientific information available to the
12 Department does/does not indicate that CLH are threatened with extinction and likely to
13 become an endangered species in the foreseeable future. The listing recommendation
14 will be provided in this report after the Department receives, evaluates, and incorporates
15 peer-review comments as appropriate.

16 **PROTECTION AFFORDED BY LISTING**

17
18 It is the policy of the State to conserve, protect, restore and enhance any endangered or
19 any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an
20 endangered or threatened species, unauthorized “take” of CLH will be prohibited,
21 making the conservation, protection, and enhancement of the species and its habitat an
22 issue of statewide concern. As noted earlier, CESA defines “take” as hunt, pursue,
23 catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any
24 person violating the take prohibition would be punishable under State law. The Fish and
25 Game Code provides the Department with related authority to authorize “take” under
26 certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) As authorized
27 through an incidental take permit, however, impacts of the taking on CLH caused by the
28 activity must be minimized and fully mitigated according to State standards.

29
30 Additional protection of CLH following listing would also occur with required public
31 agency environmental review under CEQA and its federal counter-part, the National
32 Environmental Policy Act (NEPA). CEQA and NEPA both require affected public
33 agencies to analyze and disclose project-related environmental effects, including
34 potentially significant impacts on endangered, rare, and threatened special status
35 species. Under CEQA’s “substantive mandate,” for example, state and local agencies
36 in California must avoid or substantially lessen significant environmental effects of their
37 projects to the extent feasible. With that mandate and the Department’s regulatory
38 jurisdiction generally, the Department expects related CEQA and NEPA review will likely
39 result in increased information regarding the status of CLH in California as a result of,
40 among other things, updated occurrence and abundance information for individual
41 projects. Where significant impacts are identified under CEQA, the Department expects
42 project-specific required avoidance, minimization, and mitigation measures will also
43 benefit the species. State listing, in this respect, and required consultation with the
44 Department during state and local agency environmental review under CEQA, is also
45 expected to benefit the species in terms of related impacts for individual projects that
46 might otherwise occur absent listing.

Comment [JS17]: If listed, monitoring /
collecting permits should be should be relatively
liberal to allow collection of necessary data.

1
2 If CLH are listed under CESA, it may increase the likelihood that State and federal land
3 and resource management agencies will allocate additional funds towards protection
4 and recovery actions. However, funding for species recovery and management is
5 limited, and there is a growing list of threatened and endangered species.

6 **MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES**

7
8 Current data on CLH suffers from being largely anecdotal and qualitative in nature.
9 Studies designed to provide quantitative data on CLH populations and the factors that
10 affect the ability of CLH to survive and reproduce are necessary for species
11 management. The following management recommendations were generated by
12 Department staff with considerations from local agencies, non-profits, and interested
13 parties.

- 14
- 15 • Derive a statistically valid population estimate or index allowing assessment of
- 16 impacts to the overall population and provide a baseline to maintain a
- 17 sustainable population level.
- 18 • Conduct a thorough assessment of barriers to fish movement on primary
- 19 spawning streams and provide recommendations for restoration actions on
- 20 substantial barriers.
- 21 • Complete a detailed analysis of spawning habitat in primary spawning streams
- 22 and provide recommendations for restoration actions.
- 23 • Implement identified restoration activities to increase available spawning habitat
- 24 for CLH.
- 25 • Conduct a review of reservoir operations at Highland Springs, Adobe Creek, and
- 26 Kelsey Creek detention dams to assess water release operations that may be
- 27 impacting CLH, development and implementation of guidelines for minimizing
- 28 impacts.
- 29 • Conduct an in stream flow analysis of primary spawning tributaries to determine
- 30 impacts of water diversions on stream flows, particularly during spawning
- 31 season.
- 32 • Coordinate with landowners, stakeholders, and permitting agencies on
- 33 developing strategies for reducing in stream diversions during spawning season.
- 34 • Determine the value of wetland habitat in the watershed pertaining to
- 35 survivorship of juvenile CLH and make appropriate recommendations on
- 36 restoration or modification.
- 37 • Analyze food web interactions of CLH and non-native fish to determine potential
- 38 impacts to CLH.
- 39 • Conduct a diet analysis of predatory fish species to determine the extent of their
- 40 impact on CLH.
- 41 • Conduct creel surveys to gain a better understanding of CLH capture rates
- 42 during both recreational and tournament angling.
- 43 • Develop a comprehensive monitoring program to assess both native and non-
- 44 native fish populations and their distribution in the watershed.
- 45 • Identify habitats within the watershed that may be suitable for CLH
- 46 translocations.

- 1 • Coordinate the above research and restoration efforts with interested
2 stakeholders in the watershed.
3 • Develop an outreach program to provide updates to stakeholders on recovery
4 and management efforts.

5 **PUBLIC RESPONSE**

6
7 *Note to Reviewer:* Public response will be finalized after the Department receives,
8 evaluates, and incorporates peer-review comments as appropriate.

9 **PEER REVIEW**

10
11 *Note to Reviewer:* Peer review will be finalized after the Department receives,
12 evaluates, and incorporates peer-review comments as appropriate.
13
14

15

16

17

18

19

20

21

22

23

24

25

26 **LITERATURE CITED**

27

28 Aguilar, A. and J. Jones. 2009. Nuclear and Mitochondrial Diversification in two Native
29 California Minnows: Insights into Taxonomic Identity and Regional Phylogeography.
30 *Molecular Phylogenetics and Evolution* 51 (2): 373-381.
31

1 Anderson, N.L., D.L. Woodward and A.E. Colwell. 1986. Pestiferous dipterans and two
2 recently introduced aquatic species at Clear Lake. Proceedings of the California
3 Mosquito Vector Control Association. 54:163-167.
4
5 Anderson, N.L., 1989. Letter to Rick Macedo containing notes and data from LCVCD
6 sampling efforts.
7
8 Avise, J.C. and F.J. Ayala. 1976. Genetic differentiation in speciose versus depauperate
9 phylads: Evidence from the California minnows. Evolution 30:46-58.
10
11 Barrett, S.A., 1906. The Ethno-Geography of the Pomo and Neighboring Indians.
12 University of California Publications in American Archeology and Ethnology. Vol 6 No. 1.
13
14 Bairrington, P., 1999. CDFG Clear Lake Fishery Management Plan.
15
16 Bellucci, C. J., Becker, M., & Beauchene, M. (2011). Characteristics of
17 macroinvertebrate and fish communities from 30 least disturbed small streams in
18 Connecticut. *Northeastern Naturalist*, 18(4), 411-444.
19
20 Big Valley EPA, 2013. Hitch interview notes with families of Big Valley Rancheria and
21 Elem Indian Colony.
22
23 Big Valley Rancheria, 2012. Hitch *Lavinia exilicauda* Chi Hopkirk ecology and water
24 quality studies in Big Valley sub-basin creeks in 2012.
25
26 Big Valley Rancheria, 2013. Big Valley sub-basin creek water quality, quantity, and
27 Hitch *Lavinia exilicauda* Chi Hopkirk ecology program. Spring, 2013.
28
29 Brown, A.V., M.M. Little, and K.B. Brown, 1998. Impacts of gravel mining on gravel bed
30 streams. *Transactions of the American Fisheries Society*. 127:979-994.
31
32 Bunn, S.E., and A.H. Arthington, 2002. Basic Principles and Ecological Consequences
33 of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol.
34 30:4. Pp 492-507.
35
36 California Climate Change Center, 2012. Our Changing Climate 2012 Vulnerability and
37 Adaptation to the Increasing Risks from Climate Change in California.
38
39 California Department of Fish and Game, 1955-1956. Field notes on Kelsey and Seigler
40 Creeks.
41
42 California Department of Fish and Game, 1961-2001. Commercial Catch data for Clear
43 Lake
44
45 California Department of Fish and Game, 1969. News Release on Fish Dieoffs at Clear
46 Lake.
47

1 California Department of Fish and Game, 1988. Clear Lake Electrofishing Survey, April
2 2, 1987 Memorandum.
3
4 California Department of Fish and Game, 2012. Electrofishing data, Memorandum in
5 progress.
6
7 California Department of Fish and Wildlife, 2013. Report to the Fish and Game
8 Commission Evaluation of the Petition from the Center for Biological Diversity to List
9 Clear Lake Hitch (*Lavinia exilicauda chi*) as a Threatened Species under the California
10 Endangered Species Act.
11
12 California Department of Fish and Wildlife, 2013. Commercial Fisheries Data from catch
13 records.
14
15 California Department of Fish and Wildlife, 2013. Commercial Operators permit
16 applications.
17
18 California Department of Fish and Wildlife, April 24, 2013. Press Release – CDFW
19 Seeks Public Comment and Data Regarding Clear Lake Hitch.
20
21 California Department of Water Resources. 1975. Clear Lake Water Quality Data.
22
23 California Natural Resources Agency, 2009. California Climate Adaptation Strategy
24 Discussion Draft.
25
26 California Environmental Protection Agency RWQCBCVR, 2002. Clear Lake TMDL for
27 Mercury Staff Report.
28
29 California Environmental Protection Agency RWQCBCVR, 2008, Monitoring and
30 Implementation Plan Clear Lake Mercury and Nutrient TMDL's.
31
32 California Environmental Protection Agency RWQCBCVR, 2010. Clear Lake Mercury
33 Total Maximum Daily Load Update.
34
35 California Environmental Protection Agency RWQCBCVR, 2012. Clear Lake Nutrient
36 Total Maximum Daily Load Control Program 5-year Update.
37
38 California Regulatory Notice Register, 2012. No. 41-Z. p.1501
39
40 California Regulatory Notice Register, 2013. No. 12-Z. p.488
41
42 Center for Biological Diversity, 2012. Petition to List Clear Lake Hitch (*Lavinia exilicauda*
43 *chi*) as Threatened under the California Endangered Species Act. 58 pp.
44
45 Chi Council for the Clear Lake Hitch (CCCLH). 2013. Hitch spawning survey results,
46 2005-2013. Available at <http://lakelive.info/chicouncil/>
47

1 Clear Lake Integrated Watershed Management Plan, February 2010. Prepared for West
2 Lake and East Lake Resource Conservation Districts.
3
4 Coleman, G.A. 1930. A biological survey of Clear Lake, Lake County. *Calif. Fish and*
5 *Game* 16: 221-227.
6
7 Converse, Y.A., C.P. Hawkins and R. A. VALDEZ, 1998. Habitat Relationships of
8 Subadult Humpback Chub in the Colorado River through Grand Canyon: Spatial
9 Variability and Implications of Flow Regulation. *REGULATED RIVERS: RESEARCH &*
10 *MANAGEMENT* 14: 267–284
11
12 Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1964. The impact of the fishery on the
13 midges of Clear Lake, Lake County, CA, *Annals of the Entomological Society of*
14 *America*, Vol. 57, pp. 701-707.
15
16 Cott, P. A., Sibley, P. K., Somers, W. M., Lilly, M. R., & Gordon, A. M. (2008). A
17 REVIEW OF WATER LEVEL FLUCTUATIONS ON AQUATIC BIOTA WITH AN
18 EMPHASIS ON FISHES IN ICE-COVERED LAKES¹. *Journal of the American Water*
19 *Resources Association*, 44(2), 343-359.
20
21 Cox, B., 2007. CDFG Clear Lake Fishery Surveys Summary Report.
22
23 Curtis T.C. 1977. Pesticide Laboratory report. California Department of Fish and Game,
24 E.P. No. P-133. 3pp.
25
26 Crump, KL and VL Trudeau, 2009. Mercury-induced reproductive impairment in fish.
27 *Environmental Toxicology and Chemistry*. 28(5):895-907.
28
29 Deitch, M.J., G.M. Kondolf, and A.M. Merenlender. 2009. Hydrologic impacts of
30 smallscale instream diversions for frost and heat protection in the California wine
31 country. *River Research and Applications*, Volume 25, Issue 2, pages 118-134.
32
33 Dill, W. A., and A. J. Cordone. 1997. Fish Bulletin 178. History and Status of Introduced
34 Fishes in California 1871-1996. California. Fish and Game. 414 pp.
35
36 Eagles-Smith, C.A., T.H. Suchanek, A.E. Colwell, N.L. Anderson, and P.B. Moyle. 2008.
37 Changes in fish diets and food web mercury bioaccumulation induced by an invasive
38 planktivorous fish. *Ecological Applications* 18(Supplement): A213–A226.
39
40 Ewing, B., 2013. Summary of the Clear Lake Hitch Population Estimate for Cole and
41 Kelsey Creeks, Lake County.
42
43 Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller,
44 1999. *Confronting Climate Change in California: Ecological Impacts on the Golden*
45 *State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of
46 America, Washington, DC.
47

1 Field, C.B., L.D. Mortsch,, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W.
2 Running and M.J. Scott, 2007: North America. *Climate Change 2007: Impacts,*
3 *Adaptation and Vulnerability. Contribution of Working Group II to the Fourth*
4 *Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry,
5 O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge
6 University Press, Cambridge, UK, 617-652.
7
8 Forsgren Associates Inc, 2012. Clear Lake Watershed Sanitary Survey 2012 Update
9 Final.
10
11 Franson, S. 2013. Summary of Spring 20-13 Field Monitoring with Locations chosen for
12 observing egg and larval development of Clear Lake Hitch (*Lavinia exilicauda chi*).
13
14 Gafny, S., A. Gasith, and M. Goren 2006. Effect of water level fluctuation on shore
15 spawning of *Mirogrex terraesanctae* (Steinitz), (Cyprinidae) in Lake Kinneret,
16 Israel. *Journal of Fish Biology* vol 41:6 pages 863-871
17
18 Geary, R.E. 1978. Life history of the Clear Lake hitch (*Lavinia exilicauda chi*).
19 Unpublished Master's Thesis, University of California, Davis. 27 pp.
20
21 Geary, R.E. and P.B. Moyle. 1980. Aspects of the ecology of the hitch, *Lavinia*
22 *exilicauda* (Cyprinidae), a persistent native cyprinid in Clear Lake, California.
23 *Southwest. Nat.* 25:385-390.
24
25 Giusti, G. 2009. Human Influences to Clear Lake, California A 20th Century History.
26
27 Harnly, M., S. Seidel, P. Rojas, R. Fornes, P. Flessel, D. Smith, R. Kreutzer, and L.
28 Goldman. 1996. Biological monitoring for mercury within a community with soil and fish
29 contamination. *Environmental Health Perspectives*, Vol. 105:4, 424-429.
30
31 Havens, K.E. 2008. Cyanobacterial Harmful Algal Blooms: State of the Science and
32 Research Needs. Chapter 33: Cyanobacteria blooms: effects on aquatic ecosystems.
33 Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser,
34 S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S.
35 Kalkstein, J. Lenihan, C.K. Lurch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004.
36 Emissions pathways, climate change, and impacts on California. *Proceedings of the*
37 *National Academy of Science* 101:12422-12427.
38
39 Hopkirk, J.D. 1973. Endemism in fishes of the Clear Lake region of central California.
40 *University of California Publications in Zoology* 96: 160 pp.
41
42 Horne, A.J. 1975. The Effects of Copper, Major and Minor Nutrient Element
43 Additions, and Lake Water Movements on Blue-Green Algal Bloom Development in
44 Clear Lake.
45
46 Hudon, C., Armellin, A., Gagnon, P., & Patoine, A. (2010). Variations in water
47 temperatures and levels in the St. Lawrence River (quebec, canada) and potential
48 implications for three common fish species. *Hydrobiologia*, 647(1), 145-161.

1
2 Hunt, E.G. and A.I. Bischoff. 1960. Inimical effects on wildlife or periodic DDD
3 applications to Clear Lake. California Fish and Game 46:91-106.
4
5 Jelks, H L., Stephen J. Walsh, Noel M. Burkhead, Salvador Contreras-Balderas,
6 Edmundo
7 Diaz-Pardo, Dean A. Hendrickson, John Lyons, Nicholas E. Mandrak, Frank
8 McCormick, Joseph S. Nelson, Steven P. Platania, Brady A. Porter, Claude B. Renaud,
9 Juan Jacobo Schmitter-Soto, Eric B. Taylor & Melvin L. Warren Jr. (2008): Conservation
10 Status of Imperiled North American Freshwater and Diadromous Fishes, Fisheries,
11 33:8, 372-407.
12
13 Jordan, D.S., and C.H. Gilbert. 1894. List of Fishes Inhabiting Clear Lake, California.
14 Bulletin of the United States Fish Commission, Vol. XIV.
15
16 Kelsey Creek Watershed Assessment, February 2010. Prepared for East Lake and
17 West Lake Resource Conservation Districts.
18
19 Kimsey, J.B. and L.O. Fisk. 1960. Keys to the freshwater and anadromous fishes of
20 California. Calif. Fish Game 46:453-79.
21
22 Kniffen, F.B. 1939. Pomo Geography. University of California Publications in American
23 Archaeology and Ethnology. Vol. 36 No. 6 pp. 353-400.
24
25 Kratville, D. October 7, 2013. Email correspondence on CESA MOU's issued for CLH.
26
27 Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T.
28 Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management.
29 *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working*
30 *Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate*
31 *Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.
32 Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.
33
34 Lake County Department of Agriculture, 2011. Crop Report
35
36 Lake County Department of Public Works Water Resources Division, 2003. Clear Lake
37 Wetlands Geographic Information Systems Data User Manual.
38
39 Lake County Vector Control District, 2013. Copy of verified Beach Seine 1987-2010 CL
40 Hitch with notes.
41
42 Lindquist, A.W., C.D. Deonier, and J.E. Hanley. 1943. The relationship of fish to the
43 Clear Lake gnat, in Clear Lake, California. Calif. Fish Game 29:196-202.
44
45 Lindquist, A.W. and A.R. Roth. 1950. Effect of dichlorodiphenyl dichloroethane on larva
46 of the Clear Lake gnat in California. *Journal of Economic Entomology* 43:328-332.
47
48 Macclanahan, J., E. W. Danley, H. F. Dewitt, and W. Wolber. 1972[app]. Flood control

1 project maintenance and repair, 1971 inspection report. California Department of Water
2 Resources Bulletin 149-71.
3
4 Macedo, R., 1991. Creel Survey at Clear Lake, California March – June, 1988. CDFG
5 Administrative Report No. 91-3.
6
7 Macedo, R. 1994. Swimming Upstream Without a Hitch. Outdoor California:
8 January/February 1994.
9
10 Marchetti, M.P. and P.B. Moyle, 2001. Effects of flow regime on fish assemblages in a
11 regulated California stream. *Ecological Applications*. 11(2). Pp. 530-539.
12
13 McGinnis, D. and E. Ringelberg. 2006. Lake County Fish Barrier Assessment. Technical
14 Memo.
15
16 Middle Creek Watershed Assessment, February 2010. Prepared for West Lake
17 Resource Conservation District.
18
19 Miller, R.R. 1945. A new cyprinid fish from Southern Arizona, and Sonora, Mexico, with
20 description of a new subgenus of *Gila* and a review of related species. *Copeia*
21 1945:104-110.
22
23 Miller, R.R. 1963. Synonymy, characters and variation of *Gila crassicauda*, a rare
24 California minnow, with an account of its hybridization with *Lavinia exilicauda*. *California*
25 *Fish and Game* 49 (1): 20-29.
26
27 Mioni, C., R. Kudela, and D. Baxter. 2011. Harmful cyanobacteria blooms and their
28 toxins in Clear Lake and the Sacramento-San Joaquin delta (California). Central Valley
29 Regional Water Quality Control Board: 10-058-150.
30
31 Moyle, P.B. and M. Massingill. 1981. Hybridization between hitch, *Lavinia exilicauda*,
32 and Sacramento blackfish, *Orthodon microlepidotus*, in San Luis Reservoir, California.
33 *California Fish Game* 67:196-198.
34
35 Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish
36 Species of Special Concern in California, 2nd edition.
37
38 Moyle, P.B. and T. Light, 1996. Fish Invasions in California: Do Abiotic Factors
39 Determine Success? *Ecology* 77:1666-1670.
40
41 Moyle, P. B. 2002. *Inland Fishes of California*. Berkeley: University of California Press.
42
43 Moyle, PB., JD Kiernam, PK Crain and RM Quinones, 2012. Projected Effects of Future
44 Climates on Freshwater Fishes of California. A White Paper from the California Energy
45 Commission's California Climate Change Center.
46
47 Moyle P.B., J.V Katz, and R.M. Quinones. In review. Fish Species of Special Concern
48 for California. Prepared for California Department of Fish and Game, Sacramento

1
2 Murphy, G.I. 1948. Notes on the biology of the Sacramento hitch (*Lavinia e. exilicauda*)
3 of Clear Lake, Lake County, California. Calif. Fish Game 34:101-110.
4
5 Murphy, G.I. 1951. The fishery of Clear Lake, Lake County, California. *Calif. Fish and*
6 *Game* 37: 439-484.
7
8 National Oceanic and Atmospheric Administration, 2011. Table 2. Toxicity associated
9 with mercury in tissues (ug/g) wet weight.
10
11 Nicola, S.J. 1974. The life history of the hitch, *Lavinia exilicauda* Baird and Girard, in
12 Beardsley Reservoir, California. Inland Fish. Admin. Rep. 74-6:1-16.
13
14 Osleger, D.A., R.A. Zierenberg, T.H. Suchanek, J.S. Stoner, S. Morgan, and D.P.
15 Adam. 2008. Clear Lake sediments: anthropogenic changes in physical sedimentology
16 and magnetic response. Ecological Applications 18 (Supplement): A239-A256.
17
18 Puckett, L., 1972. CDFG Memorandum-Fisheries Survey Clear Lake, Lake County.
19
20 Richerson P.J., T.H. Suchanek, and S.J. Why. 1994. The Causes and Control of Algal
21 Blooms in Clear Lake, Clean Lakes Diagnostic/Feasibility Study for Clear Lake,
22 California. Prepared for USEPA Region IX.
23
24 Ridout, W.L. 1899. A Fish Jam on Kelsey Creek. *Overland Monthly and Out West*
25 *Magazine*. Volume 34, Issue 202. p. 333.
26
27 Robinson Rancheria Environmental Center (RREC). 2011. Draft Adaptive Management
28 Plan for the Clear Lake Hitch, *Lavinia exilicauda chi*. Available
29 at <http://www.robinsonrancheria.org/environmental/water.htm>.
30
31 Rowan, J., 2008. CDFG Clear Lake, Lake County Memorandum.
32
33 Rudd, R.L. 1964. *Pesticides and the Living Landscape*. University of Wisconsin Press,
34 Madison, WI.
35
36 Sandheinrich, MB. And KM Miller, 2006. Effects of dietary methylmercury on
37 reproductive behavior of fathead minnows (*Pimephales promelas*). *Environmental*
38 *Toxicology and Chemistry*. 25(11):3053-3057.
39
40 Scotts Creek Watershed Assessment, February 2010. Prepared for West Lake
41 Conservation District.
42
43 Scotts Valley Band of Pomo Indians, 2013. Historical accounts provided to CDFW by
44 Steve Elliott and Wanda Quitiquit.
45
46 State of California Fish and Game Commission, March 11, 2013. California Fish and
47 Game Commission Notice of Findings
48

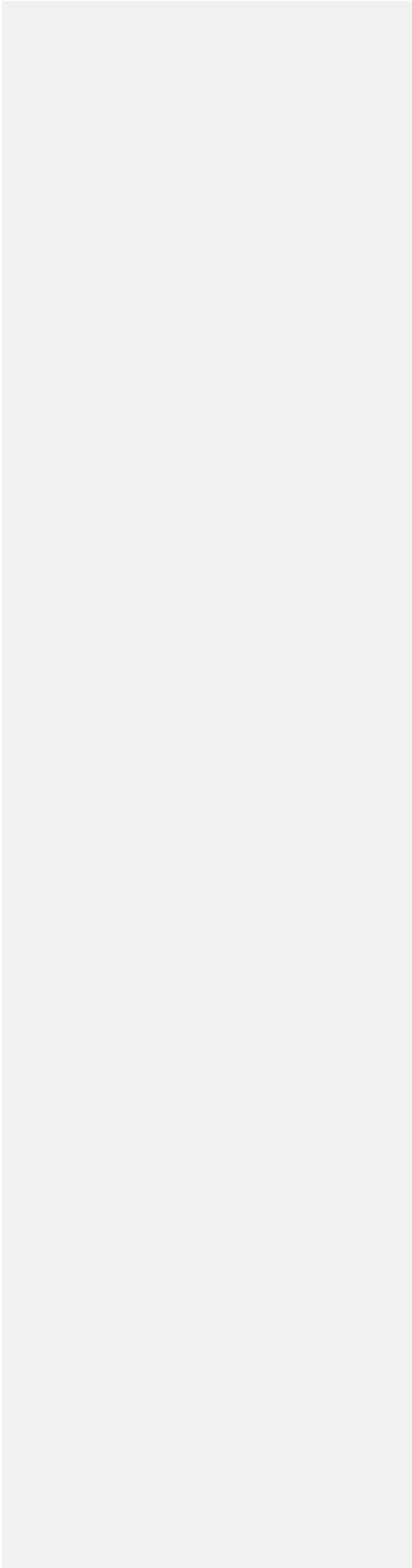
1 State of California Fish and Game Commission, October 2, 2012. California Fish and
2 Game Commission Notice of Receipt of Petition
3
4 Suchanek, T.H., P.J. Richerson, L.A. Woodward, D.G. Slotton, L.J. Holts and C.E.
5 Woodmansee. 1993. Ecological Assessment of the Sulphur Bank Mercury Mine
6 Superfund Site, Clear Lake, California: A Survey and Evaluation of Mercury In:
7 Sediment, Water, Plankton, Periphyton, Benthic Invertebrates and Fishes Within the
8 Aquatic Ecosystem of Clear Lake, California. Phase 1- Preliminary Lake Study Report.
9 Prepared for EPA-Region IX, Superfund Program. 113 pp., plus 2 attachments.
10
11 Suchanek, T.H., P.J. Richerson, D.C. Nelson, C.A. Eagles-Smith, D.W. Anderson, J.J.
12 Cech, Jr., G. Schladow, R. Zierenberg, J.F. Mount, S.C. McHatton, D.G. Slotton, L.B.
13 Webber, A.L. Bern and B.J. Swisher. 2002. Evaluating and managing a multiply-
14 stressed ecosystem at Clear Lake, California: A holistic ecosystem approach.
15 "Managing For Healthy Ecosystems: Case Studies," CRC/Lewis Press. pp. 1233-1265.
16
17 Swift, C. 1965. Early development of the hitch, *Lavinia exilicauda*, of Clear Lake,
18 California. Calif. Fish Game 51:74-80.
19
20 Thompson, L.C., G.A. Giusti, K.L. Weber, and R.F. Keiffer. 2013. The native and
21 introduced fishes of Clear Lake: a review of the past to assist with decisions of the
22 future. California Fish and Game 99(1):7-41.
23
24 U.S. Army Corps of Engineers. 1974[app]. Flood plain information: Big Valley streams
25 (Manning, Adobe, Kelsey, and Cole Creeks), Kelseyville, California. Department of
26 the Army, Sacramento District, Corps of Engineers, Sacramento, California, USA.
27
28 U.S. Environmental Protection Agency, 2012. Sulphur Bank Mercury Mine News
29 Release – EPA to Begin Construction of Test Covers in Clear Lake.
30
31 Week, L., 1982. Habitat Selectivity of Littoral Zone Fishes at Clear Lake, CDFG
32 California. Administrative Report No. 82-7.
33
34 Wetzel, R.G., 2001. Limnology lake and River Ecosystems, 3rd ed. Pg. 834.
35
36 Winder, M., J. Reuter and G. Schladow, 2010. Clear Lake Report: Clear Lake Historical
37 Data Analysis.
38
39
40
41

42 **Appendix A.** Summary graphs of spawning observations between 2005 and 2013
43
44
45
46
47
48

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

DRAFT

Appendix B. Figures depicting CLH observations on spawning tributaries



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

DRAFT

Appendix C. Description of barriers associated with CLH spawning tributaries

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

DRAFT

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

Adobe Creek: There is a flood control dam on Adobe Creek above Bell Hill Road that is impassable to CLH. There are two culverts on Adobe Creek that are mitigation barriers to spawning CLH when the water flows and velocity are not too great, but these culverts block CLH migration.

1 Alley Creek: Alley Creek has been channeled and diverted into Clover Creek. Alley
2 Creek historically supported CLH runs. During some time and under certain conditions
3 migrating CLH can access Alley Creek via the Clover channel bypass, but not when the
4 diversion has silt or sand obstructing it.
5

6 Clover Creek: There was a diversion barrier on Clover Creek, a tributary of Middle
7 Creek, which prevented fish passage into Clover Creek and Alley Creek. In 2004 the
8 Robinson Rancheria received a Tribal Wildlife Grant to mitigate the diversion barrier.
9 The work has been completed and the barrier has been modified and no longer
10 obstructs fish passage. However, CLH must pass a concrete diversion structure at the
11 junction with Alley Creek to the northwest of Upper Lake to gain the upper reaches of
12 Clover Creek. This diversion structure usually becomes a complete barrier when filled
13 with gravel and sediment.
14

15 Forbes Creek: Forbes Creek has a concrete storm water diversion structure that
16 impedes and at times blocks CLH passage.
17

18 Kelsey Creek: On Kelsey Creek, the main barriers to CLH migration are a detention
19 dam 2 to 3 miles upstream of Clear Lake, and the Main Street Bridge in Kelseyville. The
20 rock and concrete weir constructed at the base of the Main Street Bridge is a barrier to
21 the passage of CLH (Peter Windrem, personnel communication, 2012). The structure
22 has a fish ladder which is nonfunctional and the site is nonetheless a total barrier to
23 CLH (McGinnis and Ringelberg, 2008). The Kelsey Creek detention structure below
24 Dorn Crossing has retractable gates which can be opened during the CLH spawning
25 season. However, altered flow patterns and slight increases in the slope of the
26 streambed have been enough to reduce the number of spawning CLH that can pass
27 through the detention structure and move upstream. Also, rock riprap situated below the
28 retention dam seems to have impeded the upstream migration of CLH and needs to be
29 modified to provide a clear channel for fish transit. A number of drop-structures in
30 Kelsey Creek intended for gravel aggradation impede migration. Some of these do not
31 seem to impede CLH passage under current conditions, but CLH navigate them with
32 difficulty especially on the downstream passage. Further upstream, culverts that once
33 tended to clog with debris and block fish migration at the Merritt Road crossing have
34 been removed and replaced by a bridge that poses no impediment to CLH passage.
35

36 Lyons Creek: A high culvert on Lyons Creek at Lakeshore Drive prevents CLH from
37 moving upstream. Lyons Creek also has a concrete barrier at the County's Juvenile Hall
38 facility that completely prevents fish passage.
39

40 Manning Creek: A dam upstream of known CLH spawning areas in the lower reaches
41 of Manning Creek may prevent CLH from spawning further upstream.
42

43 Middle Creek: On Middle Creek, a rock and concrete weir at the Rancheria Road
44 Bridge has been a total fish passage barrier for CLH. Remedial work has been done
45 downstream, with more weirs installed in an effort to elevate the gradient so that CLH
46 could surmount the barrier and work was done to improve their stability after high flows,
47 but it remains to be seen if this will allow CLH passage. Similar weirs to capture and
48 hold gravel were installed many years ago in Adobe Creek and Kelsey Creek that do

1 not impede CLH passage, but there is concern the installed weirs on Middle Creek may
2 be potential barriers to CLH. A downstream weir at Rancheria Road is a partial barrier
3 and improperly sized rip rap at this location acts as partial migration barrier (McGinnis
4 and Ringelberg 2008). CLH were seen recently at Middle Creek Bridge and Highway 20
5 and although there are no obvious barriers, they did not appear to be able to navigate
6 the swift currents there due to the lack of resting pools. If CLH could surmount
7 Rancheria Bridge, many additional miles of spawning grounds would be accessible to
8 CLH up to areas south of Hunter Bridge, where habitat suitability ends because the
9 channel is braided and shallow due to gravel mining.

10
11 Scotts Creek: On Scotts Creek, a rock and concrete weir at the Decker Bridge is a total
12 barrier to the passage of CLH. As water levels have been lower, a barrier at the lower
13 end of Tule Lake is problematic for fish passage to Tule Lake and its tributary
14 Mendenhall Creek, Scotts Creek and tributaries, Bachelor Valley/Witter Springs area
15 tributaries, and Blue Lakes and tributaries. There is a one-way flow gate on the Blue
16 Lakes outlet at Scotts Creek that prevents CLH from entering Blue Lakes.

17
18 Seigler Canyon Creek: There are two barriers to CLH migration into Seigler Canyon
19 Creek, an exposed sewer pipe and a road crossing. The sewer pipeline which crosses
20 Seigler Canyon Creek for Anderson Marsh State Park was modified in the 1990s and
21 completely blocks CLH access to that creek, once a major spawning tributary.

Page	Line	Reviewer Comment	Department Response
		Blue Lakes, Thurston Lake, and Lampson Pond are small and not a substitute for the Clear Lake population. However, their ecology and status may give insight into factors involved in Clear Lake. Why was the Blue Lakes population extirpated?	Noted- It is not known why CLH were extirpated from Blue lake. However, spawning habitat is extremely limited in Blue Lakes and that may have been the cause.
7	35-38	Can Blue Lakes be included in the map?	Accepted- Figure updated
7	35-38	Longevity based upon scales appears to be 4-6 years (Geary 1978, Moyle 2002), but the periodically relatively high population sizes are often spaced farther apart than that. Have otoliths been examined to determine if hitch in Clear Lake live much longer than scales indicate (due to little growth in old fish), as has been demonstrated in a number of lake fishes, such as Tui chubs, Cui ui, tahoe suckers, etc. This may explain how hitch have managed to persist despite infrequent good reproductive success.	Noted- Aging fish based on otolith analysis has been discussed within the Department.
8	1-18	Based upon habitat uses by most hitch compared to inland silverside and largemouth bass, is the limnetic zone a relative refuge; are spawning success and survival of juveniles in tule beds and other shoreline habitats the major potential problems. Are data available to answer this question?	Noted- There is no area that could be described as a refuge for CLH. As detailed in the document there are impacts to CLH in all habitats they occupy.
9	28-33	Is the commercial fishing effort that supplies important incidental catch numbers quantifiable or was it reasonably similar among years. You are using number of days commercial operations occurred—is that a good measure of effort among years? The incidental catch numbers may be very misleading if effort was substantially different among years; can the incidental catch be converted to catch per unit effort to provide a more useful index?	Noted- Catch per unit effort would be a better indicator of the CLH population however, the records do not contain details on number of hours fished, number of hauls or any other metric to allow that kind of evaluation.
10	1	Rainfall totals or January–June totals (figure 2) are not a good index of stream runoff conditions during the mid-February to May period when hitch are spawning and fry are moving down to the lake (they certainly don't match my experience with streamflow conditions in the central coast for the last 1- 2 decades). A better proxy would be runoff totals (or days over 10 cfs?) at the USGS gage on Kelsey Creek or other available stream gages (Adobe Cr?).	Accepted- Stream flows on Kelsey Creek have been added in a figure and discussed in the Dams, Barriers, and Diversions section.
10	18	See comment above	Noted
10	35	See comment above	Noted
11	Figure 2	The number of occupied spawning tributaries seems to track pretty closely with runoff during March through May. 2005 and 2006 and 2010 and 2011 were the et years for spring runoff and hitch access. 2007 and 2013 were the dry years with winter/spring stream flow dropping quickly. 2012 was relatively dry, but the majority of stream flow was late (March and April).	Accepted- Information on water year applied to graph and added to text.
13	Figure 3	This chart would benefit by graphing both the number of streams and the mid-February to May rainfall total or number of days above a threshold flow.	Accepted- Points categorized as wet, normal, or dry based on spawning season stream flows.
13	Figure 3	Too bad the commercial harvest had not continued so that we would have recent data.	Noted- Commercial operations ceased following the retirement of the last operator.
13	30-36	Most abundant, but only 52 CLH captured? Electrofishing the small juveniles may not be an effective sampling technique. Trap nets?	Noted- The Department is experimenting with several sampling methods for CLH.
14	1	It appears to concerns about mortality eliminated sampling during the crucial period of CLH juvenile use of the littoral zone, so you did not get the necessary data. Isn't the data worth some incidental mortality?	Noted- When the surveys were designed they were for general fish surveys on the lake. It was requested of the Department that we reduce impacts to CLH as much as possible since the surveys were not directly targeted at them and were conducted using boat electrofishers.
14	12	If the species is listed, such an approach in collecting permits and monitoring may cripple effective monitoring needed to track population status. Similarly, it seems that the incidental catch data in the commercial harvest was extremely valuable data; can a resumption of carp and blackfish commercial harvest be encouraged to produce hitch data?	Noted- The Department works very closely with individuals conducting research on CLH. All research has been approved in a timely manner to allow for continued research on the species. Commercial catfish harvest has been banned at Clear Lake and no operators have applied for permits to catch other species in the lake.
14	12	Not in references	Accepted- reference added.
16	5	It seems like a resumption of commercial harvest of catfish might subsidize the blackfish and carp fishery and restore the incidental capture data on hitch that have been missing for the last decade.	Noted- Commercial harvest of most freshwater fishes has been banned in California.
21	11	As indicated earlier, a study of hitch age structure using otoliths would be useful to determine longevity in the lake and resilience to infrequent good spawning success.	Noted
28	4		

It appears that the decline of hitch after introduction catfish and later inland silverside and the apparent inverse year-to-year relationship between silverside/threadfin shad and hitch support competition and predation as ongoing threats. The many barriers and diversion impacts on spawning have made successful (and widespread) spawning less likely and more subject to year to year runoff effects (now and with future climate change). However, the data on hitch abundance are limited but point to a boom or bust pattern in population abundance (with uncertain longevity of individual fish). The threats and the present pattern indicate that extinction is a real possibility without intervention to improve the amount and regularity of spawning success and juvenile survival in the littoral environment.

31 24

32 24 If listed, monitoring / collecting permits should be relatively liberal to allow collection of necessary data.

Noted- As described in the management actions section the Department agrees that spawning success is critical to the survival of the species

Noted- Permit requirements for CESA species are described in Fish and Game Code and Title 14.



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
Sacramento, CA 95811
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director



January 13, 2014

Peter B. Moyle
Department of Wildlife, Fish, and Conservation Biology
University of California, Davis
1 Shields Ave
Davis, CA 95616

Dear Dr. Moyle

CLEAR LAKE HITCH (*LAVINIA EXILICAUDA CHI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife (Department) Draft Status Report of the Clear Lake hitch (*Lavinia exilicauda chi*). A copy of the Department's peer review draft status report, dated January 2014, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of Clear Lake hitch in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). The Department would appreciate receiving your peer review input on or before February 10, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened. The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission.

The Commission first received the petition to list Clear Lake hitch as threatened on September 25, 2012. The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on March 22, 2013 following publication of regulatory notice by the Office of Administrative Law. The Clear Lake hitch is currently protected under CESA in California in that capacity.

The peer review Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the best scientific information available regarding the status of Clear Lake hitch in California. Headed into peer review, the Department believes the best available science indicates that listing the species as threatened under CESA is warranted at this time. To be clear, we ask that you focus

Conserving California's Wildlife Since 1870

Name, Title
Business
Date
Page 2

your review on the scientific information and the Department's related assessment of the required population and life history elements prescribed in CESA rather than focusing on the tentative conclusion we share as a matter of professional courtesy. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the best scientific information available regarding the status of Clear Lake hitch in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA (*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important as well as whether they indicate, in your opinion, that Clear Lake hitch is likely to become, in the foreseeable future, at serious risk of becoming extinct throughout all or a significant portion of its range in California.

We ask that you assess our work for quality and conduct a thorough and proper review. As with all peer review processes, the reviewer is not the final arbiter, but your comments will inform our final decision-making. Also, please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Kevin Thomas at kevin.thomas@wildlife.ca.gov, or he may be reached by telephone at (916) 358-2845.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Stafford Lehr
Chief, Fisheries Branch

Enclosure(s)

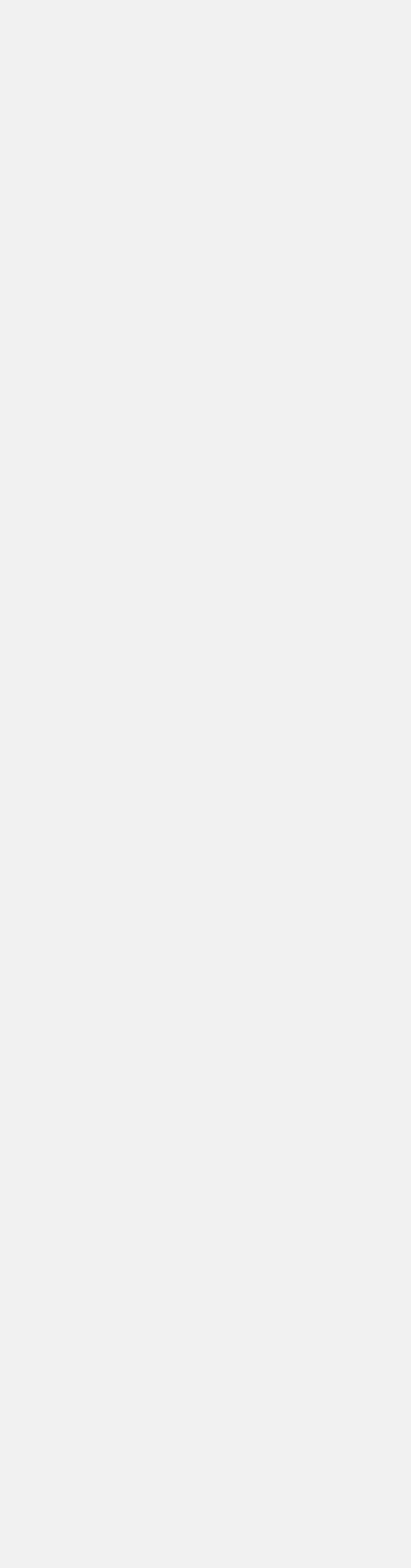
cc: Tina Bartlett
CDFW-NCR

Name, Title
Business
Date
Page 3

Thomas Gibson
CDFW-OGC

Katherine Hill
CDFW-NCR

Kevin Thomas
CDFW-NCR



1
2
3 **State of California**
4 **Natural Resources Agency**
5 **Department of Fish and Wildlife**
6
7

8
9 **REPORT TO THE FISH AND GAME COMMISSION**
10

11
12
13
14 **A STATUS REVIEW OF CLEAR LAKE HITCH (*Lavinia exilicauda ch*)**
15

16
17 **January 2014 Preliminary Draft for Peer Review**
18
19
20



21
22 Clear Lake hitch adult. Photo courtesy of Rick Macedo
23
24

25
26 **Charlton H. Bonham, Director**
27 **Department of Fish and Wildlife**
28
29
30



31
32 Report to the Fish and Game Commission

A STATUS REVIEW OF CLEAR LAKE HITCH

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

Contents

LIST OF FIGURES.....	4
LIST OF APPENDICES	4
EXECUTIVE SUMMARY	5
Background	5
Summary of Findings.....	5
Status	5
Threats	5
Petitioned Action	5
Management and Recovery Recommendations.....	6
INTRODUCTION.....	6
Petition History	6
Department Review	6
BIOLOGY.....	7
Species Description	7
Taxonomy.....	7
Range and Distribution	7
Life History	9
Habitat that May be Essential to the Continued Existence of the Species.....	10
SPECIES STATUS AND POPULATION TRENDS.....	10
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE.....	19
Present or Threatened Modification or Destruction of Habitat	19
Wetland Habitat Loss.....	19
Spawning Habitat Exclusion and Loss	19
Water Quality Impacts	23
Overexploitation	26
Commercial Harvest.....	26
Cultural Harvest	26
Predation and Competition	27
Disease and Parasites.....	28

1	Other Natural Occurrences or Human Related Activities	29
2	Climate Change	29
3	Recreational Activities	30
4	REGULATORY AND LISTING STATUS.....	30
5	Federal	30
6	State	31
7	Other Rankings.....	31
8	EXISTING MANAGEMENT EFFORTS.....	31
9	Resource Management Plans	31
10	Monitoring and Research.....	33
11	Habitat Restoration Projects.....	34
12	Impacts of Existing Management Efforts.....	34
13	SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE HITCH IN CALIFORNIA	34
14	Present or Threatened Modification or Destruction of Habitat	35
15	Overexploitation	36
16	Predation.....	36
17	Competition	36
18	Disease	37
19	There are no known diseases that are significant threats to the continued existence of CLH.	37
20	Other Natural Occurrences or Human-related Activities	37
21	SUMMARY OF KEY FINDINGS.....	37
22	RECOMMENDATION FOR PETITIONED ACTION.....	37
23	PROTECTION AFFORDED BY LISTING	38
24	MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES	39
25	PUBLIC RESPONSE	40
26	PEER REVIEW.....	40
27	LITERATURE CITED	40
28		
29		
30		

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

LIST OF FIGURES

Figure 1. Map depicting the Clear Lake watershed. 8

Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis. 13

Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013. 15

Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010. 16

Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001. 17

Figure 6. Photo from 1890s depicting spawning CLH being stranded in Kelsey Creek. 18

Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed. 21

LIST OF APPENDICES

Appendix A. Summary graphs of spawning observations between 2005 and 2013

Appendix B. Figures depicting CLH observations on spawning tributaries

Appendix C. Description of barriers associated with CLH spawning tributaries

1 **EXECUTIVE SUMMARY**

2
3 This status review report describes the current status of Clear Lake hitch (*Lavinia*
4 *exilicauda chi*) (CLH) in California as informed by the scientific information available to
5 the California Department of Fish and Wildlife (Department, CDFW, CDFG).
6

7 **Background**

- 8 • September 25, 2012: The Fish and Game Commission (Commission) received a
9 petition from the Center for Biological Diversity to list CLH as threatened under
10 the California Endangered Species Act (CESA) (Center for Biological Diversity
11 2012).
- 12 • September 26, 2012: The Commission sent a memorandum to the Department,
13 referring the petition to the Department for its evaluation.
- 14 • October 12, 2012: The Commission provided notice of the received petition from
15 the Center for Biological Diversity to list CLH as threatened under CESA (Cal.
16 Reg. Notice Register 2012, Vol. 41-Z, p.1502).
- 17 • December 12, 2012 the Commission granted a 30-day extension on the
18 submission date for the Department's Initial Review of Petition to List the Clear
19 Lake Hitch as threatened under CESA.
- 20 • January 31, 2013: The Department provided the Commission with an Initial
21 Review of Petition to List the Clear Lake Hitch as Threatened under the
22 California Endangered Species Act pursuant to Fish and Game Code, section
23 2073.5. The Department's review recommended that the petition provided
24 sufficient information to indicate the petitioned action may be warranted, and the
25 petition should be accepted and considered (CDFW 2013).
- 26 • March 6, 2013: At its scheduled public meeting in Mt. Shasta, California, the
27 Commission considered the petition, the Department's petition evaluation and
28 recommendation, and comments received by the Commission and found that the
29 petition provided sufficient information to indicate the petitioned action may be
30 warranted.
- 31 • March 22, 2013: The Commission published its Notice of Findings in the
32 California Regulatory Notice Register (CA Reg. Notice Register 2013, Vol. 12-Z
33 p. 488), stating the petition was accepted for consideration, and designated CLH
34 as a candidate species.

35 **Summary of Findings**

36
37 *Note to Reviewer.* This Summary of Findings will be finalized after the Department
38 receives, evaluates, and incorporates peer-review comments as appropriate.

39 **Status**

40 **Threats**

41 **Petitioned Action**

42

1 **Management and Recovery Recommendations**

2 **INTRODUCTION**

3
4 This status review report addresses the Clear Lake hitch (*Lavinia exilicauda chi*) (CLH),
5 the subject of a petition to list the species as threatened under the California
6 Endangered Species Act (CESA) (Fish & G. Code § 2050 *et seq.*).

7 **Petition History**

8
9 On September 25, 2012, the Fish and Game Commission (Commission) received a
10 petition from the Center for Biological Diversity (Petitioner) to list the CLH as a
11 threatened species under CESA.

12
13 On September 26, 2012 the Commission sent a memorandum to the California
14 Department of Fish and Wildlife (Department, CDFW, and CDFG) referring the petition
15 to the Department for its evaluation.

16
17 On October 12, 2012, as required by Fish and Game Code, section 2073.3, notice of
18 the petition was published in the California Notice Register (Cal. Reg. Notice Register
19 2012, Vol. 41-Z, p.1502).

20
21 On December 12, 2012 the Commission granted a 30-day extension on the submission
22 date for the Department's Initial Review of Petition to List the CLH as threatened under
23 CESA.

24
25 On January 31, 2013, the Department provided the Commission with its Initial Review of
26 Petition to List the CLH as threatened under CESA. Pursuant to Fish and Game Code,
27 section 2073.5, subdivision (a) (2), the Department recommended that the petition
28 provided sufficient information to indicate the petitioned action may be warranted.

29
30 On March 6, 2013 at its scheduled public meeting in Mt. Shasta, California, the
31 Commission considered the petition, the Department's petition evaluation and
32 recommendation, and comments received, and found that sufficient information existed
33 to indicate the petition may be warranted and accepted the petition for consideration.

34
35 Subsequently, on March 22, 2013 the Commission published its Notice of Findings for
36 CLH in the California Regulatory Notice Register, designating the CLH as a candidate
37 species (CA Reg. Notice Register 2013, Vol. 12-Z p. 488).

38 **Department Review**

39
40 Following the Commission's action to designate CLH as a candidate species, the
41 Department notified affected and interested parties and solicited data and comments on
42 the petitioned action, pursuant to Fish and Game Code, section 2074.4 (see also Cal.
43 Code Regs., Title 14, § 670.1(f)(2)) (CDFW 2013). All comments received are included
44 in Appendix D to this report. The Department commenced its review of the status of the
45 species as required by Fish and Game Code section 2074.6.

1
2 This report reflects the Department's scientific assessment to date of the status of CLH
3 in California. At this point, the report will undergo independent and competent peer
4 review by scientists with acknowledged expertise relevant to the status of CLH. Once
5 peer review is completed Appendix E will contain the specific input provided to the
6 Department by the individual peer reviewers (Cal. Code Regs., Title 14, § 670.1(f) (2)).

7 **BIOLOGY**

8 **Species Description**

9
10 Clear Lake hitch is a member of the cyprinid family (Cyprinidae), growing to 35
11 centimeters (cm) standard length (SL), and with laterally compressed bodies, small
12 heads and upward pointing mouths (Moyle et al. 1995). They are separated from other
13 California minnows by their long anal fin consisting of 11 to 14 rays. The dorsal fin (10
14 to 12 rays) originates behind the origin of the pelvic fins. Juvenile CLH have a silver
15 coloration with a black spot at the base of the tail. As CLH grow older the spot is lost
16 and they appear yellow-brown to silvery-white on the back. The body becomes deeper
17 in color as the length increases (Hopkirk 1973; Moyle 2002). CLH show little change in
18 pigmentation during the breeding season (Hopkirk 1973). The deep, compressed body,
19 small upturned mouth, and numerous long slender gill rakers (26 to 32) reflect the
20 zooplankton-feeding strategy of a limnetic forager (Moyle 2002). This lake adapted
21 subspecies also has larger eyes and larger scales than other hitch subspecies.

22 **Taxonomy**

23
24 Hopkirk (1973) described CLH as a lake-adapted subspecies based primarily on the
25 greater number of fine gill rakers. CLH are distinguished from other subspecies of hitch
26 by their deeper body, larger eyes, larger scales and more gill rakers (Hopkirk 1973).
27 Recent research on 10 microsatellite loci supports Hopkirk's description of CLH as a
28 distinct subspecies (Aguilar et al. 2009). However, mitochondrial DNA analysis has not
29 been able to distinguish CLH as a distinct subspecies from other hitch in California.
30 Yet, based upon the morphological and microsatellite analysis there is sufficient
31 evidence to warrant the designation of CLH as a distinct subspecies of hitch (Hopkirk
32 1973; Moyle et al. 1995; Aguilar et al. 2009).

33
34 CLH can hybridize with other Cyprinidae species and hybridization is known to occur
35 with the genetically similar California roach (*Lavinia symmetricus*) (Miller 1945b; Avise
36 and Ayala 1976; Moyle and Massingill 1981; Moyle et al. *in review*). However, there is
37 no documentation of these hybrids in Clear Lake. CLH were known to hybridize in
38 Clear Lake with the now extinct thickettail chub (*Gila crassicauda*) (Moyle et al. *in review*).

39 **Range and Distribution**

40
41 The entire CLH population is confined to Clear Lake, Lake County, California, and to
42 associated lakes and ponds within the Clear Lake watershed such as Thurston Lake
43 and Lampson Pond (Figure 1). Populations previously identified in the Blue Lakes, west
44 of Clear Lake, have apparently been extirpated (Macedo 1994).

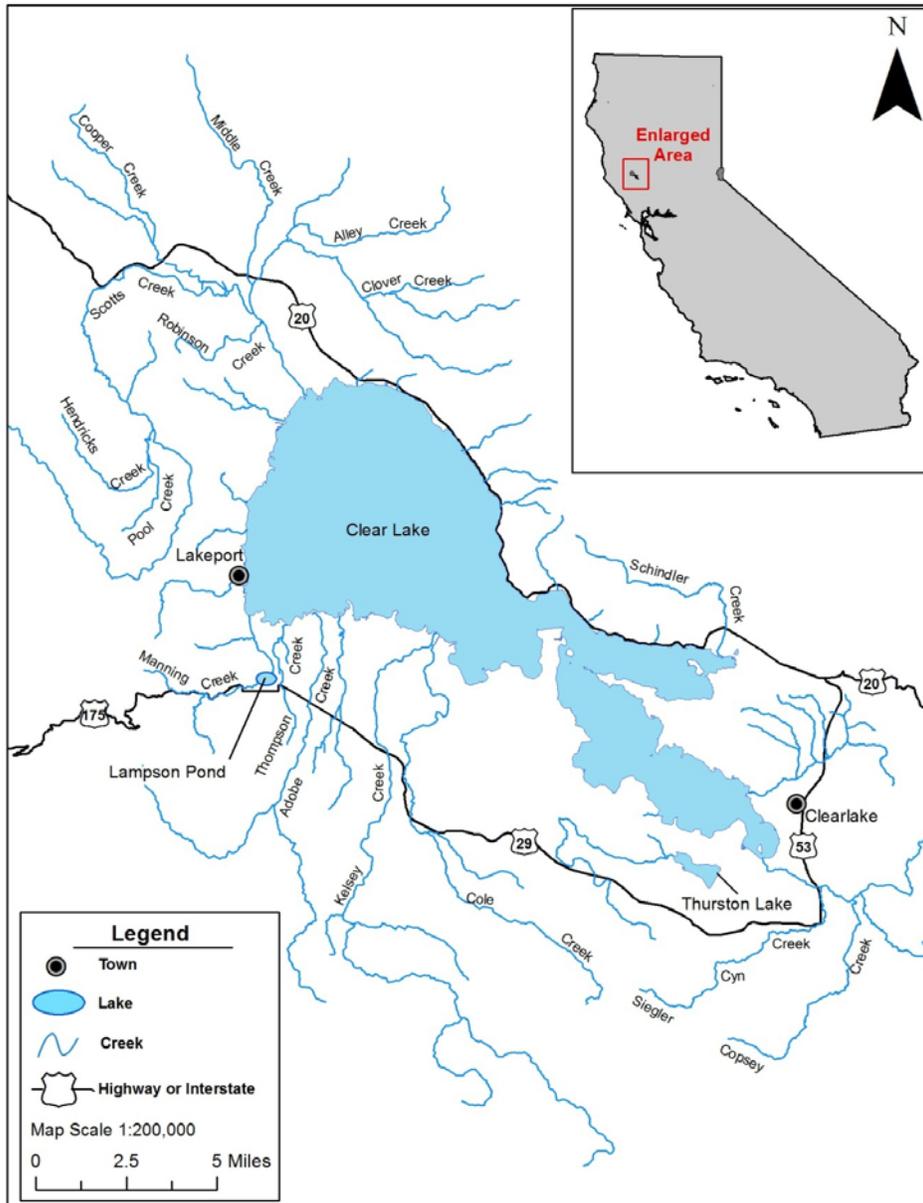


Figure 1. Map depicting the Clear Lake watershed.

1
2
3
4
5

1 Life History

2
3 Physical adaptations to lake conditions allow CLH greater than 50 millimeters (mm) SL
4 to feed ~~largely almost exclusively~~ on water fleas (*Daphnia* spp.) (Geary 1978; Geary
5 and Moyle 1980; Moyle 2002). Stomach analysis indicates that CLH feed primarily in
6 the day rather than at night (Geary 1978). Juveniles less than 50 mm SL are found in
7 shallow, littoral zone (near-shore) waters and feed primarily on the larvae and pupae of
8 ~~C~~chironomidae; planktonic crustaceans including the genera *Bosminia* and *Daphnia*;
9 and historically on the eggs, larvae, and adults of Clear Lake gnat (*Chaoborus*
10 *astictopus*) (Lindquist et al. 1943; Geary 1978; Geary and Moyle 1980). Growth in CLH
11 is faster and total size greater than that of other hitch subspecies (Nicola 1974). By
12 three months CLH have reached 44 mm SL and will continue to grow to between 80 to
13 120 mm by the end of their first year (Geary and Moyle 1980). Females become mature
14 by their second or third year, whereas males tend to mature in their first or second year
15 (Kimsey 1960). Females grow faster and are larger at maturity than males (Hopkirk
16 1973; Geary 1978; Ringelberg and McGinnis 2009). The larger size of CLH in
17 comparison to hitch from other locations translates to greater fecundity. Accordingly,
18 spawning females in Clear Lake average 36,000 eggs each year (Geary and Moyle
19 1980) compared to an average of 26,000 eggs for hitch in Beardsley Reservoir (Nicola
20 1974). Scale analysis indicates CLH live up to 6 years but it is likely that some
21 individuals live longer (Moyle 2002).

22
23 CLH spawn in both lake tributaries and in the lake itself. Clear Lake tributaries are
24 numerous and located around the lake basin (Figure 1). Most streams have
25 headwaters at higher elevations in the surrounding foothills; ~~others have headwaters in~~
26 ~~lower elevations of the basin,~~ and nearly all have low gradients in their lower reaches.
27 Some streams ~~have are more substantial than others with~~ flowing water year round, at
28 least in headwaters. ~~The lower reaches of tributary streams~~ Most are seasonal with
29 remnant pools occurring by late spring, and subsequently dry during summer months in
30 most years. ~~Those that retain water year round often have long stream reaches that are~~
31 ~~ephemeral.~~ CLH spawn in these low-gradient tributary streams and have form
32 spawning migrations that resemble small scale salmon runs. Spawning migrations
33 usually occur in response to heavy spring rains, from mid-February through May and
34 occasionally into June (Murphy 1948b; Kimsey 1960; Swift 1965; Chi Council for Clear
35 Lake Hitch (CCCLH) 2013 (unpublished data)). During wet years, CLH spawning
36 migrations may also opportunistically extend into the upper reaches of various small
37 tributaries, drainage ditches, and even flooded meadows (Moyle et al. *in review*). CLH
38 have also been observed spawning along the shores of Clear Lake, over clean gravel in
39 water 1 to 10 cm deep where wave action cleans the gravel of silt (Kimsey 1960). The
40 success of these ~~atypical~~ spawning ~~events areas~~ is not clearly understood and may be
41 limited due to losses from ~~egg desiccation and juvenile~~ predation on eggs and larvae,
42 especially by alien fishes such as bluegill and Mississippi silverside (Kimsey 1960;
43 Rowan, J. personal communication, October 10, 2013, unreferenced).

44
45 CLH spawn at water temperatures of 14 to 18°C in the lower reaches of tributaries. Egg
46 deposition occurs along the margins of streams in very shallow riffles over clean, fine-
47 to-medium sized gravel (Murphy 1948b; Kimsey 1960). Eggs are fertilized by one to
48 five males as they are released from the females (Murphy 1948b; Moyle 2002). Eggs

Comment [PM1]: ? which ones?

1 are non-adhesive and sink to the bottom after fertilization, where they become lodged
2 among the interstices in the gravel. The eggs immediately begin to absorb water and
3 swell to more than double their original size. This rapid expansion provides a protective
4 cushion of water between the outer membrane and the developing embryo (Swift 1965)
5 and may help to secure eggs in gravel interstices. The embryos hatch after
6 approximately 7 days, and larvae become free-swimming after another 7 days (Swift
7 1965). Larvae must then move downstream to the lake before stream flows become
8 ephemeral (Moyle 2002).

9
10 Within Clear Lake, larvae remain near shore and are thought to depend upon stands of
11 tules (*Schoenoplectus acutus*) and submerged weeds for cover until they assume a
12 limnetic lifestyle (CDFG 2012). Juvenile CLH require rearing habitat with water
13 temperatures of 15° C or greater for survival (Moyle 2002; Franson 2012 and 2013).
14 Juveniles are found in littoral shallow-water habitats and move into deeper offshore
15 areas after approximately 80 days, when they are between 40 to 50 mm SL (Geary
16 1978; CDFG 2012). Adult CLH are usually found in the limnetic zone (well-lit, surface
17 waters away from shore) of Clear Lake. The limnetic feeding behavior of adult fish is
18 supported by stomach analysis of CLH where very little content of benthic midges was
19 found, even though the fish were collected in the profundal (deep-water) habitat during
20 the survey (Cook et al. 1964). Additional data collected by the Department during the
21 early 1980s indicates CLH are present in the littoral zone from April to July and are
22 ~~scarce in absent from~~ this habitat during other months (Week 1982).

23
24 Adult CLH are vulnerable to predation during their spawning migration by mergansers
25 (*Mergus* spp.), herons (*Ardea* spp.), bald eagles (*Haliaeetus leucocephalus*), and other
26 birds, river otter (*Lontra canadensis*), northern raccoon (*Procyon lotor*), and striped
27 skunk (*Mephitis mephitis*) (Bairrington 1999). In addition, CLH have been recovered
28 from the stomachs of black bass (*Micropterus* spp.) caught in the lake (Bairrington
29 1999). Most predation by black bass likely occurs during spring staging periods as CLH
30 congregate and begin to ascend tributaries to spawn (Rowan, J. personal
31 communication, October 10, 2013, unreferenced).

Comment [PM2]: Are you sure? Bass fisherman use a hitch luare in the lake....

32 **Habitat that May be Essential to the Continued Existence of the Species**

33
34 At various life stages CLH utilize stream and lacustrine (lake) habitat present in the
35 watershed (Figure 1). Adult fish spawn in the tributaries of the lake during the spring
36 and juvenile fish emerge from the tributaries and utilize near shore habitats to continue
37 growth and seek refuge from predators. As juveniles mature into adults they move to
38 the main body of the lake and assume a limnetic lifestyle until returning to spawn in the
39 tributaries or shallows of the lake during the following spring.

40 **SPECIES STATUS AND POPULATION TRENDS**

41
42 Ideally, a An assessment of the status of CLH should include statistically valid population
43 estimates conducted over time, to provide population data and trends. CLH studies to
44 date have consisted primarily of qualitative sampling and are not suitable for deriving
45 population estimates; however, these study results can provide insight into the current

1 status of the species. [Glimpses into baseline numbers suggest that hitch were once](#)
2 [very abundant. One of the oldest records is that of Livingston Stone \(1876\) who lived on](#)
3 [the lake in 1872 and 1873. He states “ They ran up the streams in spring to spawn in](#)
4 [countless numbers. It is not unusual to see one or two acres of ground covered with](#)
5 [hitch, which the Indians have dried for food.” If you assume each drying fish is about](#)
6 [10 x 3 inches, this results in an estimate of about 200,000 fish per acre. Obviously,](#)
7 [such numbers are at best ‘ball park’ estimates but they do suggest hitch were vastly](#)
8 [more abundant then than they are today.](#)
9

10
11
12
13 The population trends for this status review focus on three sets of data available to the
14 Department for analysis. First, commercial catch records, submitted to the department
15 by operators on Clear Lake, contain incidental catch information on CLH dating back to
16 1961. Operators were required to keep records of CLH caught incidentally while
17 operations focused on other species in the lake. Second, the Lake County Vector
18 Control District (LCVCD) has been conducting sampling efforts along the shoreline of
19 Clear Lake since 1987. Although sampling efforts are not specific to CLH, LCVCD
20 recorded incidental data on CLH captured during each sampling. Third, spawning
21 observation data have been collected by volunteers with the CCCLH since 2005.
22 Spawning observation data provide an estimate of the number of CLH in any given
23 spawning tributary during the observation period. Results are summarized by the
24 CCCLH each year following the completion of the spawning season. Information on
25 population trends prior to 1961 is focused on small sampling efforts, published articles,
26 and traditional ecological knowledge from tribal members. Although not quantifiable,
27 this data provides an idea of the status and distribution of CLH prior to larger qualitative
28 sampling efforts.
29

30 Environmental conditions required for successful spawning and biological impacts to the
31 survivorship of CLH are highly variable from year to year and often result in multiple
32 years with reduced spawning success or reduced recruitment into the population. The
33 information presented in Figure 2 comes from the three qualitative sampling efforts
34 conducted at Clear Lake and measured rainfall totals during the past 52 years in the
35 watershed. Trend data in commercial catch records were represented for a given year
36 by totaling the number of CLH captured per year and dividing by the number of days
37 commercial operations occurred. Commercial catch data are comprised primarily of
38 adult CLH. The CLH spawning trend data were calculated by totaling the number of
39 CLH observed and dividing by the number of observation periods. LCVCD data on CLH
40 captures represent the total number of CLH captured per year. LCVCD data is
41 comprised primarily of juvenile CLH. The data represented from Table 6 of CDFG
42 (1999) were calculated by using 20,000 as a total catch baseline for percent of total
43 catch for CLH. Total rainfall data for January to June of each year was measured at the
44 Clear Lake Highlands and U.S. Geological Survey rainfall gauges. Figure 2 does not
45 reflect population numbers but rather trends in the abundance of CLH in any given year.
46 As a proxy for changes in an established population size, biologists often use qualitative
47 information as an indicator of population trends.
48

1 The trends of all data show a highly variable population that responds both positively
2 and negatively to environmental parameters and varies significantly from year to year.
3 | Rainfall totals do not appear to be significantly correlated to ~~the~~ abundance of CLH
4 during the timeframe. It is likely that a combination of environmental factors is
5 impacting the CLH population. The fluctuating abundance trend has continued
6 throughout the duration of the qualitative sampling efforts and indicates CLH
7 | populations have at times been extremely low and at other times relatively high robust.
8

DRAFT

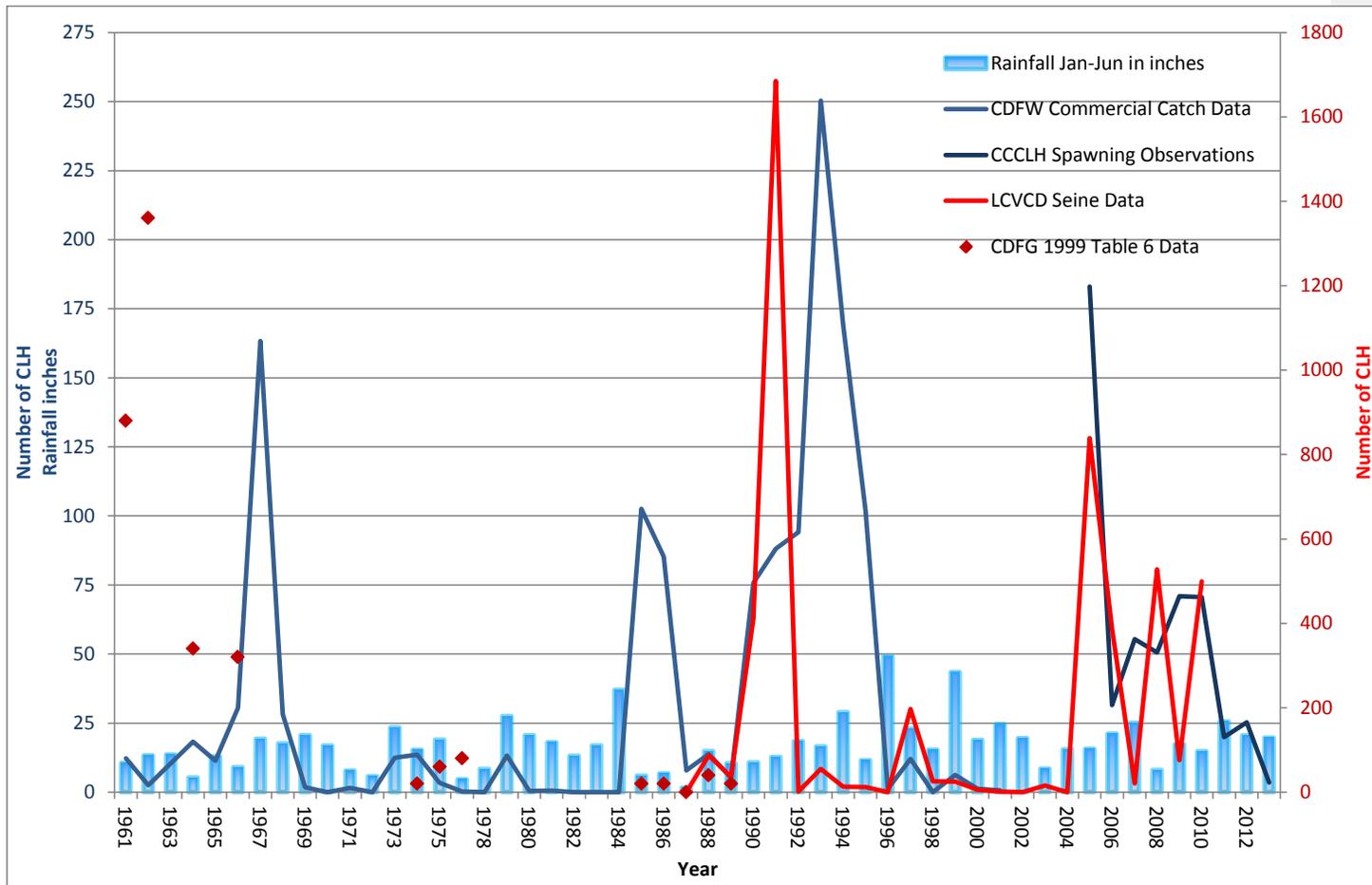


Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis.

1 In 2013 the Department conducted a mark-and-recapture study to gain a better
2 understanding of the CLH spawning population in Cole and Kelsey creeks.
3 Unfortunately, too few individuals were marked and recaptured to give a statistically
4 valid population estimate (Ewing 2013). Electrofishing surveys in June 2012 identified
5 thousands of young of year CLH in near shore habitats along the southwestern
6 shoreline of Clear Lake (CDFG 2012). Volunteers with the CCCLH conducted direct
7 observations of CLH in spawning tributaries of Clear Lake in 2013, and spawning
8 observations identified less than 500 CLH present (CCCLH 2013). Of those fish, 300 to
9 400 were found below the Kelsey Creek detention dam. No single day count totaled
10 more than 70 fish in any spawning tributary in 2013 (CCCLH 2013).

11
12 CCCLH qualitative spawning observations between 2005 and 2013 indicated peak
13 single day CLH spawning runs of 1,000 to 5,000 fish (CCCLH 2013), and daily
14 observation averages ranged from 3.5 to 183.1 fish (Figure 2). However, these
15 observations make no distinction between previously counted fish, and it may be more
16 prudent to look at fixed location single day counts from this time period. The highest
17 number of CLH observations recorded was approximately 5,000 during 2005;
18 concurring with beach seine data that demonstrate a higher than average number of
19 CLH caught in 2005 as well (CCCLH 2013; LCVCD 2013). The increased number of
20 juvenile CLH captured in the 2005 beach seine sampling is the likely reason for the
21 increase in adult spawning observations between 2007 and 2009. Appendix A contains
22 summary graphs and figures, prepared by CCCLH, for observations made between
23 2005 and 2013.

24
25 There is sufficient information from these spawning observations to suggest the number
26 of spawning tributaries being used by CLH decreased in 2013 compared to the average
27 from 2005 to 2012 (Figure 3) (CCCLH 2013). However, the data limitations do not allow
28 for quantification of observation time on each creek (survey effort) compared with the
29 number of fish observed to aid in understanding the extent of use in each tributary.
30 Appendix B contains figures depicting the decline in annual spawning runs in Clear
31 Lake tributaries between 2005 and 2013 (CCCLH 2013). Historic accounts and habitat
32 suitability predications suggest that CLH originally spawned, to some degree, in all the
33 tributaries to Clear Lake (Robinson Rancheria Ecological Center (RREC) 2011).
34 However, reports on Pomo geography speak of Pomo tribes in the area travelling to
35 Kelsey Creek to capture CLH and even of war when a tribe tried to divert Kelsey Creek
36 to gain control of the important CLH supply (Barrett 1906; Kniffen 1939). Based on
37 this reports it is unclear to what extent CLH spawned in other tributaries to Clear Lake.
38 It can be surmised the majority of CLH spawning occurred in Kelsey Creek during this
39 period. Over the past eight years the number of occupied spawning tributaries has
40 decreased from a high of 12 in 2006 to three in 2013 (CCCLH 2013). Currently, Adobe
41 Creek seems to have the largest spawning run in the Clear Lake watershed while
42 Kelsey and Cole creeks support smaller spawning runs. Based on historical accounts
43 the most important primary spawning tributary has shifted from Kelsey Creek to Adobe
44 Creek (Kniffen 1939; CCCLH 2013).

Comment [PM3]: I disagree. Kelsey Creek presumably supported the largest run because of its size but there is no reason to think the fish did not use every available tributary as they do today.

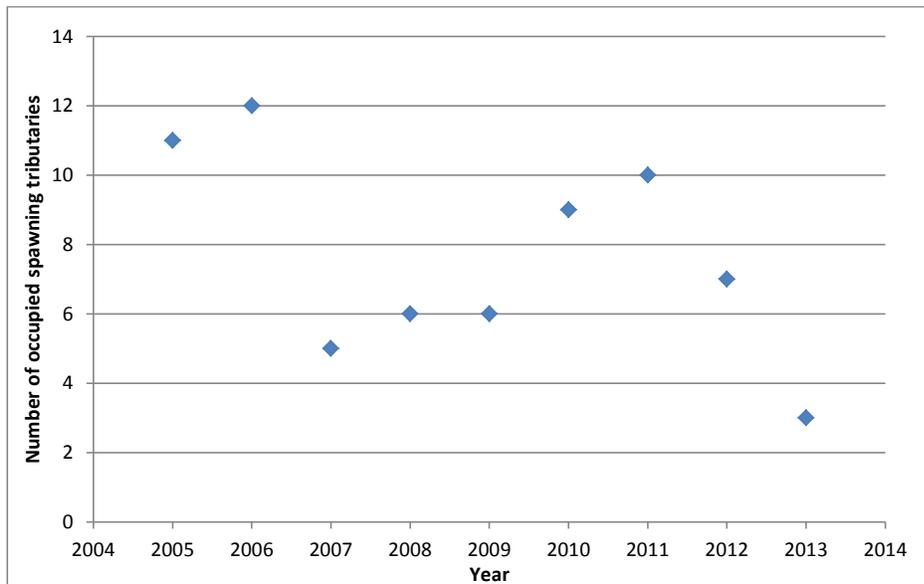


Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013.

1
2
3
4
5 LCVCD has been collecting beach seine data at various sites around the lake for more
6 than two decades. The sampling is designed to measure abundance of threadfin shad
7 (*Dorosoma petenense*) and [Mississippi inland silversides](#) (*Menidia audensberryllina*) as
8 part of a Clear Lake gnat (*Chaoborus astictopus*) surveillance program. Incidental
9 captures of CLH are recorded during these surveys; however, the data collected are not
10 appropriate for a statistically valid evaluation of CLH populations as ~~the sampling~~
11 ~~design~~ varies significantly in timing, water quality conditions, and lake depth during
12 surveys. Additionally, sample locations are in areas that contain open unvegetated
13 beaches that are not preferred habitat for CLH. Although surveys were not conducted
14 to assess CLH, capture data for these surveys is consistent with other data sources in
15 demonstrating a population that has poor recruitment in many years interspersed with
16 few years of high levels of recruitment (Figure 4) (LCVCD 2013). In most years less
17 than 100 CLH are captured during the surveys (17 of 24 years). Four of the six years
18 when more than 100 CLH were captured were between 2005 and 2010. The greatest
19 numbers of CLH were captured in 1991, a year that was described by the Department
20 as a boom for juvenile fish in the lake (Bairrington 1999). Commercial fisheries data
21 from 1991 also indicate an increase in CLH numbers captured during operations; over
22 6,000 CLH were captured and released by commercial fishery operators between
23 March and May in 1991 (CDFW Commercial Fisheries Data). Data from the early
24 1990s also indicate an increase in zooplankton and macroinvertebrate numbers
25 resulting in increased available forage for CLH (Winder et al. 2010).
26

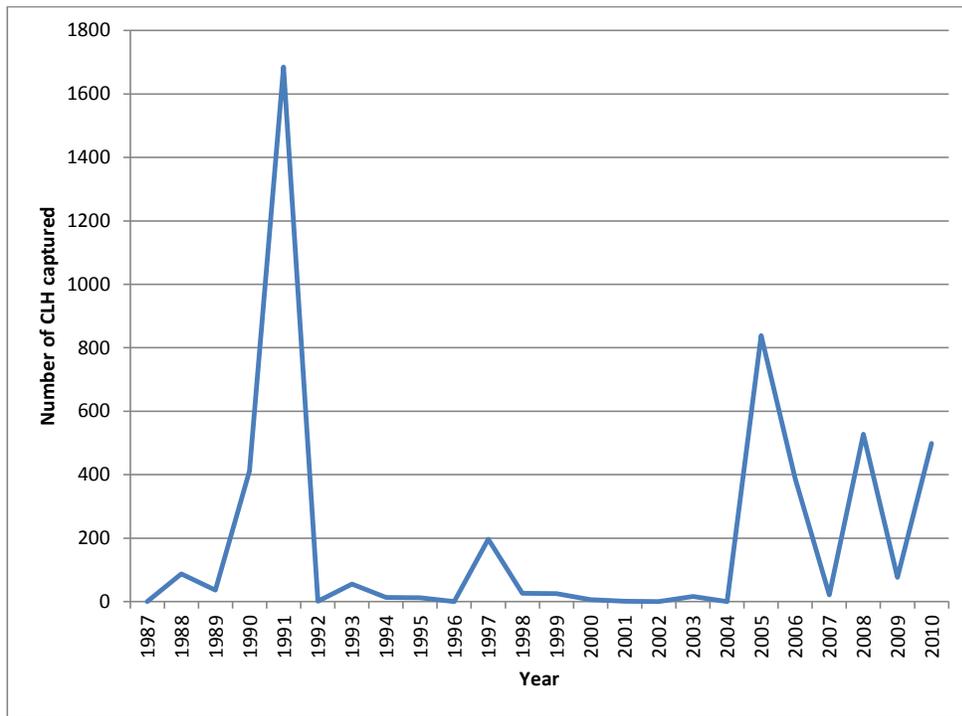


Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010.

1
2
3
4
5
6
7
8
9
10
11
12

The data available to the Department that cover the greatest timeframe come from commercial harvest records for Clear Lake. These data, 1961 to 2001, provide estimates of CLH numbers captured incidentally during operations (Figure 5). Multiple times throughout the past 50 years the number of CLH captured has surpassed 10,000 fish. There are also several years where CLH were almost or entirely absent from sample collections. These data suggest that CLH can sustain a population through multiple years of suppressed spawning or recruitment or both.

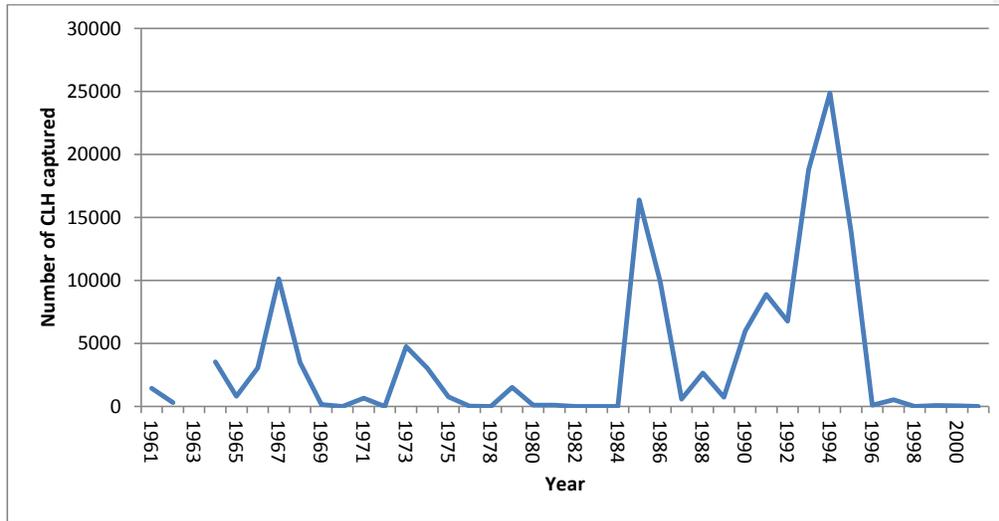


Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001.

In the 1980s, the Department began sampling Clear Lake fishes to assess native and sport fish populations in the lake. Surveys found adult and juvenile (?) CLH occupying littoral habitats between April and July each year (Week 1982). The surveys were directed towards littoral zone use and provide no information on CLH outside of those months (Week 1982). An electrofishing survey was completed in April of 1987, and CLH was the most abundant fish sampled at locations around Rattlesnake Island and Clearlake Oaks subdivision; however, only a total of 52 CLH were captured during the survey (CDFG 1988). It must be noted that this sampling was on a very small scale, targeted black crappie (*Pomoxis nigromaculatus*), and occurred in habitats where CLH would not likely be found during this time period. Additional spring and fall sampling between 1995 and 2006 found CLH to be the most abundant native fish, but the overall capture numbers were relatively low with a peak catch per unit effort (CPUE) of only 0.087 for juvenile fish in the fall of 2000 and 0.169 for adult fish in the spring of 1999. CPUE's were based on the number of fish caught per minute of electrofishing (Cox 2007). Electrofishing surveys conducted during late June 2007 reported low numbers of CLH recorded during the survey (Rowan 2008). The low numbers of CLH may be attributed to the sampling timeframe in late June. As noted in Cook et al. 1964, CLH were absent from littoral zone sampling following the start of summer. In an effort to reduce impacts to CLH while sampling, the Department's Clear Lake surveys between 2008 and 2012 were all confined to the timeframe of late June and July when CLH numbers are greatly reduced in the littoral zone.

Comment [PM4]: Using a boat electrofisher?

As late as 1972, CLH and other nongame fish were described as comprising the bulk of the Clear Lake fishery (Puckett 1972). The Lake County Mosquito Abatement District conducted surveys between 1961 and 1963 examining the relationship between fish and midges. These surveys identified CLH as the third most abundant fish in the lake.

1 The majority of CLH were captured in the littoral and profundal zones using gill nets.
 2 However, the limnetic zone was not sampled since midges do not occur in this area. A
 3 total of 1,229 fish was taken during these surveys (Cook et al. 1964).
 4
 5 Field notes from CDFG biologists in 1955 note CLH runs with large numbers in Kelsey
 6 Creek (CDFG 1955). Similar notes from 1956 indicate spawning CLH in Kelsey Creek
 7 as numbering in the hundreds and Seigler Creek containing 400 CLH for every 100 feet
 8 of stream above the Anderson Brothers ford (CDFG 1956). CLH were the second most
 9 abundant fish caught during various gill net surveys in the lake ~~in at that time (Lindquist~~
 10 ~~et al. 1943).~~ Surveys conducted between 1938 and 1941, for examination of fish and
 11 gnat interactions (Lindquist et al. 1943); ~~describe the~~ runs of Sacramento splittail
 12 (*Pogonichthys ciscooides*; *Ptychocheilus grandis*) and CLH ~~were described~~ as numbering
 13 in the tens of thousands (Lindquist et al. 1943). A photograph from 1890 depicts a
 14 spawning run so thick that CLH formed a blanket across the creek (Figure 6). Early
 15 stories from the area describe fish runs so thick that streams were difficult to ford by
 16 horses and wagons, and residents shoveled spawning fish to bring home for hog feed
 17 (Rideout 1899). The volume of dead fish found during spawning runs on Clear Lake
 18 tributaries created a stench that was intolerable to lakeshore residents (Dill and
 19 Cordone 1997). It is not entirely clear if spawning runs such as those depicted in Figure
 20 6 occurred every year or fluctuated based on tributary flows, but it is likely they
 21 fluctuated in a similar fashion to what was observed during the past decade of CCCLH
 22 spawning surveys. Regardless, the body of evidence lends support for claims of CLH
 23 as common and the most abundant fish in Clear Lake during the late nineteenth and
 24 early twentieth centuries (Coleman 1930; Jordan and Gilbert 1894).
 25
 26

Formatted: Font: Italic
 Formatted: Font: Italic
 Comment [PM5]: Hard to tell what species....



27
 28
 29 **Figure 6.** Photo from 1890s depicting spawning fish, most likely CLH, being
 30 stranded in Kelsey Creek.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Present or Threatened Modification or Destruction of Habitat

Wetland Habitat Loss

Wetlands provide critical rearing habitat for juvenile fishes native to Clear Lake (Geary 1978; CDFG 2012). Prior to the arrival of European settlers in the mid-1800s, Clear Lake was surrounded by large tracts of wetlands. Throughout the expansion of European settlements around the lake, the wetland habitat was drained and filled to provide urban and agricultural lands. Currently, the Clear Lake watershed contains over 16,000 acres of land dedicated to agricultural production (Lake County Department of Agriculture 2011; Forsgen Associates Inc. 2012). Comparisons of historical versus current wetland habitat reveal a loss of approximately 85%, from 9,000 acres in 1840 to 1,500 acres by 1977 (Week 1982; Bairrington 1999; Suchanek et al. 2002; ; Lake County Department of Public Works 2003; Giusti 2009; CEPA 2012). Loss of wetland habitat coupled with competition for existing habitat with introduced fishes has led to a decline in available rearing habitat for juvenile CLH (Week 1982).

Spawning Habitat Exclusion and Loss

Dams, Barriers, and Diversions

Cache Creek Dam was constructed at the outlet of Clear Lake in 1915, and Yolo County Flood Control and Water Conservation District (YCFCWCD) manipulates the lake water level several feet seasonally to allow for diversions for irrigation (CDWR 1975). Clear Lake is allowed to fluctuate on a yearly basis, a maximum of 7.56 feet above a mean level plane referred to as the "Rumsey gage" (CDWR 1975). The effects of lake water manipulations on CLH populations have not been quantified. Manipulation of water levels in the Clear Lake watershed likely results in decreased water quality, a reduction in spawning and rearing habitat, and increased risk of predation (Converse et al. 1998; Wetzel 2001; Gafny et al. 2006; Cott et al. 2008; Hudon et al 2009). All of these impacts can lead to the extinction of native species that evolved in lakes free of habitat modifications resulting from impoundment structures (Wetzel 2001). Impounded systems also tend to be dominated by non-native species (Moyle and Light 1996).

CLH spawn in low-gradient tributary streams to Clear Lake. All of the tributary streams to Clear Lake have been altered (Appendix C) to various degrees by dams, barriers, and diversions. Stream alterations can block migratory routes and decrease stream flows necessary for spawning. The result can be loss of spawning and rearing habitat, loss of nursery areas, increases in predation, competition from non-native aquatic species, and decreased water quality (Murphy 1948 and 1951; Moyle 2002;). A limited physical habitat analysis survey was conducted in 2013 on Adobe, Kelsey, Manning,

Comment [PM6]: Clear Lake is not a classic impoundment being a natural lake. One could argue that keeping lake levels higher in spring could benefit hatch (more littoral habitat for young).

1 Middle, and Scotts creeks. Results of the survey indicate all of the [lower reaches? of](#)
2 [the](#) creeks had low Index of Biological Integrity (IBI) scores and are either partially or
3 not supportive of aquatic life (Mosley 2013). Examples of alterations to Clear Lake
4 tributaries that have impacted CLH include agricultural irrigation pumps and diversions,
5 aggregate mining activity, flood control structures, road crossings, bridge aprons, and
6 off-highway vehicle (OHV) use (McGinnis and Ringelberg 2008).

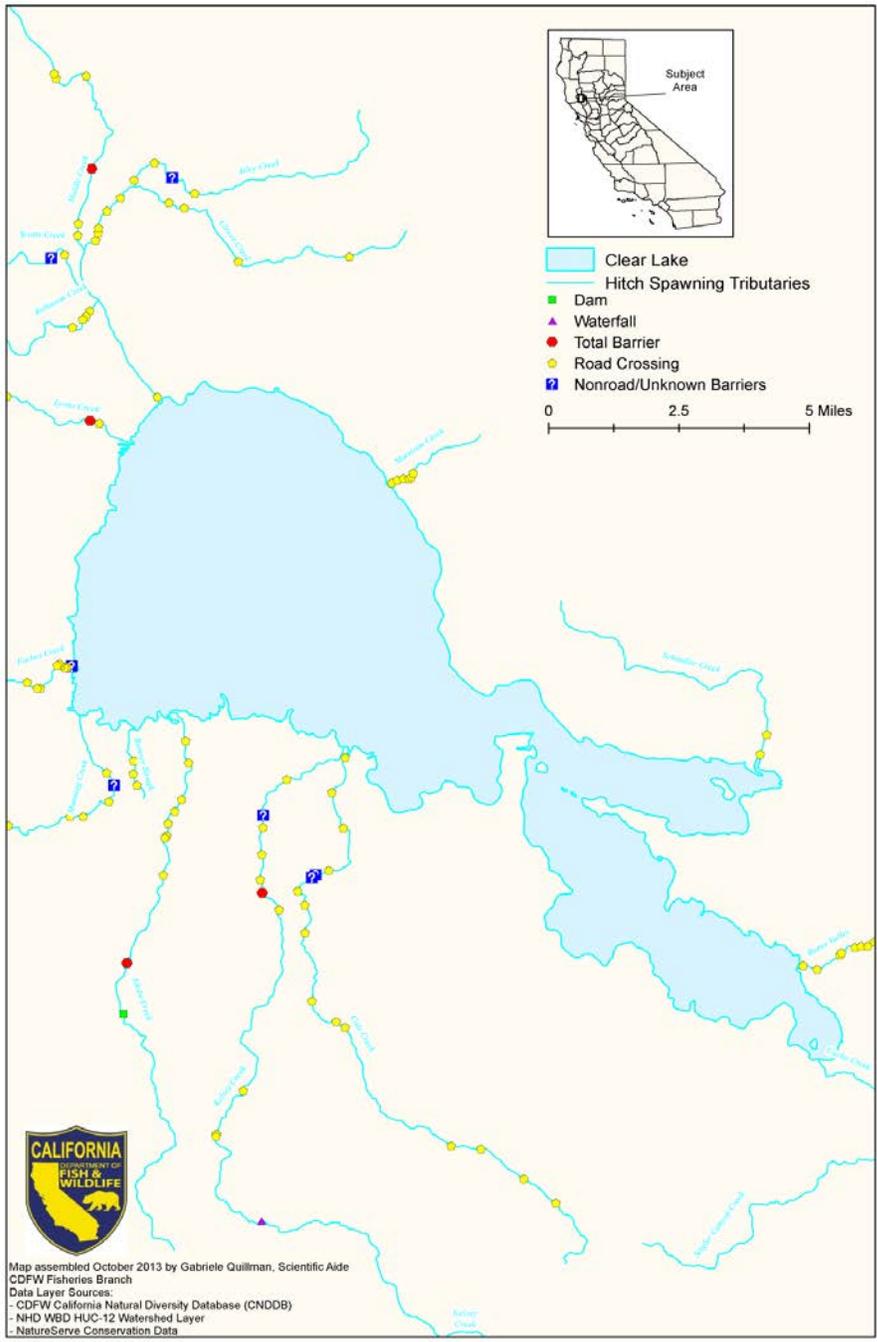
Comment [PM7]: Not in references; would like to see a copy.

7
8 Adobe Creek, Highland Creek, Middle Creek, Clover Creek, and Kelsey Creek have
9 experienced a reduction in fish spawning habitat since the installation of dams and
10 increased irrigation (Murphy 1951; Macedo 1994; McGinnis and Ringelberg 2006). A
11 barrier assessment was completed in 2006 for Middle Creek and the Kelsey Creek fish
12 ladder (McGinnis and Ringelberg 2006). The assessment found physical barriers to fish
13 migration were associated with bridge aprons and weirs as well as habitat barriers from
14 historical gravel operations (McGinnis and Ringelberg 2006). The Kelsey Creek fish
15 ladder was found unsuitable for passage of CLH. The jump heights and velocities at the
16 ladder were determined to be too great for CLH (McGinnis and Ringelberg 2006).
17 Spawning observations by CCCLH from 2005 to 2013 witnessed fish stranded below
18 multiple barriers within the watershed (CCCLH 2013).

19
20 Many Clear Lake tributaries are no longer used for spawning or have reduced spawning
21 runs as a result of artificial structures that continue to impede spawning migrations
22 (Figure 7). While some operational and physical modifications to these structures have
23 been implemented over the years, they continue to adversely impact spawning CLH,
24 especially during dry years when spring stream flows are low.

25
26 In preparation of this report, the Department estimated the loss of CLH spawning and
27 rearing habitat due to constructed barriers and impediments within the tributaries to
28 Clear Lake (Figure 7). The barrier assessment determined the approximate locations of
29 barriers and estimated miles of stream habitat as determined from the California Native
30 Diversity Database, CDFW Geographic Information System, CDFW Fish Passage
31 Assessment Database, California GIS street layer, and Google Earth Maps. Using that
32 data, the Department estimated 180 river miles were historically available to spawning
33 CLH and that barriers have eliminated or reduced access to greater than 92% of the
34 historically available spawning [habitat](#). Physical barriers, such as the footings of
35 bridges, low water crossings, dams, pipes, culverts, and water diversions in Kelsey,
36 Scotts, Middle, Clover, and other creeks interrupt or eliminate migration to spawning
37 areas (McGinnis and Ringelberg 2008). Appendix C contains a list of several tributaries
38 and some of their associated barriers.

Comment [PM8]: Good thing to do!



1
 2
 3

Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed.

1
2 Water is frequently diverted from Clear Lake tributaries, during the CLH spawning
3 season, under riparian rights associated with land ownership in the watershed. These
4 water diversions consist of direct diversion from surface water intake pumps and from
5 shallow off-channel wells that capture groundwater flows. The primary purpose of water
6 diversions from Clear Lake tributaries is for agricultural production and frost protection.
7 Water diversions for frost protection have been shown to temporarily reduce in-stream
8 flow by as much as 95% (Deitch et al. 2009). Natural flow regimes are thought to favor
9 the success of native fishes over non-native fishes (Marchetti and Moyle 2001). The
10 impact of diversion on CLH spawning tributaries is poorly understood. In some
11 tributaries, water diversion has contributed to early drying of stream reaches and
12 desiccation of CLH eggs masses and newly hatched juveniles (Macedo, R., personal
13 communication, November 25, 2013, unreferenced). Additionally, significant flow
14 reductions can lead to increased water temperatures, reduced available aquatic habitat,
15 altered or decreased biodiversity, increases in non-native species, and alterations to
16 fish assemblages (Marchetti and Moyle 2001; Bunn and Arthington 2002; Bellucci et al.
17 2011).

18
19 The impacts of spawning habitat alterations to CLH may be inferred by the fate of
20 another native Clear Lake fish that required tributaries for spawning; the Clear Lake
21 splittail was last recorded in 1972 (Puckett 1972). The Clear Lake splittail formerly
22 spawned later in the season than did CLH, and the drying up of tributaries contributed to
23 their demise (Moyle 2002). All stream spawners had “declined precipitously” by 1944
24 (Murphy 1951). [Cook et al \(1966\) noted the spittail “...underwent a drastic reduction in](#)
25 [the 1940s” \(p. 146\) and feared it “...may disappear ... if increased demands upon the](#)
26 [water further limit reproductive success.” \(p. 147\).](#) -Therefore, earlier drying of tributaries
27 by both natural and anthropogenic processes likely impacts the CLH population.
28

Comment [PM9]: Cook SF, RL MOORE, and JD Connors. 1966. Status of the native fishes of Clear Lake, Lake County, California Wasmann Journal of Biology 24: 141-160.

Dredging and Mining

29
30
31 Since the first European settlers arrived at Clear Lake and began gravel mining and
32 dredging operations, there have been documented deleterious effects on the watershed
33 (Suchanek et al. 2002). Field notes from CDFG personnel conducting stocking
34 assessments documented Kelsey Creek so loaded with silt from gravel operations that
35 creek visibility was zero (CDFG 1955). Smaller scale mining and dredging in tributary
36 streams has occurred since early settlement and has altered the amount and
37 distribution of stream gravels (Thompson et al. 2013). In some tributaries, gravel
38 extraction has resulted in the incising and channelizing of the streams and stream level
39 changes by as much as 15 feet (Suchanek et al. 2002; Eutenier, D. April 17, 2013
40 comment letter). After 1965 about one million metric tons of gravel products per year
41 were removed from the watershed until the partial moratorium on aggregate mining in
42 1981 (Richerson et al. 1994). Gravel was removed from Clear Lake tributaries to
43 provide road base for new roads created to accommodate the expanding population of
44 the area (Suchanek et al. 2002). Currently, approximately 58 acres in the Clear Lake
45 watershed are used for mining purposes (Forsgren Associates Inc. 2012).
46

1 Many areas along the tributaries to Clear Lake were channelized in response to
2 frequent flooding during the late winter and early spring (Maclanahan et al. 1972; U.S.
3 Army Corps of Engineers 1974). As a result of gravel extraction and channelization,
4 some areas were covered with riprap or confined by levees to prevent further erosion
5 and flooding. Erosion problems have contributed to sediment entering Clear Lake and
6 providing increased phosphorous loads that impair water quality (Richerson et al. 1994).
7 Gravel extraction results in channelization and down cutting of the stream bank, a
8 decrease in suitable spawning habitat, and increasing flow velocity and amount of
9 coarse material that passes through the system (Brown et al. 1998).

10 **Water Quality Impacts**

11
12 The Clear Lake watershed has seen a significant increase in the amount of
13 contaminants entering the lake over the past 75 years (Richerson et al. 1994). An
14 increase in agriculture and mining, and a shift to an urban environment, has resulted in
15 adverse water quality impacts in the lake (Mioni et al. 2011; California Environmental
16 Protection Agency [CEPA] 2012).

17
18 Erosion from construction, dredging, mining, agriculture, OHV use, grazing, and
19 urbanization has resulted in increased sediment loads to the Clear Lake watershed
20 (Forsgren Associates Inc. 2012). Increased sediment loads transport nutrient rich soil,
21 particularly phosphorous, into Clear Lake and reduce spawning habitat by increasing
22 substrate "embeddedness" (Mosley 2013). During the late 1990s and early 2000s soil
23 erosion and sedimentation became an increasing problem as existing agricultural lands
24 were converted to vineyards (Forsgren Associates Inc. 2012). From 2002 to 2011
25 vineyard acreage in the Clear Lake watershed increased from approximately 5,500
26 acres to 8,000 acres (Lake County Department of Agriculture 2011).

27
28 Development and expansion of extensive agriculture in the Clear Lake watershed
29 during the late 1890s until present day reclaimed the lake's natural wetland filtration
30 system for agricultural use. An increase in agricultural production and a decrease in
31 wetland filtration increased nutrient flows into Clear Lake. Wetland reclamation projects
32 altered the transport of sediment and nutrients, particularly phosphorous, into Clear
33 Lake, resulting in an increase in noxious cyanobacteria blooms that cover the lake in
34 warmer months (Suchanek et al. 2002). As a result of continued water quality issues,
35 Clear Lake was added to the Clean Water Act Section 303(d) list of impaired water
36 bodies in 1988 (CEPA 2010 and 2012). In recent years, noxious cyanobacteria blooms
37 have at a minimum remained constant and may have increased (CEPA 2012).

38
39 Cyanobacteria blooms have occurred at Clear Lake since the mid-1900s. Studies
40 indicate an increase in phosphorous was the driver behind water quality impairments
41 and noxious cyanobacteria blooms (Horne 1975; Richerson et al. 1994; CEPA 2012).
42 The blooms originally consisted primarily of *Microcystis*, but in recent years the blooms
43 have been attributed to both *Microcystis* and *Lyngbya*. These taxa represent both non-
44 nitrogen fixing (*Microcystis*) and nitrogen fixing (*Lyngbya*) cyanobacteria and raise
45 concerns that both phosphorous and nitrogen entering the lake need to be controlled
46 (Mioni et al. 2011; CEPA 2012). Cyanobacteria blooms have the ability to both directly
47 and indirectly impact CLH by direct interference with the growth of *Daphnia*, a limnetic

1 organism that is a food source for adult CLH, and interference with food web efficiency.
2 No studies have been conducted at Clear Lake to quantify the impact of cyanobacteria
3 blooms on the ecosystem, but studies conducted at other water bodies with varying
4 degrees of cyanobacteria blooms provide information on their impacts to the aquatic
5 environment. Cyanobacteria blooms reduce the amount of light penetration in the water
6 column and cause a reduction in producers that are unable to reposition themselves to
7 gain more light (Havens 2008). ~~Primary producers~~ ~~Organisms~~ such as epiphyton,
8 benthic algae, and rooted vascular plants have a reduced ability to function in the
9 ecosystem as a result of cyanobacteria blooms. As the cyanobacteria alter the nutrient
10 cycle of the lake they replace the producers in space and mass. The expanding
11 cyanobacteria begin to deplete CO₂ from the water body, which increases pH and
12 reduces growth of other producers (Havens 2008). The decreased CO₂ and increased
13 pH can create surface scums and result in mortality of fishes, including CLH. In the
14 summer of 1969, a large fish die off, due to heavy cyanobacteria growth and low oxygen
15 levels, was reported at Clear Lake. An estimated 170,000 fish died, consisting primarily
16 of carp, CLH, and blackfish (CDFG News Release 1969). Sub lethal and lethal effects
17 of toxins released during cyanobacteria blooms are also seen in fish and their
18 associated food web (Havens 2008).

19
20 On September 19, 2007, the U.S. Environmental Protection Agency (EPA) approved a
21 control program as a nutrient Total Maximum Daily Load (TMDL) for Clear Lake with the
22 goal of reducing point and non-point source phosphorous entering the lake (CEPA
23 2012). Sources for phosphorous entering the lake include agricultural and urban runoff,
24 timber harvest, road maintenance, construction, gravel mining, dredging, and fire.
25 Additional amounts of nutrients from home fertilizers, marijuana ~~culture~~ grows, sewer,
26 and septic systems cannot be quantified.

27
28 To allow for increased yields on agricultural land and to prevent nuisance insect species
29 around the lake, pesticides became commonplace during the early and mid-1900s. For
30 many decades the Clear Lake gnat ~~an important, a primary~~ food source for ~~juvenile~~
31 CLH, was targeted with pesticides to reduce its population. Between 1949 and 1957,
32 the Clear Lake gnat was targeted with the pesticide dichlorodiphenyldichloroethane
33 (DDD). During these years it is estimated that 99 percent of the gnat larvae in the lake
34 were killed. Concentrations of DDD were magnitudes higher in invertebrates, fish, and
35 birds than in the surrounding water in which they were found (Lindquist and Roth 1950;
36 Rudd 1964). Sampling conducted during the late 1950s identified CLH, as well as other
37 fish species, contaminated with DDD (Hunt and Bischoff 1960). Contamination levels
38 ranged from 5.27 to 115 parts per million (ppm) for edible flesh of sampled fishes (Hunt
39 and Bischoff 1960). CLH were at the lower level of DDD contamination for Clear Lake
40 fishes at 10.9 to 28.1 ppm for edible flesh content (Hunt and Bischoff 1960). The
41 ~~application results~~ of DDD in the Clear Lake watershed resulted in ~~a the first~~ major
42 ecological ~~disaster at the lake~~ and the first records of pesticide bioaccumulation in the
43 wildlife of the lake (Suchanek et al. 2002).

44
45 Following the resurgence of gnat populations in response to growing resistance to DDD,
46 two additional measures were taken to reduce the gnat population. Gnat eggs were
47 targeted with a ~~petroleum product~~, and adult gnats were targeted at roosting locations
48 with Malathion. Additional applications of methyl parathion were also made in 1962

Comment [PM10]: Introduction of aliens, agriculture etc were also disasters from the lake perspective.

Comment [PM11]: ??

1 (Suchanek et al. 2002). Clear Lake gnats are still present at the lake, but populations
2 are significantly reduced from historical levels. The likely cause of the reduced
3 population of gnats is introduced fishes, primarily [Mississippi inland-silversides](#)
4 (Suchanek et al. 2002). In 2010 and 2012 Clear Lake gnat populations reached levels
5 not seen in decades. These gnat population booms appeared to coincide with years of
6 low population levels of inland silversides (Scott, J. 2013 personal communication, Aug
7 1, 2013, unreferenced). Qualitative sampling data on CLH does not allow for a direct
8 comparison of CLH numbers in years with increases in the gnat population.
9

10 In recent years, two herbicides, Komeen™ (copper sulfate) and SONAR™ (fluridone),
11 have been used extensively to manage the *Hydrilla verticillata* infestation ~~of~~ the lake.
12 Applied concentrations of Komeen™ do not kill fish directly; however, the impacts to
13 macroinvertebrates may indirectly impact CLH populations (Bairrington 1999). These
14 systemic herbicides also pose a threat to non-target vascular aquatic plants, such as
15 tules and submerged vegetation, which juvenile CLH require for rearing habitat. As
16 noted previously, there has already been a significant reduction in wetland habitat
17 around the lake, and any additional reductions would further limit the amount of habitat
18 available for CLH. Initial studies indicate a reduction in tule habitat following SONAR™
19 applications (Bairrington 1999). Environmental monitoring of eradication activities in
20 1996 and 1997 found that invertebrate species declined within the treatment area but
21 rebounded quickly following the toxicity decay of the herbicide (Bairrington 1999). Post-
22 treatment electrofishing surveys noted an increase in the number and abundance of fish
23 species (Bairrington 1999).
24

25 Mining operations within the watershed contributed to sulphur and mercury
26 contamination in Clear Lake. The Sulphur Bank Mercury Mine began operations in
27 1865 and ended in 1957 (Osleger et al. 2008; Giusti 2009). Originally the mine focused
28 on extracting sulphur, but as operations continued into the late 1920s and the sulphur
29 was found to be contaminated with mercury sulfide, operations switched to extracting
30 mercury from the large-scale open-pit mine (Giusti 2009). As a result of contamination,
31 the mine was classified as an EPA Superfund Site in 1990 (Suchanek et al. 1993). The
32 mine is thought to have contaminated the lake with both mercury and arsenic
33 (Suchanek et al. 1993). Studies have found the mercury concentrations in sediment to
34 be high (over 400 ppm) in the vicinity of the mine, decreasing as distance from the mine
35 increases (Suchanek et al. 2002). The mine continues to produce low pH acid mine
36 drainage that delivers sulfate to the lake. Over the past decade, the EPA has taken
37 several actions to remediate contamination from the mine. These include erosion
38 control measures, removal of contaminated soil, storm water diversion, and well
39 capping (U.S. Environmental Protection Agency 2012).
40

41 During the 1970s, elevated concentrations of mercury were found in the fish of the lake
42 (Curtis 1977). [High levels of Mercury accumulation contamination](#) can lead to
43 significant impacts to the reproductive success of fishes and can result in reduced brain
44 function, altered size and function of gonads and reduced gamete production
45 (Sandheinrich and Miller 2006; Crump and Trudeau 2009). In 2003, a mercury TMDL
46 was developed for Clear Lake to reduce methylmercury in fish by reducing overall
47 mercury loads to Clear Lake (CEPA 2010). Levels of mercury found in fish, including
48 [CLH](#), are between 0.06 and 0.32 µg/g (CEPA 2002), [which](#). ~~Concentrations of mercury~~

Comment [PM12]: What are the levels specifically in CLH? I suspect the higher levels are in bass, not hitch. Note: There is an entire issue of Ecological Applications (2008) devoted to Clear Lake mercury issues.

1 | [present in Clear Lake fishes](#) have resulted in health advisories on their consumption,
2 | but are below acute toxicity thresholds (Harnly et al. 1997). Mercury levels are close to
3 | or within the effect thresholds for reproduction and growth for fathead minnow (0.32 to
4 | 0.62 µg/g) and rainbow trout (National Oceanic and Atmospheric Administration [NOAA]
5 | 2011). Concentrations with no effect on rainbow trout growth and development are 0.02
6 | to 0.09 µg/g (NOAA 2011). Lacking specific studies on CLH, based on surrogate effect
7 | levels for fathead minnows and rainbow trout, it is [possible reasonable to suspect](#) that
8 | CLH may be experiencing sub lethal chronic and reproductive effects from mercury
9 | contamination. [However, Hg levels are generally much lower in plankton feeding fish
10 | such as hitch than they are for other fishes in the lake \(Eagles-Smith et al. 2008\).](#)
11

12 | **Overexploitation**

14 | **Commercial Harvest**

15
16 | Commercial fish harvest at Clear Lake has been occurring since the early 1900s.
17 | Harvested fish were distributed to fish markets in California for sale for human
18 | consumption and animal feed. Prior to 1941, the majority of commercial operations
19 | centered on harvesting catfish (*Ictalurus* or *Ameiurus* spp.) from the lake. Although
20 | exact numbers are unavailable, it is likely that large numbers of catfish were taken
21 | during this period (Bairrington 1999). In 1942 commercial harvest of catfish was
22 | banned at Clear Lake. Beginning in the 1930s commercial harvest focused on
23 | Sacramento blackfish (*Orthodon microlepidotus*), a native species, and common carp
24 | (*Cyprinus carpio*), a non-native species. From 1932 to 1962 the annual average catch
25 | rate was 295,000 pounds for the commercial fishery (Bairrington 1999). A ratio of
26 | 1.33:1 for blackfish to carp was the average during commercial fishing operations
27 | (Bairrington 1999). In 1976 the only recorded capture and sale of CLH for commercial
28 | purposes was submitted to the Department, a total of 1,550 pounds was reported
29 | captured and sold at market that year (CDFW Commercial Fisheries Data). This is the
30 | only instance in the records of CLH being captured for commercial sale, primarily due to
31 | lack of interest and low sale price for the species (CDFW Commercial Fisheries Data).
32 | By 1960 commercial fishing operators were required to count and release all bycatch
33 | from commercial operations. CLH were found in large numbers some years and were
34 | recorded and returned to the lake when captured (Figure 5; CDFW Commercial
35 | Fisheries Data). The Department has received no commercial permit applications for
36 | operations on Clear Lake over the past several years. The lack of permit applications
37 | indicates that at this time commercial fishing operations at Clear Lake have ceased
38 | (CDFW Commercial Fishing Permit Data).
39

40 | **Cultural Harvest**

41
42 | Clear Lake hitch are culturally significant to several Pomo tribes that inhabit the Clear
43 | Lake watershed. Two Pomo [bands tribes](#) fought a war over Kelsey Creek and its
44 | important CLH supply (Barrett 1906; Kniffen 1939). Historically, large runs of CLH
45 | provided a staple food source for the local [native peoples tribes](#) (RREC 2011). During
46 | spawning runs, CLH were captured by constructing a series of dams in the creeks from

1 which the fish were then scooped with baskets. The fish were cured to provide a food
2 source throughout the year (Kniffen 1939). Historical accounts from tribal members
3 speak of CLH being easy to find as they spawned in large numbers in the tributaries to
4 the lake (Scotts Valley Band of Pomo Indians historical accounts 2013). There are no
5 estimates of the number of CLH that were taken for cultural harvest during any specific
6 timeframe. However, an account from a tribal member indicates that, historically, a
7 single family may have taken a couple thousand fish during the spawning runs (Big
8 Valley EPA 2013). Tribal accounts indicate the harvest of CLH continued until the
9 decline in spawning runs in the mid-1980s (Big Valley EPA 2013). Prior to designation
10 of CLH as a candidate species for listing, regulations in the Clear Lake watershed
11 allowed for the harvest of CLH in spawning tributaries by hand or hand-held dip net. In
12 2013 the Department issued CESA Memoranda of Understanding (Fish and Game
13 Code, § 2081(a)) to three ~~bands tribes~~ to authorize collection of CLH for scientific
14 research and public education (Kratville, D. personal communication, October 7, 2013,
15 unreferenced).
16

17 Predation and Competition

18
19 Non-native fish introductions into Clear Lake date back as far as the late 1800s (Dill and
20 Cordone 1997). Prior to the introduction of non-native fish species, between 12 and 14
21 native fish species occupied Clear Lake (Bairrington 1999; Moyle 2002; Thompson et al.
22 2013). Currently, approximately ten native species and 20 non-native species inhabit
23 the lake (Bairrington 1999; Thompson et al. 2013). Over the past 100 years one native
24 species, thicketail chub (*Gila crassicauda*), has gone extinct and two native species,
25 hardhead (*Mylopharodon conocephalus*), and Clear Lake splittail, have been extirpated
26 from the lake. Sacramento perch (*Archoplites interruptus*), has not been captured in
27 sampling efforts since 1996 (Bairrington 1999; CDFW Commercial Fisheries Data;
28 Thompson et al. 2013). The majority of non-native species introductions have been
29 conducted by the Department, various local agencies, and angling groups in an effort to
30 increase sport fishing opportunities. Introductions of fish at Clear Lake have been
31 warmwater sport fish (largemouth and Florida bass (*Micropterus spp.*), black bass,
32 sunfish (*Lepomis spp.*), catfish, etc.) or forage species for piscivorous sport fish. The
33 Department has not stocked fish in Clear Lake in the past decade. The four fish
34 species listed below were introduced without authorization from the Department
35 (Bairrington 1999; Rowan J. personal communication, October 10, 2013, unreferenced).
36 Inland silverside, threadfin shad, smallmouth bass (*Micropterus dolomieu*), and
37 pumpkinseed (*Lepomis gibbosus*) were introduced to provide forage for other game
38 fishes, provide Clear Lake gnat control, or as part of a new sport fishery (Anderson et al.
39 1986; Dill and Cordone 1997; Bairrington 1999). Non-native game fishes comprise
40 nearly 100 percent of the sport catch from the lake. Incidental captures of native
41 species occur infrequently and are rarely recorded during creel and tournament surveys
42 (Rowan J. personal communication, October 10, 2013, unreferenced).
43

44 Non-native fish introductions ~~can~~ have significant impacts on native fish species. ~~Miss~~
45 Inland silverside and threadfin shad are thought to compete directly with CLH for food
46 resources (Geary and Moyle 1980; Anderson et al. 1986; Bairrington 1999) and likely
47 prey on larvae as well. All three species are limnetic foragers that rely on

Comment [PM13]: Now aware of any records of hardhead from the lake or tributary streams. It is present in Cache Creek below the lake but the lake is not really suitable for it nor are the upstream tribs. If you believe the earliest accounts of the lake, CA roach were once abundant in shallow water; possible but identifications not strong. Check Hopkirk.

Formatted: Font: Italic

Formatted: Font: Italic

Comment [PM14]: Mississippi silverside (taxonomy has been reworked); the paper on the introduction of the silverside claims CDFG was a participant or at least did not discourage it.

Comment [PM15]: Doubt they are present in the lake; would like to see the proof.

Comment [PM16]: Not present.

Comment [PM17]: You need a table of all native and non-native species and their status

1 macroinvertebrates for food. There are no direct comparisons, but years with declines
2 in threadfin shad and inland silverside are thought to coincide with increases in CLH
3 numbers, and years with decreased threadfin shad and inland silverside result in
4 increased young of year recruitment for other native and non-native species (Rowan J.
5 personal communication, October 10, 2013, unreferenced). [Eagles-Smith et al. \(2008\)](#)
6 [found that zooplankton populations declined precipitously as threadfin shad populations](#)
7 [increased, causing other common plankton-feeding fishes \(juvenile largemouth bass](#)
8 [and bluegill, Mississippi silverside\) to switch to benthic feeding. Hitch, being more](#)
9 [specialized for zooplankton feeding may have been strongly affected by the threadfin](#)
10 [shad \(introduced in the 1980s\), which undergoes boom-and-bust population cycles in](#)
11 [the lake \(Eagles-Smith et al \(2008\)\).](#)

Comment [PM18]: Could you make some?

13 Competition for juvenile rearing habitat and food has likely increased with the reduction
14 in wetland habitat and increase in non-native fish species. Rearing habitat is essential
15 for CLH recruitment to any year class. A reduction in recruitment leads to a decrease
16 in spawning adults in the following years. A species with highly fluctuating population
17 trends, such as CLH, is particularly vulnerable to population level impacts in years with
18 reduced recruitment. Piscivorous fish species such as largemouth bass (*Micropterus*
19 *salmoides*) prey directly on both juvenile and adult CLH. Although no comprehensive
20 diet studies have been done, incidental data indicate that CLH are found in the
21 stomachs of piscivorous species in the lake (Moyle et al. in progress). Omnivorous
22 species such as bullhead catfish (*Ameiurus* spp.) are known to prey on various life
23 stages of native fishes. It is suggested that the introduction of white and channel
24 catfish to Clear Lake may have played a role in the decline of native fish species (Dill
25 and Cordone 1997). The introduction of white catfish (*A. catus*) was described, by
26 Captain J.D. Dondero of the Division of Fish and Game, as having solved the problem
27 of large spawning runs of fish dying in tributaries to Clear Lake and that the population
28 of nongame fish diminished following their introduction (Dill and Cordone 1997). Jordan
29 and Gilbert (1894) also describe catfish as being destructive to the spawn of other
30 species. The rates at which CLH are consumed in relation to other prey species and
31 the amount of CLH consumed are unknown. It is likely that during years when
32 alternative prey abundance is low, CLH predation increases (Eagles-Smith et al. 2008).

Comment [PM19]: Note that Florida bass (*M. floridae*) are regarded as a separate species from LMB. They apparently initially hybridized with LMB in the lake but now appear to be dominant. They grow larger than LMB so will be more inclined to eat adult CLH

34 [Overall, alien species appear to be a major factor in contributing to hitch declines in](#)
35 [Clear Lake. While fairly substantial runs of hitch have persisted into recent years, it is](#)
36 [likely that the combination of introductions of Florida bass \(1970s\), Mississippi](#)
37 [silverside \(1967\), and threadfin shad \(1980s\) have created an environment in which it is](#)
38 [increasingly hard for hitch to persist. The voracious and large-sized bass will eat adults](#)
39 [as well as juveniles. Threadfin shad deplete off shore plankton populations on which the](#)
40 [hitch depend for much of their life. Silversides deplete inshore sources of food and](#)
41 [presumably prey on larvae as they come out of the streams, as they have been shown](#)
42 [to do for various fishes in the Sacramento San Joaquin Delta \(ref. \)](#)

Comment [PM20]: This is probably true, but Eagles-Smith et al. don't say this in relation to hitch or even fish predation.

45 Disease and Parasites

1 Disease outbreaks in fishes have been known to occur at Clear Lake. The outbreaks
2 are primarily koi herpes virus (KHV) and it affects introduced carp and goldfish. Native
3 minnows, including CLH, show no effects from KHV. Fish fungi (*Saprolegnia* spp.) have
4 been observed on fishes captured in Clear Lake and results from physical injury or
5 infection. CLH are susceptible to fish fungi but it is not readily observed in captured
6 fish. All fish in Clear Lake are susceptible to anchor worms (*Lernaea* spp.) and heavy
7 infestations can lead to mortality. No CLH with heavy anchor worm infestations have
8 been observed during CDFW fishery surveys at Clear Lake (Rowan J. personal
9 communication, October 10, 2013, unreferenced). The Big Valley Rancheria Band of
10 Pomo Indians has documented light loads of anchor worms occurring on CLH (Big
11 Valley Rancheria 2012 and 2013).
12

13 Other Natural Occurrences or Human Related Activities

14 Climate Change

15
16 It is likely that native fishes in California will be vulnerable to physical and chemical
17 changes as a result of climate change (Moyle et al. 2012). Research has shown that
18 the annual mean temperature in North America has increased between 1955 and 2005
19 and is predicted to continue increasing in the future (Field et al. 1999; Hayhoe et al.
20 2004); however, it varies across North America, is more pronounced in spring and
21 winter, and has affected daily minimum temperatures more than daily maximum
22 temperatures (Field et al. 2007). In general, climate change models for California
23 indicate an increase in overall air temperature, decreased and warmer rainfall, and an
24 increase in overall water temperatures (California Climate Change Center [CCCC]
25 2012). Cold storms are expected to decrease, giving way to warmer storms that create
26 earlier run-off and less water storage capabilities (Field et al. 1999; Hayhoe et al. 2004;
27 CCCC 2012). Climate change in the Clear Lake watershed is likely to cause **some**
28 changes to the interannual variability in rainfall. The change in rainfall variability would
29 likely increase the occurrence of drought and flood years (Clear Lake Integrated
30 Watershed Management Plan [CLIWMP] 2010). Expected climate change impacts to
31 California and the Clear Lake watershed will be significant during annual CLH spawning
32 cycles. CLH require winter and spring storms that provide suitable spawning flows in
33 the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff **will**
34 **likely** ~~could~~ significantly impact the ability of CLH to successfully spawn. ~~A~~ Climate
35 driven **anthropogenic** change in the Clear Lake watershed could result in the loss of
36 spawning habitat, reduced access to spawning habitat, stranding of spawning and
37 juvenile fish, and egg desiccation.
38

39 A report on the projected effects of climate on California freshwater fishes, prepared for
40 the California Energy Commission's California Climate Change Center, determined CLH
41 to be critically vulnerable to impacts from climate change (Moyle et al. 2012). The
42 report evaluated criteria such as population size, population trends, range, lifespan, and
43 vulnerability to stochastic events to identify the degree of vulnerability of each fish
44 species. The Intergovernmental Panel on Climate Change has stated that of all
45 ecosystems, freshwater ecosystems will have the highest proportion of species
46 threatened with extinction due to climate change (Kundzewicz et al. 2007). Freshwater
47 lake species are more susceptible to extirpation because they are unable to emigrate

Comment [PM21]: This has now been published
Moyle, P.B., J. D. Kieman, P. K. Crain, and R. M. Quinones. 2013. Climate change vulnerability of native and alien freshwater fishes of California: a systematic assessment approach. PLoS One. <http://dx.plos.org/10.1371/journal.pone.0063883>

1 should habitat changes occur (CA Natural Resources Agency 2009), [Moyle et al.](#)
2 [\(2012, 2013\) rated Clear Lake hitch as 'critically vulnerable' to extinction from the added](#)
3 [effects of climate change, suggesting that CLH would be extinct by 2100 if steps were](#)
4 [not taken to improve conditions for it.](#)
5

6 **Recreational Activities**

7

8 The natural resources of the Clear Lake watershed are a tremendous recreational
9 resource for residents and visitors to Lake County. As the largest freshwater lake
10 wholly in California, with opportunities for multiple aquatic recreational activities, the
11 lake receives tens thousands of visitors per year. According to 2008 data acquired from
12 Lake County quagga mussel (*Dreissena rostriformis*) inspection sticker application
13 forms; there were 11,230 boats that visited the lake that year. Jet skis and pleasure
14 boats accounted for 41 percent of the boating activity at the lake (CLIWMP 2010).
15

16 Permanent structures, associated with boat docks, boat ramps, and swimming beaches,
17 have reduced littoral zone habitat around the lake. These structures require clearing of
18 littoral zone habitat to maintain access for recreational boaters and swimmers. It is
19 estimated that there are over 600 private boat docks and boat ramps on the lake
20 shoreline. In addition to reducing littoral zone habitat these structures provide additional
21 habitat for non-native sport fish, such as largemouth bass, that prey on CLH.
22

23 Recreational and tournament angling generate a significant amount of the activity in the
24 Clear Lake aquatic environment. In 2008, 18 percent of all boats entering the lake
25 identified their recreational activity as angling (CLIWMP 2010). In a single year creel
26 survey conducted in 1988 by the Department, CLH comprised two percent of the
27 recreational sport catch (Macedo 1991).
28

29 The number of angling tournaments, primarily targeting largemouth bass, has drastically
30 increased over the last three decades in response to Clear Lake's reputation as a
31 premiere sport fishery. Between 2001 and 2008 the number of angling tournaments
32 increased from 98 to 208 per year (Rowan J. personal communication, October 10,
33 2013, unreferenced). It is believed that recreational and tournament anglers' capture
34 CLH incidentally while angling. The impact to CLH from the increase in angling
35 tournaments is unknown, but is likely negligible because tournament anglers do not
36 target CLH and bycatch would be an inadvertent snagging on an artificial lure, a rare
37 occurrence.

38 **REGULATORY AND LISTING STATUS**

39 **Federal**

40

41 On September 25, 2012 the Center for Biological Diversity petitioned the U.S. Fish and
42 Wildlife Service (USFWS) to list CLH as endangered or threatened under the federal
43 Endangered Species Act (ESA). As of the publication of this status review there has
44 been no action taken on the petition by USFWS.
45

1 The U.S. Forest Service (USFS) lists CLH as a sensitive species. USFS sensitive
2 species are those plant and animal species identified by a regional forester that are not
3 listed or proposed for listing under the federal ESA for which population viability is a
4 concern.

5 **State**

6
7 The Department designated CLH as a Species of Special Concern (SSC) in 1994. A
8 SSC is a species, subspecies, or distinct population of an animal native to California
9 that currently satisfies one or more of the following (not necessarily mutually exclusive)
10 criteria:

- 11 • Is extirpated from the State or, in the case of birds, in its primary seasonal or
12 breeding role;
- 13 • Is listed as Federally, but not State, threatened or endangered;
- 14 • Is experiencing, or formerly experienced, serious (noncyclical) population
15 declines or range restrictions (not reversed) that, if continued or resumed, could
16 qualify it for State threatened or endangered status;
- 17 • Has naturally small populations exhibiting high susceptibility to risk from any
18 factor(s) that if realized, could lead to declines that would qualify it for State
19 threatened or endangered status.

20
21 The intent of designating a species as a SSC is to:

- 22 • Focus attention on animals at conservation risk by the Department, other State,
23 local and Federal government entities, regulators, land managers, planners,
24 consulting biologists, and others;
- 25 • Stimulate research on poorly known species;
- 26 • Achieve conservation and recovery of these animals before they meet California
27 Endangered Species Act criteria for listing as threatened or endangered.

28 There are no provisions in the Fish and Game Code that specifically prohibit take of
29 CLH or protect its habitat.
30

31 **Other Rankings**

32
33 The American Fisheries Society ranks CLH as vulnerable, meaning the taxon is in
34 imminent danger of becoming threatened throughout all or a significant portion of its
35 range (Jelks et al. 2011).

36 **EXISTING MANAGEMENT EFFORTS**

37

38 **Resource Management Plans**

39

40 An increase in resource management efforts throughout the Clear Lake watershed has
41 benefitted CLH, and several plans and strategies are in place to assist in reducing the
42 threats to CLH.
43

1 The Clear Lake Integrated Watershed Management Plan (2010) was prepared by two
2 resource conservation districts and provides details of past and current resource
3 management within the Clear Lake watershed. The plan seeks to identify opportunities
4 to improve and protect the health and function of the watershed and identifies specific
5 implementation actions to improve and protect watershed resources. Recommended
6 actions are prioritized on a timeline. As funding allows, implementation of these actions
7 will be undertaken by various non-governmental organizations (NGO) and local, state,
8 and federal agencies that share an interest in promoting the health and function of the
9 watershed. Multiple action items listed in the plan would benefit CLH and their habitats.
10 Several tributaries to Clear Lake have completed Watershed Assessment plans as well.
11 These include Kelsey Creek Watershed Assessment (2010), Middle Creek Watershed
12 Assessment (2010), and Scotts Creek Watershed Assessment (2010). These plans
13 were all completed by Lake County Water Resources Division for West and East Lake
14 Resource Conservation Districts.

15
16 With adoption of the TMDL for Clear Lake, several projects are in process or have been
17 completed to reduce the amount of phosphorous entering the lake. Specifically, the
18 Middle Creek Flood Damage Reduction and Ecosystem Restoration Project seeks to
19 reduce the amount of phosphorous entering the lake by 40 percent (CEPA 2012). Lake
20 County and the California Department of Transportation have implemented several best
21 management practices (BMPs) for managing storm water runoff to reduce the amount
22 of phosphorous and other contaminants that enter the lake. Both the USFS and Bureau
23 of Land Management (BLM) have undertaken projects to reduce nutrients entering the
24 lake as a result of off-highway vehicles and other land uses. BLM, in coordination with
25 Scotts Valley Band of Pomo Indians, received a grant to implement the Eightmile Valley
26 Sediment Reduction and Habitat Enhancement Project Design. Controlling sediment
27 from Eightmile Valley is crucial to controlling the amount of nutrients entering the lake.
28 Many of these projects are still in design or early implementation and it will be several
29 years before changes in nutrient loads within the lake can be observed and studied.

30
31 The adverse effects from an increase in sedimentation as a result of conversion of
32 various types of agricultural land to vineyard resulted in the formation of the Erosion
33 Prevention and Education Committee (EPEC). The EPEC is a group of county
34 agencies and private entities that provide educational outreach regarding erosion
35 control and water quality protection. In addition, the Lake County Grading Ordinance
36 was approved in 2007 and requires grading permits and Erosion Control and Sediment
37 Detention Plans for projects with the probability of resulting in increased sedimentation
38 (Forsgren Associates, Inc. 2012).

39
40 Concerns over the reduction in habitat quality resulting from gravel mining prompted
41 Lake County to adopt an Aggregate Resources Management Plan in 1994. The plan
42 called for a moratorium on gravel mining in several tributaries to Clear Lake. The
43 implementation of gravel mining regulations has resulted in reduced in-stream and bank
44 erosion and increased riparian habitat along the creeks (CEPA 2008).

45
46 To prevent further destruction of wetland habitat along the lake shoreline, in 2000 and
47 2003 amendments, Lake County adopted Section 23-15 of the Clear Lake Shoreline
48 Ordinance that prohibits the destruction of woody species and tules. In addition to the

1 ordinance, there is a no net-loss requirement for commercial, resort, and public
2 properties that seek to clear vegetation from areas along the shoreline (CLIWMP 2010).

3
4 RREC produced an Adaptive Management Plan (HAMP) for the Clear Lake Hitch,
5 *Lavinia exilicauda chi* (RREC 2011). The HAMP describes the current status of CLH
6 habitat and problems for habitat recovery. The habitat assessments are included in a
7 management plan that identifies action items, issues of uncertainty, stakeholder
8 involvement, sustainability, and plan amendment procedures. The RREC is currently in
9 the process of revising the HAMP.

10
11 The Department has created or approved two Conceptual Area Protection Plans
12 (CAPP) for the Clear Lake Watershed. The creation of a CAPP for an area allows the
13 Department, as well as local and federal agencies, and NGOs, to apply for land
14 acquisition funding from the Wildlife Conservation Board. The first, the Clear Lake
15 CAPP, was approved in 2002 and addresses land acquisition needs in the area of
16 Middle Creek. The plan focuses on protecting wetland and riparian habitat for the
17 benefit of natural resources. The second CAPP, Big Valley Wetlands, is currently in
18 development with possible approval in 2014. The Big Valley Wetlands CAPP focuses
19 on land acquisitions in the western portion of the Clear Lake watershed for the purpose
20 of protecting wetland and riparian habitat. Both CAPP's will benefit CLH in the
21 protection of riparian and wetland habitat critical for spawning and rearing CLH. Land
22 acquisitions that seek to protect and restore existing CLH habitat should create a stable
23 environment for CLH populations.

24
25 The Department published a Clear Lake Fishery Management Plan in 1999 (Bairrington
26 1999). The plan provides a review of past and present biological information for Clear
27 Lake. The primary focus of the plan is to maintain fishery resources of the lake and
28 enhance recreational fishing opportunities. The plan identifies areas of controversy
29 between various stakeholder groups in the watershed, and states that "adapting to the
30 biological and social settings at Clear Lake involves a variety of compromises between
31 these groups and the non-angling groups who wish to ensure the well-being of Clear
32 Lake's native fish species." The plan identifies the decline in native fish species at
33 Clear Lake as being detrimental both socially and biologically. No specific guidelines
34 are given for addressing impacts to native species, but restoration of spawning habitat
35 and natural flow regimes are discussed as critical for native species survival.

37 **Monitoring and Research**

38
39 In 2013 the Department attempted to conduct a status assessment of the CLH
40 population present in Cole and Kelsey creeks. Sampling produced too few fish to
41 facilitate a statistically valid mark and recapture study. As a result, a population
42 estimate was not completed. The Department has proposed additional funding in 2014
43 to begin a multi-year mark-recapture study to determine a statistically valid population
44 estimate or index of CLH.

45
46 The CCCLH has been conducting annual spawning observations since 2005. A simple
47 protocol is followed that identifies the time, observer, and number of CLH observed.

1 Volunteers have put in hundreds of hours monitoring CLH spawning runs during this
2 time period. Although not quantitative, the surveys provide a glimpse into the number of
3 spawning CLH and how successful spawning is in a particular season. Results of these
4 surveys are included in Appendices A and B and summarized in Section 4.1 and 4.2
5 above.

6 **Habitat Restoration Projects**

7
8 In recent years, local, state, and federal agencies have begun implementing actions to
9 aid in the protection and restoration of Clear Lake wetland habitat. The Middle Creek
10 Flood Damage Reduction and Ecosystem Restoration Project will restore up to 1,400
11 acres of wetland habitat around Middle Creek and Rodman Slough, essentially doubling
12 the amount of existing wetland habitat in the watershed (CLIWMP 2010).
13

14 **Impacts of Existing Management Efforts**

15
16 To date, existing management efforts have focused on CLH habitat restoration ~~in the~~
17 ~~watershed~~. Wetland restoration projects that would significantly benefit CLH have been
18 proposed and have been or will be implemented through the Middle Creek Flood
19 Damage Reduction and Ecosystem Restoration Project and the two CAPPs that cover
20 portions of the watershed. Wetland restoration is expected to aid in increasing
21 spawning success and juvenile recruitment into the population. Increased wetland
22 acreage would enhance filtration of tributary waters resulting in decreased amounts of
23 nutrients entering the lake and an increase in the water table. The increased water
24 table will help maintain surface flow in tributaries, resulting in suitable spawning habitat
25 being maintained throughout the spawning season. The Clear Lake Shoreline
26 Ordinance has resulted in a “no net loss” of shoreline wetland habitat around the lake
27 since its enactment. However, because these wetland restoration projects are either
28 recent or yet to be implemented, a thorough assessment of direct and indirect impacts
29 to CLH populations cannot be included in this status review.
30

31 Establishment of TMDLs for mercury and nutrients has led to a reduction in inputs and
32 an increase in monitoring efforts in the Clear Lake watershed. Past and future steps by
33 the federal government will reduce mercury contamination resulting from the Sulphur
34 Bank Mercury Mine. Most of the identified initial actions for cleanup have been
35 implemented. The focus will now be on two long-term projects to address waste pile
36 and lake sediment cleanup, which should result in significant reductions in mercury
37 contamination in the watershed. Nutrient loads entering Clear Lake have been
38 addressed by several measures including wetland restoration, BMPs for storm water
39 runoff, and erosion control measures. Many of these projects are in the early stages of
40 implementation, and a thorough assessment of impacts to CLH is yet to be been
41 completed. It is likely that reduced mercury and nutrient loads in Clear Lake will result
42 in a significant benefit to CLH.

43 **SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE** 44 **HITCH IN CALIFORNIA**

45

1 CESA directs the Department to prepare this report regarding the status of CLH based
2 upon the best scientific information available to the Department. CESA's implementing
3 regulations identify key factors that are relevant to the Department's analyses.
4 Specifically, a "species shall be listed as endangered or threatened ... if the Commission
5 determines that its continued existence is in serious danger or is threatened by any one
6 or any combination of the following factors: (1) present or threatened modification or
7 destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease;
8 or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, §
9 670.1 (i)(1)(A)).

10
11 The definitions of endangered and threatened species in the Fish and Game Code
12 provide guidance to the Department's scientific determination. An endangered species
13 under CESA is one "which is in serious danger of becoming extinct throughout all, or a
14 significant portion, of its range due to one or more causes, including loss of habitat,
15 change in habitat, over exploitation, predation, competition, or disease." (Fish & G.
16 Code, § 2062). A threatened species under CESA is one "that, although not presently
17 threatened with extinction, is likely to become an endangered species in the foreseeable
18 future in the absence of special protection and management efforts required by
19 [CESA]." (*Id.*, § 2067).

20
21 The preceding sections of this status review report describe the best scientific
22 information available to the Department, with respect to the key factors identified in the
23 regulations. The Department's scientific determinations regarding these factors as peer
24 review begins are summarized below.
25

26 **Present or Threatened Modification or Destruction of Habitat**

27
28 Beginning with the arrival of European settlers in the mid-1800s, alterations to habitats
29 in the watershed have directly impacted the ability of CLH to survive. Habitats
30 necessary for both spawning and rearing have been reduced or severely decreased in
31 suitability in the past century resulting in an observable decrease in the overall
32 abundance of CLH and its habitat. Spawning tributaries have been physically altered by
33 a combination of dams, diversions, and mining operations that have altered the course
34 and timing of spring flows and the amount and quality of spawning habitat available for
35 CLH. Dams create barriers to CLH passage that reduce the amount of available
36 spawning habitat while altering the natural flow regime of tributaries. Water diversions
37 in tributaries have resulted in decreased flows during critical spawning migrations for
38 CLH. Loss of eggs, juvenile, and adult fish due to desiccation and stranding from water
39 diversions are likely a significant impact on CLH populations. Gravel mining removed
40 large amounts of spawning substrate during peak operations in the mid-1900s.
41 Spawning substrate has been restored slowly after gravel mining was discontinued in
42 the majority of the watershed. Water quality impacts to the watershed have resulted in
43 Clear Lake being listed as an impaired water body and led to the establishment of
44 TMDLs for both mercury and nutrients for the lake. It is unclear to what extent the water
45 quality impacts are affecting CLH populations. The Department considers modification
46 and destruction of habitat a significant threat to the continued existence of CLH.

1 **Overexploitation**

2
3 Harvest of CLH has occurred by both Pomo ~~bands tribes~~ and commercial fishery
4 operators at Clear Lake. Historic accounts from tribal members indicate that significant
5 amounts of CLH were harvested during spawning runs. In recent years, the amount of
6 harvest by the Pomo has been minimal, and the CLH are used strictly for educational
7 and cultural reasons. Since the early 1990s commercial fishery operations have been
8 required to return all CLH captured to the lake. Prior to that, CLH had not been
9 regularly harvested for sale. It is likely that incidental catch during commercial harvest
10 operations resulted in mortality of some CLH. However, there is no information
11 indicating that overexploitation threatens the continued existence of CLH.

Comment [PM22]: This section is pretty weak.

12 **Predation**

13
14 Direct predation of CLH by fish, birds, and mammals ~~o-ccurs is known to occur in~~
15 ~~suitable habitats within the watershed~~. Spawning runs are vulnerable to predation from
16 birds and mammals as fish migrate upstream and become stranded at various
17 locations. Stranding occurs both naturally and as a result of habitat modifications,
18 ~~especially flow reductions~~, described above. Non-native fishes prey directly on
19 different life stages of CLH in all ~~occupied~~ habitats. CLH have been found during
20 stomach content analyses of largemouth bass. Incidental observations indicate that
21 largemouth bass may target CLH as the CLH stage at the entrance to ascend spawning
22 tributaries in early spring. Other introduced fishes, such as ~~white and channel~~ catfish
23 ~~species~~, also prey on CLH. ~~Larvae are probably eaten by Mississippi silversides~~. A
24 detailed diet study of ~~selected n~~-introduced fishes is necessary to determine the extent
25 of predation from introduced fishes ~~but needs to be targeted at places where hitch and~~
26 ~~alien fishes come in the most contact (e., mouths of streams)~~. There is scientific
27 information suggesting that ~~predation by introduced fishes threatens the continued~~
28 existence of CLH.

Comment [PM23]: What does this mean?

29 **Competition**

30
31 The extent of impacts on CLH from competition with other aquatic species is poorly
32 understood. Studies conducted on diet analysis of CLH indicate that there is
33 competition between CLH and other macroinvertebrate consuming fish species,
34 primarily ~~Mississippi inland~~-silversides and threadfin shad. Observations by Department
35 biologists and others indicate that CLH populations fluctuate on ~~alternating~~ cycles with
36 inland silverside populations. CLH directly compete with other native and non-native
37 fishes for juvenile rearing habitat. ~~The majority of fishes in Clear Lake utilize near shore~~
38 ~~wetland habitat for juvenile rearing~~. ~~With the decrease in wetland habitat over the past~~
39 century, there is increased competition for the remaining habitat. Although no formal
40 studies have been completed, it is likely that competition for resources threatens the
41 continued existence of CLH.

Comment [PM24]: ? Most likely when both TFS and MSS are depressed.

Comment [PM25]: We don't actually know this. Competition is mre likely for food than space.

Comment [PM26]: They do? Reference?

1 **Disease**

2 There are no known diseases that are significant threats to the continued existence of
3 CLH.

4 **Other Natural Occurrences or Human-related Activities**

5
6 Expected climate change impacts to California and the Clear Lake watershed will be
7 significant during annual CLH spawning cycles. CLH require winter and spring storms
8 that provide suitable spawning flows in the tributaries of Clear Lake. A shift in timing,
9 temperature, and amount of runoff could significantly impact the ability of CLH to
10 successfully spawn. A report on the projected effects of climate on California
11 freshwater fishes determined CLH to be critically vulnerable to impacts from climate
12 change.

13
14 Numerous recreational activities take place in Clear Lake each year. The majority of
15 recreational activities pose no significant threat to the survival of CLH. However, it is
16 believed that recreational and tournament anglers' capture CLH incidentally, at a low
17 rate. The extent of impacts to CLH from angling is unknown, but likely do not threaten
18 the continued existence of CLH.

19 **SUMMARY OF KEY FINDINGS**

20
21 At present time, the species can be found in portions of its historic habitat and
22 qualitative surveys indicate a variable interannual population. Based on qualitative
23 survey efforts to date a population estimate or index of CLH is not attainable. Without a
24 current population or index for CLH it is necessary to estimate impacts not based on a
25 set baseline but rather against trends seen in abundance and distribution in sampling
26 efforts over the past half century.

27
28 | It ~~is will be~~ imperative for the Department and the conservation community to study and
29 monitor the population of CLH over the next decade. A review of the scientific
30 determinations regarding the status of CLH indicates there are significant threats to the
31 continued existence of the species, particularly related to historical and ongoing habitat
32 modification, predation from introduced species, and competition. Many of these
33 threats are currently or in the near future being addressed by existing management
34 efforts. Monitoring impacts from existing management efforts will be imperative to
35 assessing the future status of CLH.

36 **RECOMMENDATION FOR PETITIONED ACTION**

37
38 CESA directs the Department to prepare this report regarding the status of CLH in
39 California based upon the best scientific information available. CESA also directs the
40 Department based on its analysis to indicate in the status report whether the petitioned
41 action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd.
42 (f)). The Department includes and makes its recommendation in its status report as

1 submitted to the Commission in an advisory capacity based on the best available
2 science.

3
4 Based on the criteria described above, the scientific information available to the
5 Department does/~~does not~~ indicate that CLH are threatened with extinction and likely to
6 become an endangered species in the foreseeable future. The listing recommendation
7 will be provided in this report after the Department receives, evaluates, and incorporates
8 peer-review comments as appropriate.

9 PROTECTION AFFORDED BY LISTING

10
11 It is the policy of the State to conserve, protect, restore and enhance any endangered or
12 any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an
13 endangered or threatened species, unauthorized “take” of CLH will be prohibited,
14 making the conservation, protection, and enhancement of the species and its habitat an
15 issue of statewide concern. As noted earlier, CESA defines “take” as hunt, pursue,
16 catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any
17 person violating the take prohibition would be punishable under State law. The Fish and
18 Game Code provides the Department with related authority to authorize “take” under
19 certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) As authorized
20 through an incidental take permit, however, impacts of the taking on CLH caused by the
21 activity must be minimized and fully mitigated according to State standards.

22
23 Additional protection of CLH following listing would also occur with required public
24 agency environmental review under CEQA and its federal counter-part, the National
25 Environmental Policy Act (NEPA). CEQA and NEPA both require affected public
26 agencies to analyze and disclose project-related environmental effects, including
27 potentially significant impacts on endangered, rare, and threatened special status
28 species. Under CEQA’s “substantive mandate,” for example, state and local agencies
29 in California must avoid or substantially lessen significant environmental effects of their
30 projects to the extent feasible. With that mandate and the Department’s regulatory
31 jurisdiction generally, the Department expects related CEQA and NEPA review will likely
32 result in increased information regarding the status of CLH in California as a result of,
33 among other things, updated occurrence and abundance information for individual
34 projects. Where significant impacts are identified under CEQA, the Department expects
35 project-specific required avoidance, minimization, and mitigation measures will also
36 benefit the species. State listing, in this respect, and required consultation with the
37 Department during state and local agency environmental review under CEQA, is also
38 expected to benefit the species in terms of related impacts for individual projects that
39 might otherwise occur absent listing.

40
41 If CLH are listed under CESA, it may increase the likelihood that State and federal land
42 and resource management agencies will allocate additional funds towards protection
43 and recovery actions. However, funding for species recovery and management is
44 limited, and there is a growing list of threatened and endangered species.

1 **MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES**

2
3 Current data on CLH suffers from being largely anecdotal and qualitative in nature.
4 Studies designed to provide quantitative data on CLH populations and the factors that
5 affect the ability of CLH to survive and reproduce are necessary for species
6 management. The following management recommendations were generated by
7 Department staff with considerations from local agencies, non-profits, and interested
8 parties.

- 9
10 • Derive a statistically valid population estimate or index allowing assessment of
11 impacts to the overall population and provide a baseline to maintain a
12 sustainable population level. [The best place to start is improvement of the stream](#)
13 [spawning surveys, by hiring a full-time coordinator for citizen survey crews.](#)
14 • Conduct a thorough assessment of barriers to fish movement on primary
15 spawning streams and provide recommendations for restoration actions on
16 substantial barriers.
17 • Complete a detailed analysis of spawning habitat in primary spawning streams
18 and provide recommendations for restoration actions.
19 • Implement identified restoration activities to increase available spawning [and](#)
20 [rearing](#) habitat for CLH.
21 • Conduct a review of reservoir operations at Highland Springs, Adobe Creek, and
22 Kelsey Creek detention dams to assess water release operations that may be
23 impacting CLH, development and implementation of guidelines for minimizing
24 impacts.
25 • Conduct an in-stream flow analysis of primary spawning tributaries to determine
26 impacts of water diversions on stream flows, particularly during spawning
27 season.
28 • Coordinate with landowners, stakeholders, and permitting agencies on
29 developing strategies for reducing in stream diversions during spawning season.
30 • Determine the value of wetland habitat in the watershed pertaining to
31 survivorship of juvenile CLH and make appropriate recommendations on
32 restoration or modification.
33 • Analyze food web interactions of CLH and non-native fish to determine potential
34 impacts to CLH.
35 • Conduct a [focused](#) diet analysis of predatory fish species to determine the extent
36 of their impact on CLH.
37 • [Conduct creel surveys to gain a better understanding of CLH capture rates](#)
38 [during both recreational and tournament angling.](#)
39 • Develop a comprehensive monitoring program to assess both native and non-
40 native fish populations and their distribution in the watershed.
41 • Identify habitats within the watershed that may be suitable for CLH
42 translocations. [In particular, develop ponds that can be used to create 'back up'](#)
43 [populations of hitch in case the lake populations disappear.](#)
44 • Coordinate the above research and restoration efforts with interested
45 stakeholders in the watershed.
46 • Develop an outreach program to provide updates to stakeholders on recovery
47 and management efforts.

Comment [PM27]: For hitch? This would be expensive & yield little data.

1 **PUBLIC RESPONSE**

2

3 *Note to Reviewer.* Public response will be finalized after the Department receives,
4 evaluates, and incorporates peer-review comments as appropriate.

5 **PEER REVIEW**

6

7 *Note to Reviewer.* Peer review will be finalized after the Department receives,
8 evaluates, and incorporates peer-review comments as appropriate.

9

10

11

12

13

14

15

16

17

18

19

20

21

22 **LITERATURE CITED**

23

24 Aguilar, A. and J. Jones. 2009. Nuclear and Mitochondrial Diversification in two Native
25 California Minnows: Insights into Taxonomic Identity and Regional Phylogeography.
26 *Molecular Phylogenetics and Evolution* 51 (2): 373-381.

27

28 Anderson, N.L., D.L. Woodward and A.E. Colwell. 1986. Pestiferous dipterans and two
29 recently introduced aquatic species at Clear Lake. *Proceedings of the California*
30 *Mosquito Vector Control Association.* 54:163-167.

31

1 Anderson, N.L., 1989. Letter to Rick Macedo containing notes and data from LCVCD
2 sampling efforts.
3

4 Avise, J.C. and F.J. Ayala. 1976. Genetic differentiation in speciose versus depauperate
5 phylads: Evidence from the California minnows. *Evolution* 30:46-58.
6

7 Barrett, S.A., 1906. The Ethno-Geography of the Pomo and Neighboring Indians.
8 University of California Publications in American Archeology and Ethnology. Vol 6 No. 1.
9

10 Bairrington, P., 1999. CDFG Clear Lake Fishery Management Plan.
11

12 Bellucci, C. J., Becker, M., & Beauchene, M. (2011). Characteristics of
13 macroinvertebrate and fish communities from 30 least disturbed small streams in
14 Connecticut. *Northeastern Naturalist*, 18(4), 411-444.
15

16 Big Valley EPA, 2013. Hitch interview notes with families of Big Valley Rancheria and
17 Elem Indian Colony.
18

19 Big Valley Rancheria, 2012. Hitch *Lavinia exilicauda* Chi Hopkirk ecology and water
20 quality studies in Big Valley sub-basin creeks in 2012.
21

22 Big Valley Rancheria, 2013. Big Valley sub-basin creek water quality, quantity, and
23 Hitch *Lavinia exilicauda* Chi Hopkirk ecology program. Spring, 2013.
24

25 Brown, A.V., M.M. Little, and K.B. Brown, 1998. Impacts of gravel mining on gravel bed
26 streams. *Transactions of the American Fisheries Society*. 127:979-994.
27

28 Bunn, S.E., and A.H. Arthington, 2002. Basic Principles and Ecological Consequences
29 of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol.
30 30:4. Pp 492-507.
31

32 California Climate Change Center, 2012. Our Changing Climate 2012 Vulnerability and
33 Adaptation to the Increasing Risks from Climate Change in California.
34

35 California Department of Fish and Game, 1955-1956. Field notes on Kelsey and Seigler
36 Creeks.
37

38 California Department of Fish and Game, 1961-2001. Commercial Catch data for Clear
39 Lake
40

41 California Department of Fish and Game, 1969. News Release on Fish Dieoffs at Clear
42 Lake.
43

44 California Department of Fish and Game, 1988. Clear Lake Electrofishing Survey, April
45 2, 1987 Memorandum.
46

47 California Department of Fish and Game, 2012. Electrofishing data, Memorandum in
48 progress.

1
2 California Department of Fish and Wildlife, 2013. Report to the Fish and Game
3 Commission Evaluation of the Petition from the Center for Biological Diversity to List
4 Clear Lake Hitch (*Lavinia exilicauda chi*) as a Threatened Species under the California
5 Endangered Species Act.
6
7 California Department of Fish and Wildlife, 2013. Commercial Fisheries Data from catch
8 records.
9
10 California Department of Fish and Wildlife, 2013. Commercial Operators permit
11 applications.
12
13 California Department of Fish and Wildlife, April 24, 2013. Press Release – CDFW
14 Seeks Public Comment and Data Regarding Clear Lake Hitch.
15
16 California Department of Water Resources. 1975. Clear Lake Water Quality Data.
17
18 California Natural Resources Agency, 2009. California Climate Adaptation Strategy
19 Discussion Draft.
20
21 California Environmental Protection Agency RWQCBCVR, 2002. Clear Lake TMDL for
22 Mercury Staff Report.
23
24 California Environmental Protection Agency RWQCBCVR, 2008, Monitoring and
25 Implementation Plan Clear Lake Mercury and Nutrient TMDL's.
26
27 California Environmental Protection Agency RWQCBCVR, 2010. Clear Lake Mercury
28 Total Maximum Daily Load Update.
29
30 California Environmental Protection Agency RWQCBCVR, 2012. Clear Lake Nutrient
31 Total Maximum Daily Load Control Program 5-year Update.
32
33 California Regulatory Notice Register, 2012. No. 41-Z. p.1501
34
35 California Regulatory Notice Register, 2013. No. 12-Z. p.488
36
37 Center for Biological Diversity, 2012. Petition to List Clear Lake Hitch (*Lavinia exilicauda*
38 *chi*) as Threatened under the California Endangered Species Act. 58 pp.
39
40 Chi Council for the Clear Lake Hitch (CCCLH). 2013. Hitch spawning survey results,
41 2005-2013. Available at <http://lakelive.info/chicouncil/>
42
43 Clear Lake Integrated Watershed Management Plan, February 2010. Prepared for West
44 Lake and East Lake Resource Conservation Districts.
45
46 Coleman, G.A. 1930. A biological survey of Clear Lake, Lake County. *Calif. Fish and*
47 *Game* 16: 221-227.
48

- 1 Converse, Y.A., C.P. Hawkins and R. A. VALDEZ, 1998. Habitat Relationships of
2 Subadult Humpback Chub in the Colorado River through Grand Canyon: Spatial
3 Variability and Implications of Flow Regulation. *REGULATED RIVERS: RESEARCH &*
4 *MANAGEMENT* **14**: 267–284
- 5
- 6 Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1964. The impact of the fishery on the
7 midges of Clear Lake, Lake County, CA, *Annals of the Entomological Society of*
8 *America*, Vol. 57, pp. 701-707.
- 9
- 10 Cott, P. A., Sibley, P. K., Somers, W. M., Lilly, M. R., & Gordon, A. M. (2008). A
11 REVIEW OF WATER LEVEL FLUCTUATIONS ON AQUATIC BIOTA WITH AN
12 EMPHASIS ON FISHES IN ICE-COVERED LAKES¹. *Journal of the American Water*
13 *Resources Association*, *44*(2), 343-359.
- 14
- 15 Cox, B., 2007. CDFG Clear Lake Fishery Surveys Summary Report.
- 16
- 17 Curtis T.C. 1977. Pesticide Laboratory report. California Department of Fish and Game,
18 E.P. No. P-133. 3pp.
- 19
- 20 Crump, KL and VL Trudeau, 2009. Mercury-induced reproductive impairment in fish.
21 *Environmental Toxicology and Chemistry*. 28(5):895-907.
- 22
- 23 Deitch, M.J., G.M. Kondolf, and A.M. Merenlender. 2009. Hydrologic impacts of
24 smallscale instream diversions for frost and heat protection in the California wine
25 country. *River Research and Applications*, Volume 25, Issue 2, pages 118-134.
- 26
- 27 Dill, W. A., and A. J. Cordone. 1997. Fish Bulletin 178. History and Status of Introduced
28 Fishes in California 1871-1996. California. Fish and Game. 414 pp.
- 29
- 30 Eagles-Smith, C.A., T.H. Suchanek, A.E. Colwell, N.L. Anderson, and P.B. Moyle. 2008.
31 Changes in fish diets and food web mercury bioaccumulation induced by an invasive
32 planktivorous fish. *Ecological Applications* 18(Supplement): A213–A226.
- 33
- 34 Ewing, B., 2013. Summary of the Clear Lake Hitch Population Estimate for Cole and
35 Kelsey Creeks, Lake County.
- 36
- 37 Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller,
38 1999. *Confronting Climate Change in California: Ecological Impacts on the Golden*
39 *State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of
40 America, Washington, DC.
- 41
- 42 Field, C.B., L.D. Mortsch, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W.
43 Running and M.J. Scott, 2007: North America. *Climate Change 2007: Impacts,*
44 *Adaptation and Vulnerability. Contribution of Working Group II to the Fourth*
45 *Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry,
46 O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge
47 University Press, Cambridge, UK, 617-652.
- 48

1 Forsgren Associates Inc, 2012. Clear Lake Watershed Sanitary Survey 2012 Update
2 Final.
3

4 Franson, S. 2013. Summary of Spring 20-13 Field Monitoring with Locations chosen for
5 observing egg and larval development of Clear Lake Hitch (*Lavinia exilicauda chi*).
6

7 Gafny, S., A. Gasith, and M. Goren 2006. Effect of water level fluctuation on shore
8 spawning of *Mirogrex terraesanctae* (Steinitz), (Cyprinidae) in Lake Kinneret,
9 Israel. Journal of Fish Biology vol 41:6 pages 863-871
10

11 Geary, R.E. 1978. Life history of the Clear Lake hitch (*Lavinia exilicauda chi*).
12 Unpublished Master's Thesis, University of California, Davis. 27 pp.
13

14 Geary, R.E. and P.B. Moyle. 1980. Aspects of the ecology of the hitch, *Lavinia*
15 *exilicauda* (Cyprinidae), a persistent native cyprinid in Clear Lake, California.
16 Southwest. Nat. 25:385-390.
17

18 Giusti, G. 2009. Human Influences to Clear Lake, California A 20th Century History.
19

20 Harnly, M., S. Seidel, P. Rojas, R. Fornes, P. Flessel, D. Smith, R. Kreutzer, and L.
21 Goldman. 1996. Biological monitoring for mercury within a community with soil and fish
22 contamination. *Environmental Health Perspectives*, Vol. 105:4, 424-429.
23

24 Havens, K.E. 2008. Cyanobacterial Harmful Algal Blooms: State of the Science and
25 Research Needs. Chapter 33: Cyanobacteria blooms: effects on aquatic ecosystems.
26 Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser,
27 S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S.
28 Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004.
29 Emissions pathways, climate change, and impacts on California. Proceedings of the
30 National Academy of Science 101:12422-12427.
31

32 Hopkirk, J.D. 1973. Endemism in fishes of the Clear Lake region of central California.
33 University of California Publications in Zoology 96: 160 pp.
34

35 Horne, A.J. 1975. The Effects of Copper, Major and Minor Nutrient Element
36 Additions, and Lake Water Movements on Blue-Green Algal Bloom Development in
37 Clear Lake.
38

39 Hudon, C., Armellin, A., Gagnon, P., & Patoine, A. (2010). Variations in water
40 temperatures and levels in the St. Lawrence River (quebec, canada) and potential
41 implications for three common fish species. *Hydrobiologia*, 647(1), 145-161.
42

43 Hunt, E.G. and A.I. Bischoff. 1960. Inimical effects on wildlife or periodic DDD
44 applications to Clear Lake. California Fish and Game 46:91-106.
45

46 Jelks, H L., Stephen J. Walsh, Noel M. Burkhead, Salvador Contreras-Balderas,
47 Edmundo

1 Diaz-Pardo, Dean A. Hendrickson, John Lyons, Nicholas E. Mandrak, Frank
2 McCormick, Joseph S. Nelson, Steven P. Platania, Brady A. Porter, Claude B. Renaud,
3 Juan Jacobo Schmitter-Soto, Eric B. Taylor & Melvin L. Warren Jr. (2008): Conservation
4 Status of Imperiled North American Freshwater and Diadromous Fishes, *Fisheries*,
5 33:8, 372-407.
6
7 Jordan, D.S., and C.H. Gilbert. 1894. List of Fishes Inhabiting Clear Lake, California.
8 *Bulletin of the United States Fish Commission*, Vol. XIV.
9
10 Kelsey Creek Watershed Assessment, February 2010. Prepared for East Lake and
11 West Lake Resource Conservation Districts.
12
13 Kimsey, J.B. and L.O. Fisk. 1960. Keys to the freshwater and anadromous fishes of
14 California. *Calif. Fish Game* 46:453-79.
15
16 Kniffen, F.B. 1939. Pomo Geography. University of California Publications in American
17 Archaeology and Ethnology. Vol. 36 No. 6 pp. 353-400.
18
19 Kratville, D. October 7, 2013. Email correspondence on CESA MOU's issued for CLH.
20
21 Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T.
22 Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management.
23 *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working*
24 *Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate*
25 *Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.
26 Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.
27
28 Lake County Department of Agriculture, 2011. Crop Report
29
30 Lake County Department of Public Works Water Resources Division, 2003. Clear Lake
31 Wetlands Geographic Information Systems Data User Manual.
32
33 Lake County Vector Control District, 2013. Copy of verified Beach Seine 1987-2010 CL
34 Hitch with notes.
35
36 Lindquist, A.W., C.D. Deonier, and J.E. Hanley. 1943. The relationship of fish to the
37 Clear Lake gnat, in Clear Lake, California. *Calif. Fish Game* 29:196-202.
38
39 Lindquist, A.W. and A.R. Roth. 1950. Effect of dichlorodiphenyl dichloroethane on larva
40 of the Clear Lake gnat in California. *Journal of Economic Entomology* 43:328-332.
41
42 Macclanahan, J., E. W. Danley, H. F. Dewitt, and W. Wolber. 1972[app]. Flood control
43 project maintenance and repair, 1971 inspection report. California Department of Water
44 Resources Bulletin 149-71.
45
46 Macedo, R., 1991. Creel Survey at Clear Lake, California March – June, 1988. CDFG
47 Administrative Report No. 91-3.
48

- 1 Macedo, R. 1994. Swimming Upstream Without a Hitch. Outdoor California:
2 January/February 1994.
3
- 4 Marchetti, M.P. and P.B. Moyle, 2001. Effects of flow regime on fish assemblages in a
5 regulated California stream. *Ecological Applications*. 11(2). Pp. 530-539.
6
- 7 McGinnis, D. and E. Ringelberg. 2006. Lake County Fish Barrier Assessment. Technical
8 Memo.
9
- 10 Middle Creek Watershed Assessment, February 2010. Prepared for West Lake
11 Resource Conservation District.
12
- 13 Miller, R.R. 1945. A new cyprinid fish from Southern Arizona, and Sonora, Mexico, with
14 description of a new subgenus of *Gila* and a review of related species. *Copeia*
15 1945:104-110.
16
- 17 Miller, R.R. 1963. Synonymy, characters and variation of *Gila crassicauda*, a rare
18 California minnow, with an account of its hybridization with *Lavinia exilicauda*. *California*
19 *Fish and Game* 49 (1): 20-29.
20
- 21 Mioni, C., R. Kudela, and D. Baxter. 2011. Harmful cyanobacteria blooms and their
22 toxins in Clear Lake and the Sacramento-San Joaquin delta (California). *Central Valley*
23 *Regional Water Quality Control Board*: 10-058-150.
24
- 25 Moyle, P.B. and M. Massingill. 1981. Hybridization between hitch, *Lavinia exilicauda*,
26 and Sacramento blackfish, *Orthodon microlepidotus*, in San Luis Reservoir, California.
27 *California Fish Game* 67:196-198.
28
- 29 Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. *Fish*
30 *Species of Special Concern in California*, 2nd edition.
31
- 32 Moyle, P.B. and T. Light, 1996. Fish Invasions in California: Do Abiotic Factors
33 Determine Success? *Ecology* 77:1666-1670.
34
- 35 Moyle, P. B. 2002. *Inland Fishes of California*. Berkeley: University of California Press.
36
- 37 Moyle, PB., JD Kiernam, PK Crain and RM Quinones, 2012. Projected Effects of Future
38 Climates on Freshwater Fishes of California. A White Paper from the California Energy
39 Commission's California Climate Change Center.
40
- 41 Moyle P.B., J.V Katz, and R.M. Quinones. In review. *Fish Species of Special Concern*
42 *for California*. Prepared for California Department of Fish and Game, Sacramento
43
- 44 Murphy, G.I. 1948. Notes on the biology of the Sacramento hitch (*Lavinia e. exilicauda*)
45 of Clear Lake, Lake County, California. *Calif. Fish Game* 34:101-110.
46
- 47 Murphy, G.I. 1951. The fishery of Clear Lake, Lake County, California. *Calif. Fish and*
48 *Game* 37: 439-484.

1
2 National Oceanic and Atmospheric Administration, 2011. Table 2. Toxicity associated
3 with mercury in tissues (ug/g) wet weight.
4
5 Nicola, S.J. 1974. The life history of the hitch, *Lavinia exilicauda* Baird and Girard, in
6 Beardsley Reservoir, California. Inland Fish. Admin. Rep. 74-6:1-16.
7
8 Osleger, D.A., R.A. Zierenberg, T.H. Suchanek, J.S. Stoner, S. Morgan, and D.P.
9 Adam. 2008. Clear Lake sediments: anthropogenic changes in physical sedimentology
10 and magnetic response. Ecological Applications 18 (Supplement): A239-A256.
11
12 Puckett, L., 1972. CDFG Memorandum-Fisheries Survey Clear Lake, Lake County.
13
14 Richerson P.J., T.H. Suchanek, and S.J. Why. 1994. The Causes and Control of Algal
15 Blooms in Clear Lake, Clean Lakes Diagnostic/Feasibility Study for Clear Lake,
16 California. Prepared for USEPA Region IX.
17
18 Ridout, W.L. 1899. A Fish Jam on Kelsey Creek. *Overland Monthly and Out West*
19 *Magazine*. Volume 34, Issue 202. p. 333.
20
21 Robinson Rancheria Environmental Center (RREC). 2011. Draft Adaptive Management
22 Plan for the Clear Lake Hitch, *Lavinia exilicauda chi*. Available
23 at <http://www.robinsonrancheria.org/environmental/water.htm>.
24
25 Rowan, J., 2008. CDFG Clear Lake, Lake County Memorandum.
26
27 Rudd, R.L. 1964. *Pesticides and the Living Landscape*. University of Wisconsin Press,
28 Madison, WI.
29
30 Sandheinrich, MB. And KM Miller, 2006. Effects of dietary methylmercury on
31 reproductive behavior of fathead minnows (*Pimephales promelas*). *Environmental*
32 *Toxicology and Chemistry*. 25(11):3053-3057.
33
34 Scotts Creek Watershed Assessment, February 2010. Prepared for West Lake
35 Conservation District.
36
37 Scotts Valley Band of Pomo Indians, 2013. Historical accounts provided to CDFW by
38 Steve Elliott and Wanda Quitiquit.
39
40 State of California Fish and Game Commission, March 11, 2013. California Fish and
41 Game Commission Notice of Findings
42
43 State of California Fish and Game Commission, October 2, 2012. California Fish and
44 Game Commission Notice of Receipt of Petition
45
46 Suchanek, T.H., P.J. Richerson, L.A. Woodward, D.G. Slotton, L.J. Holts and C.E.
47 Woodmansee. 1993. Ecological Assessment of the Sulphur Bank Mercury Mine
48 Superfund Site, Clear Lake, California: A Survey and Evaluation of Mercury In:

1 Sediment, Water, Plankton, Periphyton, Benthic Invertebrates and Fishes Within the
2 Aquatic Ecosystem of Clear Lake, California. Phase 1- Preliminary Lake Study Report.
3 Prepared for EPA-Region IX, Superfund Program. 113 pp., plus 2 attachments.
4
5 Suchanek, T.H., P.J. Richerson, D.C. Nelson, C.A. Eagles-Smith, D.W. Anderson, J.J.
6 Cech, Jr., G. Schladow, R. Zierenberg, J.F. Mount, S.C. McHatton, D.G. Slotton, L.B.
7 Webber, A.L. Bern and B.J. Swisher. 2002. Evaluating and managing a multiply-
8 stressed ecosystem at Clear Lake, California: A holistic ecosystem approach.
9 "Managing For Healthy Ecosystems: Case Studies," CRC/Lewis Press. pp. 1233-1265.
10
11 Swift, C. 1965. Early development of the hitch, *Lavinia exilicauda*, of Clear Lake,
12 California. Calif. Fish Game 51:74-80.
13
14 Thompson, L.C., G.A. Giusti, K.L. Weber, and R.F. Keiffer. 2013. The native and
15 introduced fishes of Clear Lake: a review of the past to assist with decisions of the
16 future. California Fish and Game 99(1):7-41.
17
18 U.S. Army Corps of Engineers. 1974[app]. Flood plain information: Big Valley streams
19 (Manning, Adobe, Kelsey, and Cole Creeks), Kelseyville, California. Department of
20 the Army, Sacramento District, Corps of Engineers, Sacramento, California, USA.
21
22 U.S. Environmental Protection Agency, 2012. Sulphur Bank Mercury Mine News
23 Release – EPA to Begin Construction of Test Covers in Clear Lake.
24
25 Week, L., 1982. Habitat Selectivity of Littoral Zone Fishes at Clear Lake, CDFG
26 California. Administrative Report No. 82-7.
27
28 Wetzel, R.G., 2001. Limnology lake and River Ecosystems, 3rd ed. Pg. 834.
29
30 Winder, M., J. Reuter and G. Schladow, 2010. Clear Lake Report: Clear Lake Historical
31 Data Analysis.
32
33
34
35

36 **Appendix A.** Summary graphs of spawning observations between 2005 and 2013
37
38
39
40
41
42
43
44
45
46
47
48

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

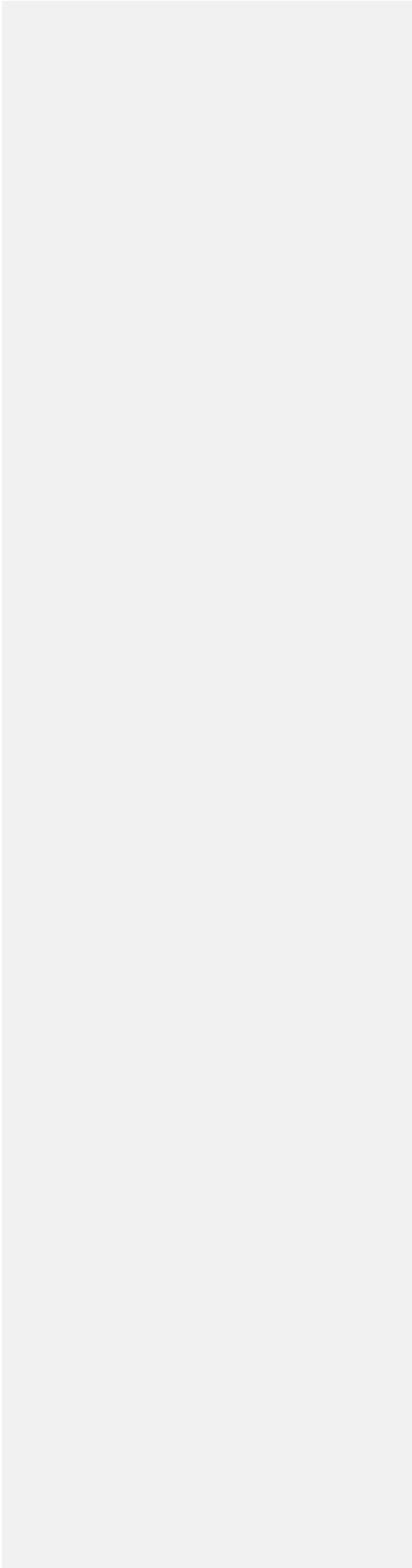
DRAFT

Appendix B. Figures depicting CLH observations on spawning tributaries

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

DRAFT

Appendix C. Description of barriers associated with CLH spawning tributaries



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

DRAFT

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

Adobe Creek: There is a flood control dam on Adobe Creek above Bell Hill Road that is impassable to CLH. There are two culverts on Adobe Creek that are mitigation barriers to spawning CLH when the water flows and velocity are not too great, but these culverts block CLH migration.

Alley Creek: Alley Creek has been channeled and diverted into Clover Creek. Alley Creek historically supported CLH runs. During some time and under certain conditions migrating CLH can access Alley Creek via the Clover channel bypass, but not when the diversion has silt or sand obstructing it.

1 Clover Creek: There was a diversion barrier on Clover Creek, a tributary of Middle
2 Creek, which prevented fish passage into Clover Creek and Alley Creek. In 2004 the
3 Robinson Rancheria received a Tribal Wildlife Grant to mitigate the diversion barrier.
4 The work has been completed and the barrier has been modified and no longer
5 obstructs fish passage. However, CLH must pass a concrete diversion structure at the
6 junction with Alley Creek to the northwest of Upper Lake to gain the upper reaches of
7 Clover Creek. This diversion structure usually becomes a complete barrier when filled
8 with gravel and sediment.
9

10 Forbes Creek: Forbes Creek has a concrete storm water diversion structure that
11 impedes and at times blocks CLH passage.
12

13 Kelsey Creek: On Kelsey Creek, the main barriers to CLH migration are a detention
14 dam 2 to 3 miles upstream of Clear Lake, and the Main Street Bridge in Kelseyville. The
15 rock and concrete weir constructed at the base of the Main Street Bridge is a barrier to
16 the passage of CLH (Peter Windrem, personnel communication, 2012). The structure
17 has a fish ladder which is nonfunctional and the site is nonetheless a total barrier to
18 CLH (McGinnis and Ringelberg, 2008). The Kelsey Creek detention structure below
19 Dorn Crossing has retractable gates which can be opened during the CLH spawning
20 season. However, altered flow patterns and slight increases in the slope of the
21 streambed have been enough to reduce the number of spawning CLH that can pass
22 through the detention structure and move upstream. Also, rock riprap situated below the
23 retention dam seems to have impeded the upstream migration of CLH and needs to be
24 modified to provide a clear channel for fish transit. A number of drop-structures in
25 Kelsey Creek intended for gravel aggradation impede migration. Some of these do not
26 seem to impede CLH passage under current conditions, but CLH navigate them with
27 difficulty especially on the downstream passage. Further upstream, culverts that once
28 tended to clog with debris and block fish migration at the Merritt Road crossing have
29 been removed and replaced by a bridge that poses no impediment to CLH passage.
30

31 Lyons Creek: A high culvert on Lyons Creek at Lakeshore Drive prevents CLH from
32 moving upstream. Lyons Creek also has a concrete barrier at the County's Juvenile Hall
33 facility that completely prevents fish passage.
34

35 Manning Creek: A dam upstream of known CLH spawning areas in the lower reaches
36 of Manning Creek may prevent CLH from spawning further upstream.
37

38 Middle Creek: On Middle Creek, a rock and concrete weir at the Rancheria Road
39 Bridge has been a total fish passage barrier for CLH. Remedial work has been done
40 downstream, with more weirs installed in an effort to elevate the gradient so that CLH
41 could surmount the barrier and work was done to improve their stability after high flows,
42 but it remains to be seen if this will allow CLH passage. Similar weirs to capture and
43 hold gravel were installed many years ago in Adobe Creek and Kelsey Creek that do
44 not impede CLH passage, but there is concern the installed weirs on Middle Creek may
45 be potential barriers to CLH. A downstream weir at Rancheria Road is a partial barrier
46 and improperly sized rip rap at this location acts as partial migration barrier (McGinnis
47 and Ringelberg 2008). CLH were seen recently at Middle Creek Bridge and Highway 20
48 and although there are no obvious barriers, they did not appear to be able to navigate

1 the swift currents there due to the lack of resting pools. If CLH could surmount
2 Rancheria Bridge, many additional miles of spawning grounds would be accessible to
3 CLH up to areas south of Hunter Bridge, where habitat suitability ends because the
4 channel is braided and shallow due to gravel mining.

5
6 Scotts Creek: On Scotts Creek, a rock and concrete weir at the Decker Bridge is a total
7 barrier to the passage of CLH. As water levels have been lower, a barrier at the lower
8 end of Tule Lake is problematic for fish passage to Tule Lake and its tributary
9 Mendenhall Creek, Scotts Creek and tributaries, Bachelor Valley/Witter Springs area
10 tributaries, and Blue Lakes and tributaries. There is a one-way flow gate on the Blue
11 Lakes outlet at Scotts Creek that prevents CLH from entering Blue Lakes.

12
13 Seigler Canyon Creek: There are two barriers to CLH migration into Seigler Canyon
14 Creek, an exposed sewer pipe and a road crossing. The sewer pipeline which crosses
15 Seigler Canyon Creek for Anderson Marsh State Park was modified in the 1990s and
16 completely blocks CLH access to that creek, once a major spawning tributary.

DRAFT

Page	Line	Reviewer Comment	Department Response
9	4	suggested edit "to feed largely on water fleas"	Accepted
9	8	suggested edit "Chironomidae; planktonic crustaceans including the genera Bosmina and Daphnia;"	Accepted
9	20-21	suggested addition "Scale analysis indicates CLH live up to 6 years but it is likely that some individuals live longer (Moyle 2002)."	Accepted
9	23	suggested addition "CLH spawn in both lake tributaries and in the lake itself."	No Change- this information is provided further in the paragraph.
9	25-26	? which ones?	No Change- this is a general description of tributaries.
9	26	suggested edit "and nearly all have low gradients in their lower reaches." suggested edit "Some streams have flowing water year round, at least in headwaters. The lower reaches of tributary streams are seasonal with remnant pools occurring by late spring, and subsequently dry during summer months in most years."	Accepted
9	27-31	suggested edit "CLH spawn in these low-gradient tributary streams and have spawning migrations"	No Change- The seasonality of tributaries is described.
9	31	suggested edit "The success of these spawning events is not clearly understood and may be limited due to losses from predation on eggs and larvae, especially by alien fishes such as bluegill and Mississippi silverside"	Accepted
9	39-43	suggested edit "CLH are present in the littoral zone from April to July and are scarce in this habitat during other months"	Accepted- removed atypical and added events and predation on eggs and larvae. No Change- especially by alien fishes such as bluegill and Mississippi silversides as no reference was provided.
10	21-22	Are you sure? Bass fisherman use a hitch lure in the lake....	Accepted
10	29-30	suggested edit "tributaries or shallows of the lake during the following spring."	Accepted- The statement has been removed from the document.
10	39	suggested edit "Ideally, an assessment"	Accepted
10	42	suggested addition "Glimpses into baseline numbers suggest that hitch were once very abundant. One of the oldest records is that of Livingston Stone (1876) who lived on the lake in 1872 and 1873. He states " They ran up the streams in spring to spawn in countless numbers. It is not unusual to see one or two acres of ground covered with hitch, which the Indians have dried for food." If you assume each drying fish is about 10 x 3 inches, this results in an estimate of about 200,000 fish per acre. Obviously, such numbers are at best "ball park" estimates but they do suggest hitch were vastly more abundant then than they are today."	No Change
11	1	"	No Change- Paragraph insertion. Historic information is provided later in the document.
12	3	suggested edit "correlated to abundance of CLH"	Accepted- Addition of Livingston Stone quote.
12	7	suggested edit "populations have at times been extremely low and at other times relatively high."	Accepted
14	20	suggested edit "CLH in 2005 is the likely"	Accepted
14	37	suggested edit "Based on this reports"	No Change
14	36-39	I disagree. Kelsey Creek presumably supported the largest run because of its size but there is no reason to think the fish did not use every available tributary as they do today.	Accepted- Sentence reworded to state the largest run occurred in Kelsey Creek. No Change- The paragraph does not detail the importance of spawning tributaries only the importance of the CLH supply.
14	43	suggested edit "the most important spawning tributary"	Accepted
15	7	suggested edit "and Mississippi silversides (Menidia audens)"	Accepted
15	10-11	suggested edit "CLH populations as sampling varies significantly"	Accepted- Reworded based on other peer review comments
17	6	Using a boat electrofisher?	Accepted- Added sampling method to each survey.
17	7	Surveys found adult and juvenile (?) CLH	Accepted- Added adult. No Change- "not" as CLH were the most abundant fish in the habitat they would be found in.
17	15	would not? likely be found during this time period suggested edit "CLH were the second most abundant fish caught during various gill net surveys conducted between 1938 and 1941, for examination of fish and gnat interactions(Lindquist et al. 1943); runs of Sacramento splittail (Pogonichthys ciscoides) and CLH were described as numbering in the tens of thousands (Lindquist et al. 1943)."	Accepted- Clear Lake splittail scientific name. No Change- Paragraph rewording as original was clear on intent.
18	8-13	Hard to tell what species	Accepted- Sentence reworded.

18	Figure 6	suggested edit "Photo from 1890s depicting spawning fish, most likely CLH, being stranded in Kelsey Creek." Clear Lake is not a classic impoundment being a natural lake. One could argue that keeping lake levels higher	Accepted- Sentence reworded
19	35	in spring could benefit hitch (more littoral habitat for young). Results of the survey indicate all of the lower reaches? of the creeks had low Index of Biological Integrity	Accepted- Information added on the amount of fluctuation seen in traditional reservoirs.
20	1-2	(IBI) scores	Accepted- Sentence reworded
20	3	Not in references; would like to see a copy.	Accepted- Added to references
20	34	Good thing to do!	Noted
		suggested addition "Cook et al (1966) noted the spittail "...underwent a drastic reduction in the 1940s" (p. 146) and feared it "...may disappear ... if increased demands upon the water further limit reproductive	
22	24-26	success." pg 147	Accepted
		Cook SF, RL MOORE, and JD Connors. 1966. Status of the native fishes of Clear Lake, Lake County, California	
22	24-26	Wasmann Journal of Biology 24: 141-160.	Accepted
24	7	suggested edit "Primary producers such as epiphyton"	Accepted
24	9	suggested edit "As the cyanobacteria alter"	Accepted
24	11	suggested edit "cyanobacteria begin to deplete"	Accepted
24	25	suggested edit "marijuana culture"	Accepted
24	30	suggested edit "Clear Lake gnat, an important food source for juvenile CLH,"	Accepted
		suggested edit "application of DDD in the Clear Lake watershed resulted in a major ecological disaster and	
24	41-43	the first records of pesticide bioaccumulation in the wildlife of the lake"	Accepted
		Introduction of aliens, agriculture etc were also disasters from the lake perspective.	
24	42		No Change- Sentence reworded to clarify first ecological disaster from pesticides.
24	47	petroleum product ?????	Accepted- name added
25	3	suggested edit "Mississippi silversides"	Accepted
25	11	suggested edit "infestation of the lake"	Accepted
25	42	suggested edit "High levels of Mercury accumulation can lead to"	Accepted
		What are the levels specifically in CLH? I suspect the higher levels are in bass, not hitch. Note; There is an	
25	48	entire issue of Ecological Applications (2008) devoted to Clear Lake mercury issues.	Accepted- Level for CLH added
		suggested edit "), which have resulted in health advisories on their consumption, but are below acute	
25-26	48-1	toxicity thresholds"	Accepted
26	7	suggested edit "it is possible that"	Accepted
		suggested addition "However, Hg levels are generally much lower in plankton feeding fish such as hitch than	
26	9	they are for other fishes in the lake (Eagles-Smith et al. 2008)."	No Change- The levels for CLH have been identified previously.
26	43	suggested edit "Two Pomo bands fought"	No Change
26	45	suggested edit "for the local native peoples"	No Change
27	13	suggested edit "to three bands to authorize"	No Change
		Now aware of any records of hardhead from the lake or tributary streams. It is present in Cache Creek	
		below the lake but the lake is not really suitable for it nor are the upstream tribs. If you believe the earliest	
		accounts of the lake, CA roach were once abundant in shallow water; possible but identifications not strong.	
27	25	Check Hopkirk.	Accepted- Hardhead removed as reference in Thompson et al 2013 is unsubstantiated.
27	31	suggested edit "(largemouth and Florida bass (Micropterus spp)"	Accepted
		Mississippi silverside (taxonomy has been reworked); the paper on the introduction of the silverside claims	
27	36	CDFG was a participant or at least did not discourage it.	No Change- According to Dill and Cordone the introduction into Clear Lake was not authorized by the Fish and Game Commission.
			No Change- The sentence states they were introduced. In the next sentence it is described
27	36	Doubt they are present in the lake; would like to see the proof.	that they never established.
			No Change- The sentence states they were introduced. In the next sentence it is described
27	37	Not present.	that they never established.
27	19-42	You need a table of all native and non-native species and their status	No Change- Species are discussed at length in document.
			No Change - It is not within the references of this document to assert that all fish
27	44	suggested edit "Non-native fish introductions have significant impacts on native fish species."	introductions have impacts to native fish species.

27	45	suggested edit "Mississippi silverside"	Accepted
27	46-47	suggested edit "compete directly with CLH for food resources and likely prey on larvae as well"	No Change- No reference provided to substantiate claim of "likely prey on larvae" Noted- The Department sought the LCVCD data on threadfin shad and Mississippi silverside abundance to make a comparison but the data was not provided to the Department.
28	1	Could you make some?	
		suggested addition "Eagles-Smith et al. (2008) found that zooplankton populations declined precipitously as threadfin shad populations increased, causing other common plankton-feeding fishes (juvenile largemouth bass and bluegill, Mississippi silverside) to switch to benthic feeding. Hitch, being more specialized for zooplankton feeding may have been strongly affected by the threadfin shad (introduced in the 1980s), which undergoes boom-and-bust population cycles in the lake (Eagles-Smith et al (2008)."	Accepted- Information has been added on Mississippi silverside, threadfin shad, and CLH abundance.
28	5	suggested edit "rearing habitat and food has likely increased"	Accepted
28	13	Note that Florida bass (<i>M. floridae</i>) are regarded as a separate species from LMB. They apparently initially hybridized with LMB in the lake but now appear to be dominant. They grow larger than LMB so will be more inclined to eat adult CLH	Accepted- Florida bass added to sentence.
28	18-19	suggested edit "such as bullhead catfish (<i>Ameiurus</i> spp.)"	Accepted
28	22	suggested edit "introduction of white and channel catfish"	No Change- Changed to bullhead catfish
28	23	suggested edit "The introduction of white catfish (<i>A. catus</i>) was described"	Accepted
28	25		
28	31-32	This is probably true, but Eagles-Smith et al. don't say this in relation to hitch or even fish predation.	Accepted- Sentence removed
		suggested addition "Overall, alien species appear to be a major factor in contributing to hitch declines in Clear Lake. While fairly substantial runs of hitch have persisted into recent years, it is likely that the combination of introductions of Florida bass (1970s), Mississippi silverside (1967), and threadfin shad (1980s) have created an environment in which it is increasingly hard for hitch to persist. The voracious and large-sized bass will eat adults as well as juveniles. Threadfin shad deplete off shore plankton populations on which the hitch depend for much of their life. Silversides deplete inshore sources of food and presumably prey on larvae as they come out of the streams, as they have been shown to do for various fishes in the Sacramento San Joaquin Delta (ref.)	
28	34	suggested edit "likely to cause changes"	No Change- The same information has already been provided in the section.
29	27	suggested edit "amount of runoff will likely significantly"	Accepted
29	33	suggested edit "Climate driven anthropogenic change"	Accepted
29	34-35	This has now been published; Moyle, P.B., J. D. Kiernan, P. K. Crain, and R. M. Quiñones. 2013. Climate change vulnerability of native and alien freshwater fishes of California: a systematic assessment approach. <i>PLoS One</i> . http://dx.plos.org/10.1371/journal.pone.0063883	Accepted
29	41	suggested addition "). , Moyle et al. (2012. 2013) rated Clear Lake hitch as 'critically vulnerable' to extinction from the added effects of climate change, suggesting that CLH would be extinct by 2100 if steps were not taken to improve conditions for it.	No Change- Same info stated in first line of paragraph.
30	1	suggested edit "habitat restoration."	Accepted
34	16-17	suggested edit "Pomo bands"	No Change
36	3		
		This section is pretty weak.	Noted- This is a summary section of the threats to CLH by predation. A detailed account is found in Factors Affecting the Ability to Survive and Reproduce section.
36	12	suggested edit "mammals occurs"	No Change
36	14-15	suggested edits "modifications, especially flow reductions, described above"	No Change
36	17-18	suggested edits "CLH in all habitats"	No Change- Sentence reworded based on other peer review comments.
36	19	suggested edits "such as white and channel catfish"	No Change- Added bullhead catfish
36	22-23	suggested addition "Larvae are probably eaten by Mississippi silversides. "	No Change- No supporting documentation provided.
36	23	suggested edit "diet study of selected introduced"	Accepted
36	24		

36	25-26	suggested addition "introduced fishes but needs to be targeted at places where hitch and alien fishes come in the most contact (e., mouths of streams). "	No Change- A specific sample design would need to be created for the survey. That is out of the scope of this section.
36	27	What does this mean?	Accepted- Sentence reworded
36	34	suggested edit "Mississippi silverside"	Accepted
36	35	? Most likely when both TFS and MSS are depressed.	Accepted
36	36-37	We don't actually know this. Competition is more likely for food than space.	Noted- It is reasonable to assume that CLH compete for space in a system that is dominated by non-native species.
36	37-38	They do? Reference?	Accepted- Sentence reworded
37	28	suggested edit "It is imperative"	Accepted
38	5	suggested edit "Department does indicate"	Noted
39	10	The best place to start is improvement of the stream spawning surveys, by hiring a full-time coordinator for citizen survey crews.	No Change- The comment is outside the scope of this document.
39	19	suggested edit "spawning and rearing habitat"	Accepted
39	35	suggested edit "• Conduct a focused diet analysis"	No Change- Wording changed to reflect statements in previous sections.
39	37	For hitch? This would be expensive & yield little data.	No Change- Creel surveys provide information on all species including CLH.
39	41	suggested addition ". In particular, develop ponds that can be used to create 'back up' populations of hitch in case the lake populations disappear."	No Change- Statement is implied by management action.



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
Sacramento, CA 95811
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director



January 13, 2014

Thomas Taylor
Senior Consultant, Aquatic Biologist
Cardno ENTRIX
701 University Ave Suite 200
Sacramento, CA 95825

Dear Mr. Taylor

CLEAR LAKE HITCH (*LAVINIA EXILICAUDA CHI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife (Department) Draft Status Report of the Clear Lake hitch (*Lavinia exilicauda chi*). A copy of the Department's peer review draft status report, dated January 2014, is enclosed for your use in that review. The Department seeks your expert analysis and input regarding the scientific validity of the report and its assessment of the status of Clear Lake hitch in California based on the best scientific information currently available. The Department is interested in and respectfully requests that you focus your peer review effort on the body of relevant scientific information and the Department's assessment of the required population and life history elements prescribed in the California Endangered Species Act (CESA). The Department would appreciate receiving your peer review input on or before February 10, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission under CESA. As you may know, the Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened. The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to focus on the best scientific information available to make related recommendations to the Commission.

The Commission first received the petition to list Clear Lake hitch as threatened on September 25, 2012. The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on March 22, 2013 following publication of regulatory notice by the Office of Administrative Law. The Clear Lake hitch is currently protected under CESA in California in that capacity.

The peer review Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the best scientific information available regarding the status of Clear Lake hitch in California. Headed into peer review, the Department believes the best available science indicates that listing the species as threatened under CESA is warranted at this time. To be clear, we ask that you focus

Conserving California's Wildlife Since 1870

Name, Title
Business
Date
Page 2

your review on the scientific information and the Department's related assessment of the required population and life history elements prescribed in CESA rather than focusing on the tentative conclusion we share as a matter of professional courtesy. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the best scientific information available regarding the status of Clear Lake hitch in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA (*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important as well as whether they indicate, in your opinion, that Clear Lake hitch is likely to become, in the foreseeable future, at serious risk of becoming extinct throughout all or a significant portion of its range in California.

We ask that you assess our work for quality and conduct a thorough and proper review. As with all peer review processes, the reviewer is not the final arbiter, but your comments will inform our final decision-making. Also, please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Kevin Thomas at kevin.thomas@wildlife.ca.gov, or he may be reached by telephone at (916) 358-2845.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,



Stafford Lehr
Chief, Fisheries Branch

Enclosure(s)

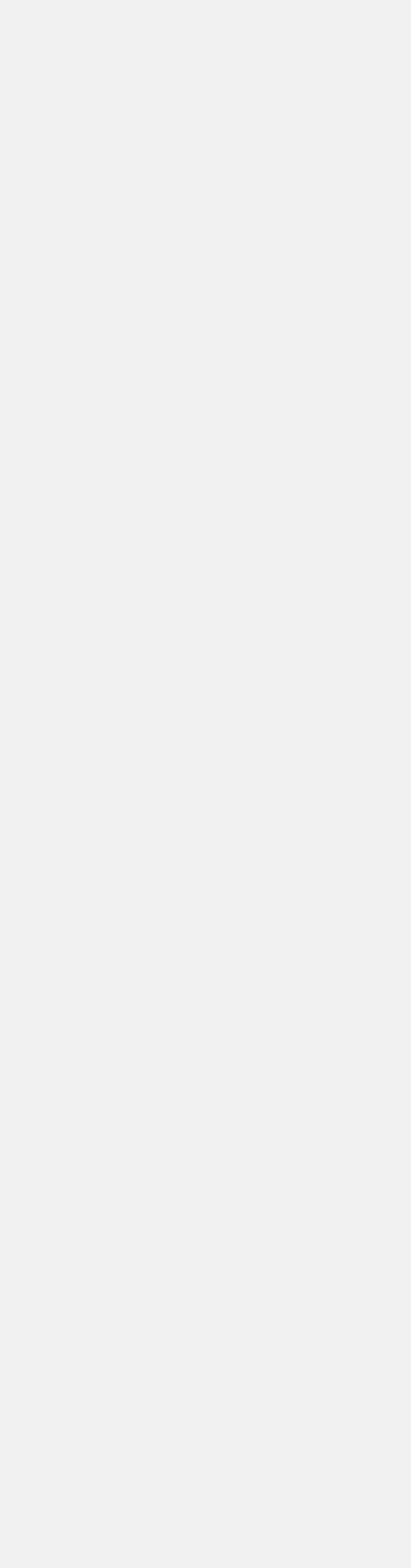
cc: Tina Bartlett
CDFW-NCR

Name, Title
Business
Date
Page 3

Thomas Gibson
CDFW-OGC

Katherine Hill
CDFW-NCR

Kevin Thomas
CDFW-NCR



Thomas, Kevin@Wildlife

From: Tom Taylor <thomas.taylor@cardno.com>
Sent: Monday, February 10, 2014 2:28 PM
To: Thomas, Kevin@Wildlife
Subject: CLH Status Report - Peer Review
Attachments: CLH Status review_peer review document_1-13-14_TT.docx

Dear Kevin,

Attached are my peer review comments and edits on the CLH Status Review document. Edits are in track changes and comments are included in the document. IN summary, I think the Status Review does an adequate job of vetting the breadth of potential causes that are active in the Clear Lake Basin on CLH, but it was less than definitive in establishing any long-term trends or solid linkages of cause and effect. I recognize that any census information on the species is usually an amalgamation of efforts to monitor other species that would not have targeted CLH. Outside of the relatively recent surveys of spawning runs by the CCCLH, all other population assessments are based on incidental catches of CLH. I have made three suggestions – two for additional analyses and one other to rectify an internal conflict in the document:

- 1) Hydrology and Spawning Access Analysis. This analysis would look at changes to spawning stream hydrology in combination with temporal changes to spawning habitat access from the lake AND access back to the lake for larvae. This issue seems to be at the heart of the CLH decline but the biological data is not strong enough to categorically conclude cause and effect. This analysis would examine the relationship of stream connectivity with the lake as a factor in population decline. Examine flow recession curves on key tributaries, or use indicator tributaries. This is more mechanistic than looking at rainfall. The analysis would test for reduced flows, flows of shorter duration (starting later or ending sooner) during the CLH spawning season. Also, if there is any information that would provide for a temporal perspective in the rate of decline of spawning tributary access either through documenting installation of barriers over time or a systematic reduction of access to spawning habitat (area reduction over time) this could provide stronger linkage to cause and effect. Operational info on the detention dam on Kelsey Creek might provide important data.
- 2) Analysis of threadfin shad and inland silversides juvenile abundance indices in the lake and association with CLH juvenile abundance and other lake factors. This would add some credibility to statements about this implied association between these species and perhaps vet the lake rearing habitat-related issue. Alternatively, while the report includes a statement of the reduction of marginal wetlands, it's treated as an on or off variable. Can wetland loss be quantified from available historical aerial photographs over the past 40 years?
- 3) Rectify or explain the counter intuitive nature between the stream connectivity theory (more CLH in wet years) and the graphics that appear to show higher CLH abundance in the lake associated with dry years.

Given the history of the CLH, I think it warrants listing at this time. We are at a key decision point because past efforts have failed to result in recovery, however, I don't think the Status Review, as written, leads one to reach that conclusion.

Please don't hesitate to give me a call if you have any questions.

I have not forgotten about your request to share some of my CLH images from late 1970s-early 1980s – I've just been too busy to move this to my active agenda.

Thomas L. Taylor
SENIOR CONSULTANT / AQUATIC BIOLOGIST
CARDNO ENTRIX



Phone (+1) 916-923-1097 Fax (+1) 916-386-3841 Direct (+1) 916-386-3828 Mobile (+1) 916-844-4295

Address 701 University Avenue, Suite 200, Sacramento, CA 95825 USA

Email thomas.taylor@cardno.com Web www.cardno.com - www.cardnoentrix.com

This email and its attachments may contain confidential and/or privileged information for the sole use of the intended recipient(s). All electronically supplied data must be checked against an applicable hardcopy version which shall be the only document which Cardno warrants accuracy. If you are not the intended recipient, any use, distribution or copying of the information contained in this email and its attachments is strictly prohibited. If you have received this email in error, please email the sender by replying to this message and immediately delete and destroy any copies of this email and any attachments. The views or opinions expressed are the author's own and may not reflect the views or opinions of Cardno.

1
2
3 **State of California**
4 **Natural Resources Agency**
5 **Department of Fish and Wildlife**
6
7

8
9 **REPORT TO THE FISH AND GAME COMMISSION**
10

11
12
13
14 **A STATUS REVIEW OF CLEAR LAKE HITCH (*Lavinia exilicauda ch*)**
15

16
17 **January 2014 Preliminary Draft for Peer Review**
18
19
20



21
22 Clear Lake hitch adult. Photo courtesy of Rick Macedo
23

24
25
26 **Charlton H. Bonham, Director**
27 **Department of Fish and Wildlife**
28
29
30



31
32 Report to the Fish and Game Commission

A STATUS REVIEW OF CLEAR LAKE HITCH

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

Contents

LIST OF FIGURES.....	4
LIST OF APPENDICES	4
EXECUTIVE SUMMARY	5
Background	5
Summary of Findings.....	5
Status	5
Threats	5
Petitioned Action	5
Management and Recovery Recommendations.....	6
INTRODUCTION.....	6
Petition History	6
Department Review	6
BIOLOGY.....	7
Species Description	7
Taxonomy.....	7
Range and Distribution	7
Life History	9
Habitat that May be Essential to the Continued Existence of the Species.....	10
SPECIES STATUS AND POPULATION TRENDS.....	10
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE.....	18
Present or Threatened Modification or Destruction of Habitat	18
Wetland Habitat Loss.....	18
Spawning Habitat Exclusion and Loss	18
Water Quality Impacts	22
Overexploitation	25
Commercial Harvest.....	25
Cultural Harvest	25
Predation and Competition	26
Disease and Parasites.....	27

1	Other Natural Occurrences or Human Related Activities	27
2	Climate Change	27
3	Recreational Activities	28
4	REGULATORY AND LISTING STATUS.....	29
5	Federal	29
6	State	29
7	Other Rankings.....	30
8	EXISTING MANAGEMENT EFFORTS.....	30
9	Resource Management Plans	30
10	Monitoring and Research.....	32
11	Habitat Restoration Projects.....	32
12	Impacts of Existing Management Efforts.....	32
13	SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE HITCH IN CALIFORNIA	33
14	Present or Threatened Modification or Destruction of Habitat	34
15	Overexploitation	34
16	Predation.....	34
17	Competition	35
18	Disease	35
19	There are no known diseases that are significant threats to the continued existence of CLH.	35
20	Other Natural Occurrences or Human-related Activities	35
21	SUMMARY OF KEY FINDINGS	35
22	RECOMMENDATION FOR PETITIONED ACTION	36
23	PROTECTION AFFORDED BY LISTING	36
24	MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES	37
25	PUBLIC RESPONSE	38
26	PEER REVIEW.....	38
27	LITERATURE CITED	39
28		
29		
30		

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

LIST OF FIGURES

Figure 1. Map depicting the Clear Lake watershed. 8
Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis. 12
Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013. 14
Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010. 15
Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001. 16
Figure 6. Photo from 1890s depicting spawning CLH being stranded in Kelsey Creek. 17
Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed. 20

LIST OF APPENDICES

Appendix A. Summary graphs of spawning observations between 2005 and 2013
Appendix B. Figures depicting CLH observations on spawning tributaries
Appendix C. Description of barriers associated with CLH spawning tributaries

1 **EXECUTIVE SUMMARY**

2
3 This status review report describes the current status of Clear Lake hitch (*Lavinia*
4 *exilicauda chi*) (CLH) in California as informed by the scientific information available to
5 the California Department of Fish and Wildlife (Department, CDFW, CDFG).
6

7 **Background**

- 8 • September 25, 2012: The Fish and Game Commission (Commission) received a
9 petition from the Center for Biological Diversity to list CLH as threatened under
10 the California Endangered Species Act (CESA) (Center for Biological Diversity
11 2012).
- 12 • September 26, 2012: The Commission sent a memorandum to the Department,
13 referring the petition to the Department for its evaluation.
- 14 • October 12, 2012: The Commission provided notice of the received petition from
15 the Center for Biological Diversity to list CLH as threatened under CESA (Cal.
16 Reg. Notice Register 2012, Vol. 41-Z, p.1502).
- 17 • December 12, 2012 the Commission granted a 30-day extension on the
18 submission date for the Department's Initial Review of Petition to List the Clear
19 Lake Hitch as threatened under CESA.
- 20 • January 31, 2013: The Department provided the Commission with an Initial
21 Review of Petition to List the Clear Lake Hitch as Threatened under the
22 California Endangered Species Act pursuant to Fish and Game Code, section
23 2073.5. The Department's review recommended that the petition provided
24 sufficient information to indicate the petitioned action may be warranted, and the
25 petition should be accepted and considered (CDFW 2013).
- 26 • March 6, 2013: At its scheduled public meeting in Mt. Shasta, California, the
27 Commission considered the petition, the Department's petition evaluation and
28 recommendation, and comments received by the Commission and found that the
29 petition provided sufficient information to indicate the petitioned action may be
30 warranted.
- 31 • March 22, 2013: The Commission published its Notice of Findings in the
32 California Regulatory Notice Register (CA Reg. Notice Register 2013, Vol. 12-Z
33 p. 488), stating the petition was accepted for consideration, and designated CLH
34 as a candidate species.

35 **Summary of Findings**

36
37 *Note to Reviewer.* This Summary of Findings will be finalized after the Department
38 receives, evaluates, and incorporates peer-review comments as appropriate.

39 **Status**

40 **Threats**

41 **Petitioned Action**

42

1 **Management and Recovery Recommendations**

2 **INTRODUCTION**

3
4 This status review report addresses the Clear Lake hitch (*Lavinia exilicauda chi*) (CLH),
5 the subject of a petition to list the species as threatened under the California
6 Endangered Species Act (CESA) (Fish & G. Code § 2050 *et seq.*).

7 **Petition History**

8
9 On September 25, 2012, the Fish and Game Commission (Commission) received a
10 petition from the Center for Biological Diversity (Petitioner) to list the CLH as a
11 threatened species under CESA.

12
13 On September 26, 2012 the Commission sent a memorandum to the California
14 Department of Fish and Wildlife (Department, CDFW, and CDFG) referring the petition
15 to the Department for its evaluation.

16
17 On October 12, 2012, as required by Fish and Game Code, section 2073.3, notice of
18 the petition was published in the California Notice Register (Cal. Reg. Notice Register
19 2012, Vol. 41-Z, p.1502).

20
21 On December 12, 2012 the Commission granted a 30-day extension on the submission
22 date for the Department's Initial Review of Petition to List the CLH as threatened under
23 CESA.

24
25 On January 31, 2013, the Department provided the Commission with its Initial Review of
26 Petition to List the CLH as threatened under CESA. Pursuant to Fish and Game Code,
27 section 2073.5, subdivision (a) (2), the Department recommended that the petition
28 provided sufficient information to indicate the petitioned action may be warranted.

29
30 On March 6, 2013 at its scheduled public meeting in Mt. Shasta, California, the
31 Commission considered the petition, the Department's petition evaluation and
32 recommendation, and comments received, and found that sufficient information existed
33 to indicate the petition may be warranted and accepted the petition for consideration.

34
35 Subsequently, on March 22, 2013 the Commission published its Notice of Findings for
36 CLH in the California Regulatory Notice Register, designating the CLH as a candidate
37 species (CA Reg. Notice Register 2013, Vol. 12-Z p. 488).

38 **Department Review**

39
40 Following the Commission's action to designate CLH as a candidate species, the
41 Department notified affected and interested parties and solicited data and comments on
42 the petitioned action, pursuant to Fish and Game Code, section 2074.4 (see also Cal.
43 Code Regs., Title 14, § 670.1(f)(2)) (CDFW 2013). All comments received are included
44 in Appendix D to this report. The Department commenced its review of the status of the
45 species as required by Fish and Game Code section 2074.6.

1
2 This report reflects the Department's scientific assessment to date of the status of CLH
3 in California. At this point, the report will undergo independent and competent peer
4 review by scientists with acknowledged expertise relevant to the status of CLH. Once
5 peer review is completed Appendix E will contain the specific input provided to the
6 Department by the individual peer reviewers (Cal. Code Regs., Title 14, § 670.1(f) (2)).

7 **BIOLOGY**

8 **Species Description**

9
10 Clear Lake hitch is a member of the cyprinid family (Cyprinidae), growing to 35
11 centimeters (cm) standard length (SL), and with laterally compressed bodies, small
12 heads and upward pointing mouths (Moyle et al. 1995). They are separated from other
13 California minnows by their long anal fin consisting of 11 to 14 rays. The dorsal fin (10
14 to 12 rays) originates behind the origin of the pelvic fins. Juvenile CLH have a silver
15 coloration with a black spot at the base of the tail. As CLH grow older the spot is lost
16 and they appear yellow-brown to silvery-white on the back. The body becomes deeper
17 in color as the length increases (Hopkirk 1973; Moyle 2002). CLH show little change in
18 pigmentation during the breeding season (Hopkirk 1973). The deep, compressed body,
19 small upturned mouth, and numerous long slender gill rakers (26 to 32) reflect the
20 zooplankton-feeding strategy of a limnetic forager (Moyle 2002). This lake adapted
21 subspecies also has larger eyes and larger scales than other hitch subspecies.

22 **Taxonomy**

23
24 Hopkirk (1973) described CLH as a lake-adapted subspecies based primarily on the
25 greater number of fine gill rakers. CLH are distinguished from other subspecies of hitch
26 by their deeper body, larger eyes, larger scales and more gill rakers (Hopkirk 1973).
27 Recent research on 10 microsatellite loci supports Hopkirk's description of CLH as a
28 distinct subspecies (Aguilar et al. 2009). However, mitochondrial DNA analysis has not
29 been able to distinguish CLH as a distinct subspecies from other hitch in California.
30 Yet, based upon the morphological and microsatellite analysis there is sufficient
31 evidence to warrant the designation of CLH as a distinct subspecies of hitch (Hopkirk
32 1973; Moyle et al. 1995; Aguilar et al. 2009).

33
34 CLH can hybridize with other Cyprinidae species and hybridization is known to occur
35 with the genetically similar California roach (*Lavinia symmetricus*) (Miller 1945b; Avise
36 and Ayala 1976; Moyle and Massingill 1981; Moyle et al. *in review*). However, there is
37 no documentation of these hybrids in Clear Lake. CLH were known to hybridize in
38 Clear Lake with the now extinct thickettail chub (*Gila crassicauda*) (Moyle et al. *in review*).

Comment [TT1]: or in streams tributary to the Lake?

39 **Range and Distribution**

40
41 The entire CLH population is confined to Clear Lake, Lake County, California, and to
42 associated lakes and ponds within the Clear Lake watershed such as Thurston Lake
43 and Lampson Pond (Figure 1). Populations previously identified in the Blue Lakes, west
44 of Clear Lake, have apparently been extirpated (Macedo 1994).

Comment [TT2]: Not shown in Fig 1.

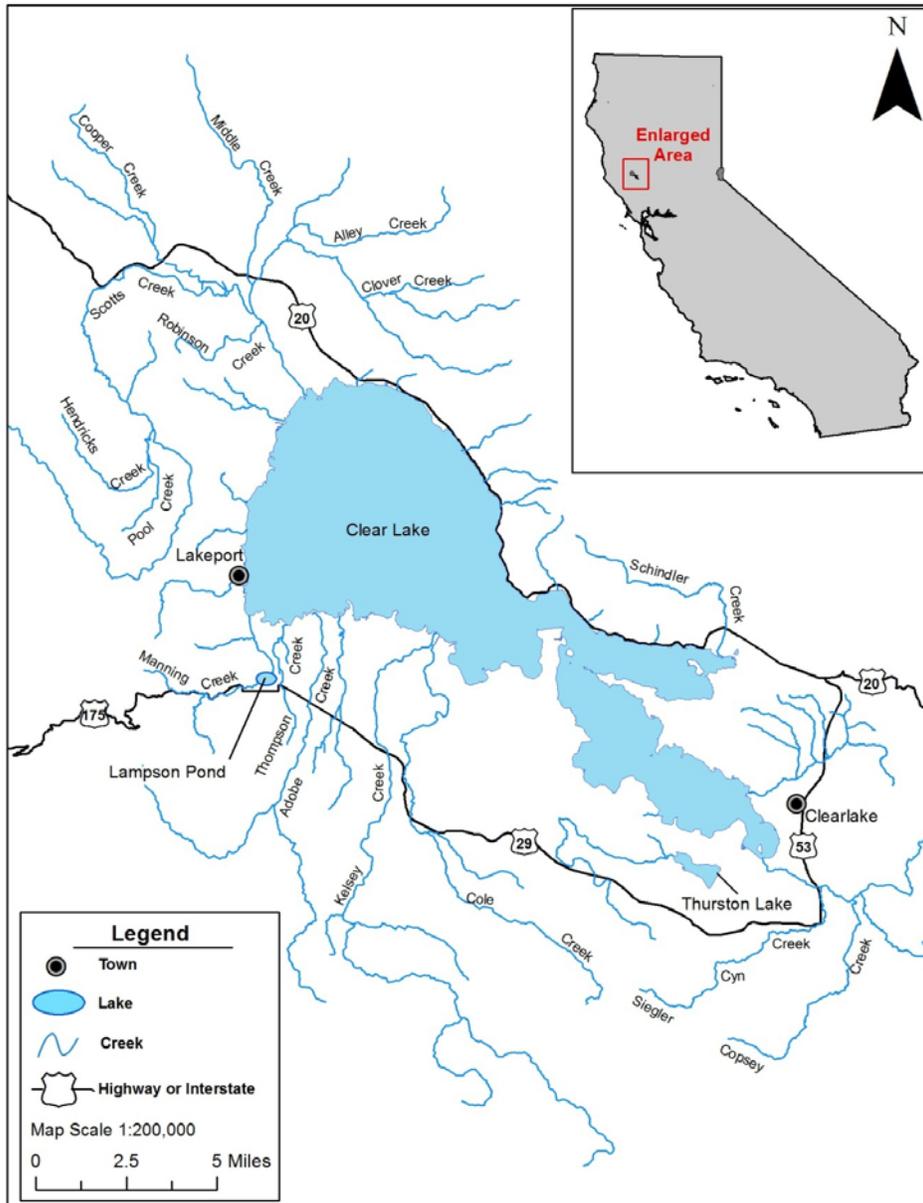


Figure 1. Map depicting the Clear Lake watershed.

Comment [TT3]: The map shows stream systems tributary to Clear Lake and does not include the entire watershed. Note that the Cache Creek outflow channel from Clear Lake is not labeled as such.

1
2
3
4
5

1 **Life History**

2
3 Physical adaptations to lake conditions allow CLH greater than 50 millimeters (mm) SL
4 to feed almost exclusively on water fleas (*Daphnia* spp.) (Geary 1978; Geary and Moyle
5 1980; Moyle 2002). Stomach analysis indicates that CLH feed primarily in the day
6 rather than at night (Geary 1978). Juveniles less than 50 mm SL are found in shallow,
7 littoral zone (near-shore) waters and feed primarily on the larvae and pupae of
8 chironomidae; planktonic crustaceans including the genera *Bosnia* and *Daphnia*; and
9 historically on the eggs, larvae, and adults of Clear Lake gnat (*Chaoborus astictopus*)
10 (Lindquist et al. 1943; Geary 1978; Geary and Moyle 1980). Growth in CLH is faster
11 and total size greater than that of other hitch subspecies (Nicola 1974). By three
12 months CLH have reached 44 mm SL and will continue to grow to between 80 to 120
13 mm by the end of their first year (Geary and Moyle 1980). Females become mature by
14 their second or third year, whereas males tend to mature in their first or second year
15 (Kimsey 1960). Females grow faster and are larger at maturity than males (Hopkirk
16 1973; Geary 1978; Ringelberg and McGinnis 2009). The larger size of CLH in
17 comparison to hitch from other locations translates to greater fecundity. Accordingly,
18 spawning females in Clear Lake average 36,000 eggs each year (Geary and Moyle
19 1980) compared to an average of 26,000 eggs for hitch in Beardsley Reservoir (Nicola
20 1974).

21
22 Clear Lake tributaries are numerous and located around the lake basin (Figure 1). Most
23 streams have headwaters at higher elevations in the surrounding foothills; others have
24 headwaters in lower elevations of the basin, and nearly all have low gradients. Some
25 streams are more substantial than others with flowing water year round. Most are
26 seasonal with remnant pools occurring by late spring, and subsequently dry during
27 summer months. Those that retain water year round often have long stream reaches
28 that are ephemeral. CLH spawn in these low-gradient tributary streams and form
29 spawning migrations that resemble small scale salmon runs. Spawning migrations
30 usually occur in response to heavy spring rains, from mid-February through May and
31 occasionally into June (Murphy 1948b; Kimsey 1960; Swift 1965; Chi Council for Clear
32 Lake Hitch (CCCLH) 2013 (unpublished data)). During wet years, CLH spawning
33 migrations may also opportunistically extend into the upper reaches of various small
34 tributaries, drainage ditches, and even flooded meadows (Moyle et al. *in review*). CLH
35 have also been observed spawning along the shores of Clear Lake, over clean gravel in
36 water 1 to 10 cm deep where wave action cleans the gravel of silt (Kimsey 1960). The
37 success of these atypical spawning areas is not clearly understood and may be limited
38 due to losses from egg desiccation and juvenile predation (Kimsey 1960; Rowan, J.
39 personal communication, October 10, 2013, unreferenced).

40
41 CLH spawn at water temperatures of 14 to 18°C in the lower reaches of tributaries. Egg
42 deposition occurs along the margins of streams in very shallow riffles over clean, fine-
43 to-medium sized gravel (Murphy 1948b; Kimsey 1960). Eggs are fertilized by one to
44 five males as they are released from the females (Murphy 1948b; Moyle 2002). Eggs
45 are non-adhesive and sink to the bottom after fertilization, where they become lodged
46 among the interstices in the gravel. The eggs immediately begin to absorb water and
47 swell to more than double their original size. This rapid expansion provides a protective
48 cushion of water between the outer membrane and the developing embryo (Swift 1965)

Comment [TT4]: I've observed spawning mid channel too – and some of these eggs will “eddy out” in the margins. Also note that large volumes of eggs may deplete stream margin areas of oxygen resulting in the mortality of large numbers of eggs

1 and may help to secure eggs in gravel interstices. The embryos hatch after
2 approximately 7 days, and larvae become free-swimming after another 7 days (Swift
3 1965). Larvae must then move downstream to the lake before stream flows become
4 ephemeral (Moyle 2002).

Comment [TT5]: I would restate saying that larvae must move downstream to the lake before the stream flow disconnects with the lake (the stream may still be flowing at upstream locations).

5
6 Within Clear Lake, larvae remain near shore and are thought to depend upon stands of
7 tules (*Schoenoplectus acutus*) and submerged weeds for cover until they assume a
8 limnetic lifestyle (CDFG 2012). Juvenile CLH require rearing habitat with water
9 temperatures of 15° C or greater for survival (Moyle 2002; Franson 2012 and 2013).
10 Juveniles are found in littoral shallow-water habitats and move into deeper offshore
11 areas after approximately 80 days, when they are between 40 to 50 mm SL (Geary
12 1978; CDFG 2012). Adult CLH are usually found in the limnetic zone (well-lit, surface
13 waters away from shore) of Clear Lake. The limnetic feeding behavior of adult fish is
14 supported by stomach analysis of CLH where very little content of benthic midges was
15 found, even though the fish were collected in the profundal (deep-water) habitat during
16 the survey (Cook et al. 1964). Additional data collected by the Department during the
17 early 1980s indicates CLH are present in the littoral zone from April to July and are
18 absent from this habitat during other months (Week 1982).

19
20 Adult CLH are vulnerable to predation during their spawning migration by mergansers
21 (*Mergus* spp.), herons (*Ardea* spp.), bald eagles (*Haliaeetus leucocephalus*), and other
22 birds, river otter (*Lontra canadensis*), northern raccoon (*Procyon lotor*), and striped
23 skunk (*Mephitis mephitis*) (Bairrington 1999). In addition, CLH have been recovered
24 from the stomachs of black bass (*Micropterus* spp.) caught in the lake (Bairrington
25 1999). Most predation by black bass likely occurs during spring staging periods as CLH
26 congregate and begin to ascend tributaries to spawn (Rowan, J. personal
27 communication, October 10, 2013, unreferenced).

Comment [TT6]: This is a strong statement of a cause-effect given it is an unreferenced P-C.

28 **Habitat that May be Essential to the Continued Existence of the Species**

29
30 At various life stages CLH utilize stream and lacustrine (lake) habitat present in the
31 watershed (Figure 1). Adult fish spawn in the tributaries of the lake during the spring
32 and juvenile fish emerge from the tributaries and utilize near shore habitats to continue
33 growth and seek refuge from predators. As juveniles mature into adults they move to
34 the main body of the lake and assume a limnetic lifestyle until returning to spawn in the
35 tributaries the following spring.

Comment [TT7]: Not all tribs are of equal value to spawning. Some of the small channels will only flow during wet years (many of the short tribs on the east side) while others offer some spawning habitat nearly every year (these used to be Seigler, Kelsey, and Middle Cks)

36 **SPECIES STATUS AND POPULATION TRENDS**

37
38 An assessment of the status of CLH should include statistically valid population
39 estimates conducted over time, to provide population data and trends. CLH studies to
40 date have consisted primarily of qualitative sampling and are not suitable for deriving
41 population estimates; however, these study results can provide insight into the current
42 status of the species.

43
44 The population trends for this status review focus on three sets of data available to the
45 Department for analysis. First, commercial catch records, submitted to the department

1 by operators on Clear Lake, contain incidental catch information on CLH dating back to
2 1961. Operators were required to keep records of CLH caught incidentally while
3 operations focused on other species in the lake. Second, the Lake County Vector
4 Control District (LCVCD) has been conducting sampling efforts along the shoreline of
5 Clear Lake since 1987. Although sampling efforts are not specific to CLH, LCVCD
6 recorded incidental data on CLH captured during each sampling. Third, spawning
7 observation data have been collected by volunteers with the CCCLH since 2005.
8 Spawning observation data provide an estimate of the number of CLH in any given
9 spawning tributary during the observation period. Results are summarized by the
10 CCCLH each year following the completion of the spawning season. Information on
11 population trends prior to 1961 is focused on small sampling efforts, published articles,
12 and traditional ecological knowledge from tribal members. Although not quantifiable,
13 this data provides an idea of the status and distribution of CLH prior to larger qualitative
14 sampling efforts.

15
16 Environmental conditions required for successful spawning and biological impacts to the
17 survivorship of CLH are highly variable from year to year and often result in multiple
18 years with reduced spawning success or reduced recruitment into the population. The
19 information presented in Figure 2 comes from the three qualitative sampling efforts
20 conducted at Clear Lake and measured rainfall totals during the past 52 years in the
21 watershed. Trend data in commercial catch records were represented for a given year
22 by totaling the number of CLH captured per year and dividing by the number of days
23 commercial operations occurred. Commercial catch data are comprised primarily of
24 adult CLH. The CLH spawning trend data were calculated by totaling the number of
25 CLH observed and dividing by the number of observation periods. LCVCD data on CLH
26 captures represent the total number of CLH captured per year. LCVCD data is
27 comprised primarily of juvenile CLH. The data represented from Table 6 of CDFG
28 (1999) were calculated by using 20,000 as a total catch baseline for percent of total
29 catch for CLH. Total rainfall data for January to June of each year was measured at the
30 Clear Lake Highlands and U.S. Geological Survey rainfall gauges. Figure 2 does not
31 reflect population numbers but rather trends in the abundance of CLH in any given year.
32 As a proxy for changes in to an ~~estimated established~~ population size, biologists often
33 use qualitative information as an indicator of population trends.

34
35 The trends of all data show a highly variable population that responds both positively
36 and negatively to environmental parameters and varies significantly from year to year.
37 Rainfall totals do not appear to be significantly correlated to the abundance of CLH
38 during the timeframe. It is likely that a combination of environmental factors is
39 impacting the CLH population. The fluctuating abundance trend has continued
40 throughout the duration of the qualitative sampling efforts and indicates CLH
41 populations have at times been extremely low and at other times relatively robust.
42

Comment [TT8]: Has rainfall been linked to streamflows that sustain CLH reproductive success? Are there other data to use besides rainfall (streamflow, lake level, number of passage flow days in representative creeks for adults migrating out of the lake and for larvae moving downstream)? The Status Review is lacking in analysis of hydrology.

Comment [TT9]: This is conclusion jumping – Consider the factors at work here 1) there's the qualitative nature of the data, 2) some of the CLH data may not be linked to rainfall (juvenile or adult abundance may be lagged one or more years, or 3) there could be compensatory survival in years of high reproductive success, only so many larvae will survive to juvenile or adult life stages.

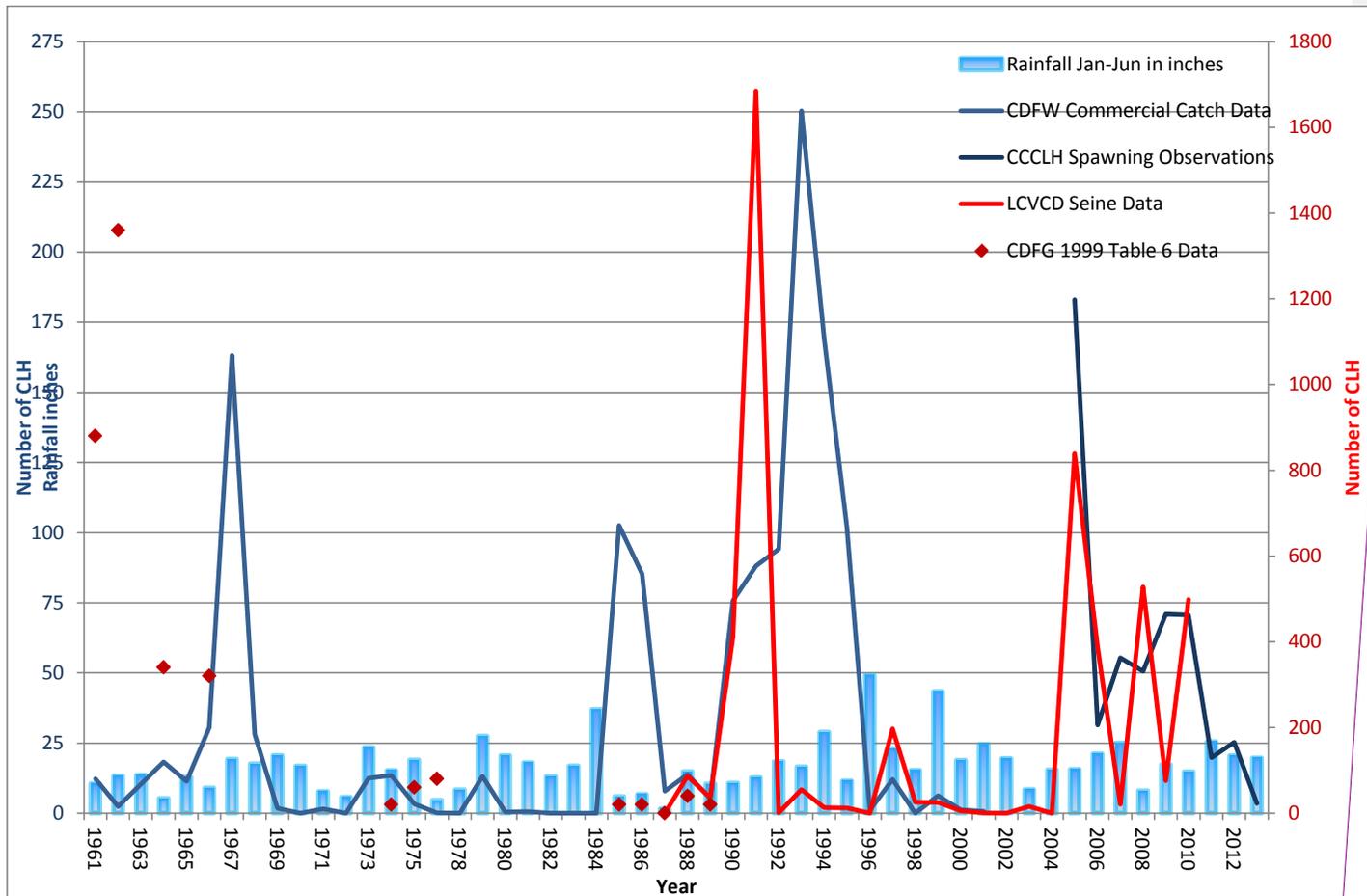


Figure 2. Clear Lake hitch population trends over the past 52 years as measured by three methods of qualitative sampling and spawning season rainfall totals as recorded at the Clear Lake Highlands and U.S. Geological Survey 385525122335501 rainfall gauges. Data in blue tones corresponds to the primary y axis and data in red tones corresponds to the secondary y axis.

Comment [TT10]: These data are all discrete and should be graphed with bars, not lines. I suggest not combining with rainfall it's too confusing in one graph. I question if total rainfall is a good measure for cause-effect. As an example, in 1997, all the rainfall came in January, so spawning conditions later were not that good. Are there other factors to examine in more detail such as lake level during the spawning period? Streamflow volume and persistence are other factors to examine in the individual streams or in index streams.

Also juvenile and adult fish should be lagged by an appropriate time step if you're looking at linkages between good spawning conditions relating to strong cohort years.

Comment [TT11]: Can you include other notable events, such as construction of the detention dam on Kelsey Creek, or other such known features?

1 In 2013 the Department conducted a mark-and-recapture study to gain a better
2 understanding of the CLH spawning population in Cole and Kelsey creeks.
3 Unfortunately, too few individuals were marked and recaptured to give a statistically
4 valid population estimate (Ewing 2013). Electrofishing surveys in June 2012 identified
5 thousands of young of year CLH in near shore habitats along the southwestern
6 shoreline of Clear Lake (CDFG 2012). Volunteers with the CCCLH conducted direct
7 observations of CLH in spawning tributaries of Clear Lake in 2013, and spawning
8 observations identified less than 500 CLH present (CCCLH 2013). Of those fish, 300 to
9 | 400 CLH were found below the Kelsey Creek detention dam. No single day count
10 totaled more than 70 fish in any spawning tributary in 2013 (CCCLH 2013).

11
12 CCCLH qualitative spawning observations between 2005 and 2013 indicated peak
13 | single day CLH counts of spawning runs of 1,000 to 5,000 fish (CCCLH 2013), and daily
14 observation averages ranged from 3.5 to 183.1 fish (Figure 2). However, these
15 observations make no distinction between previously counted fish, and it may be more
16 prudent to look at fixed location single day counts from this time period. The highest
17 number of CLH observations recorded was approximately 5,000 during 2005;
18 concurring with beach seine data that demonstrate a higher than average number of
19 CLH caught in 2005 as well (CCCLH 2013; LCVCD 2013). The increased number of
20 juvenile CLH captured in the 2005 beach seine sampling is the likely reason for the
21 increase in adult spawning observations between 2007 and 2009. Appendix A contains
22 summary graphs and figures, prepared by CCCLH, for observations made between
23 2005 and 2013.

24
25 There is sufficient information from these spawning observations to suggest the number
26 of spawning tributaries being used by CLH decreased in 2013 compared to the average
27 from 2005 to 2012 (Figure 3) (CCCLH 2013). However, the data limitations do not allow
28 for quantification of observation time on each creek (survey effort) compared with the
29 number of fish observed to aid in understanding the extent of use in each tributary.
30 Appendix B contains figures depicting the decline in annual spawning runs in Clear
31 Lake tributaries between 2005 and 2013 (CCCLH 2013). Historic accounts and habitat
32 suitability predications suggest that CLH originally spawned, to some degree, in all the
33 tributaries to Clear Lake (Robinson Rancheria Ecological Center (RREC) 2011).
34 However, reports on Pomo geography speak of Pomo tribes in the area travelling to
35 Kelsey Creek to capture CLH and even of war when a tribe tried to divert Kelsey Creek
36 to gain control of the important CLH supply (Barrett 1906; Kniffen 1939). Based on the
37 reports it is unclear to what extent CLH spawned in other tributaries to Clear Lake. It
38 can be surmised the majority of CLH spawning occurred in Kelsey Creek during this
39 period. Over the past eight years the number of occupied spawning tributaries has
40 decreased from a high of 12 in 2006 to three in 2013 (CCCLH 2013). Currently, Adobe
41 Creek seems to have the largest spawning run in the Clear Lake watershed while
42 Kelsey and Cole creeks support smaller spawning runs. Based on historical accounts
43 the primary spawning tributary has shifted from Kelsey Creek to Adobe Creek (Kniffen
44 1939; CCCLH 2013).

45
46

Comment [TT12]: As is wording implies the fish are only in the stream for a day, which is not the case.

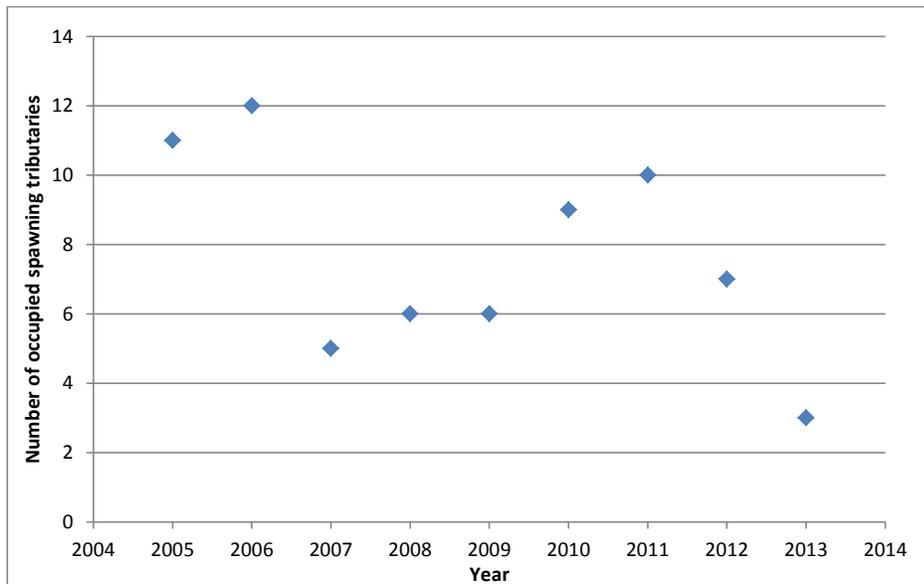


Figure 3. Number of occupied Clear Lake hitch spawning tributaries documented by CCCLH observers between 2005 and 2013.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

LCVCD has been collecting beach seine data at various sites around the lake for more than two decades. The sampling is designed to measure abundance of threadfin shad (*Dorosoma petenense*) and inland silversides (*Menidia beryllina*) as part of a Clear Lake gnat (*Chaoborus astictopus*) surveillance program. Incidental captures of CLH are recorded during these surveys; however, the data collected are not appropriate for a statistically valid evaluation of CLH populations as the sample design varies significantly in timing, water quality conditions, and lake depth during surveys. Additionally, sample locations are in areas that contain open unvegetated beaches that are not preferred habitat for CLH. Although surveys were not conducted to assess CLH, capture data for these surveys is consistent with other data sources in demonstrating a population that has poor recruitment in many years interspersed with few years of high levels of recruitment (Figure 4) (LCVCD 2013). In most years less than 100 CLH are captured during the surveys (17 of 24 years). Four of the six years when more than 100 CLH were captured were between 2005 and 2010. The greatest numbers of CLH were captured in 1991, a year that was described by the Department as a boom for juvenile fish in the lake (Bairrington 1999). Commercial fisheries data from 1991 also indicate an increase in CLH numbers captured during operations; over 6,000 CLH were captured and released by commercial fishery operators between March and May in 1991 (CDFW Commercial Fisheries Data). Data from the early 1990s also indicate an increase in zooplankton and macroinvertebrate numbers resulting in increased available forage for CLH (Winder et al. 2010).

Comment [TT13]: Do TFS and Inland Silversides populations show similar patterns in abundance to CLH? These are not stream spawners, so would reflect more lake conditions for larval/juv rearing, vs. conditions for spawning. Has this been examined?

Comment [TT14]: It is of interest that these high abundance years were drought years (1987-1992) in California

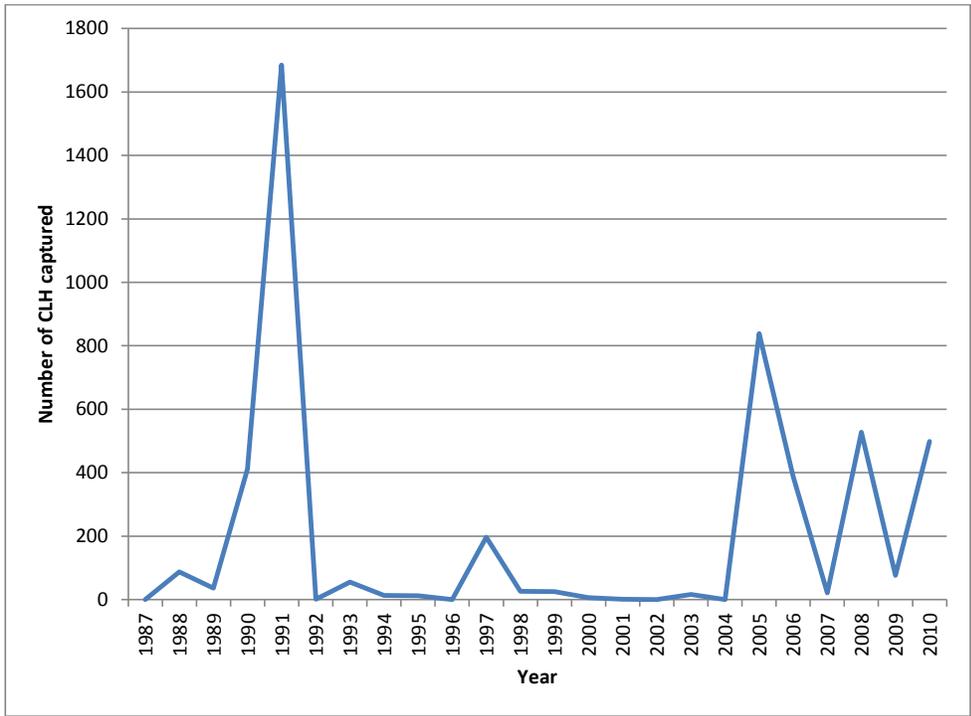


Figure 4. Summary of Clear Lake hitch captured during Lake County Vector Control District beach seine surveys conducted from 1987 to 2010.

The data available to the Department that cover the greatest timeframe come from commercial harvest records for Clear Lake. These data, 1961 to 2001, provide estimates of CLH numbers captured incidentally during operations (Figure 5). Multiple times throughout the past 50 years the number of CLH captured has surpassed 10,000 fish. There are also several years where CLH were almost or entirely absent from sample collections. These data suggest that CLH can sustain a population through multiple years of suppressed spawning or recruitment or both.

Comment [TT15]: Do we have metadata on seining dates, locations or methods that may influence the catch of CLH?

1
2
3
4
5
6
7
8
9
10
11
12

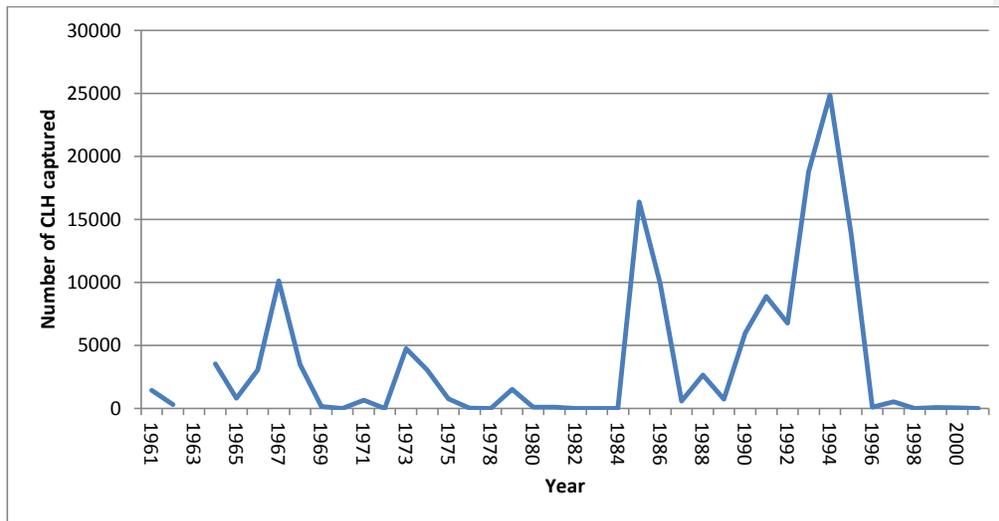


Figure 5. Number of Clear Lake hitch captured incidentally during commercial harvest operations between 1961 and 2001.

In the 1980s, the Department began sampling Clear Lake fishes to assess native and sport fish populations in the lake. Surveys found CLH occupying littoral habitats between April and July each year (Week 1982). The surveys were directed towards littoral zone use and provide no information on CLH outside of those months (Week 1982). An electrofishing survey was completed in April of 1987, and CLH was the most abundant fish sampled at locations around Rattlesnake Island and Clearlake Oaks subdivision; however, only a total of 52 CLH were captured during the survey (CDFG 1988). It must be noted that this sampling was on a very small scale, targeted black crappie (*Pomoxis nigromaculatus*), and occurred in habitats where CLH would likely be found during this time period. Additional spring and fall sampling between 1995 and 2006 found CLH to be the most abundant native fish, but the overall capture numbers were relatively low with a peak catch per unit effort (CPUE) of only 0.087 for juvenile fish in the fall of 2000 and 0.169 for adult fish in the spring of 1999. CPUE's were based on the number of fish caught per minute of electrofishing (Cox 2007). Electrofishing surveys conducted during late June 2007 reported low numbers of CLH recorded during the survey (Rowan 2008). The low numbers of CLH may be attributed to the sampling timeframe in late June. As noted in Cook et al. 1964, CLH were absent from littoral zone sampling following the start of summer. In an effort to reduce impacts to CLH while sampling, the Department's Clear Lake surveys between 2008 and 2012 were all confined to the timeframe of late June and July when CLH numbers are greatly reduced in the littoral zone.

As late as 1972, CLH and other nongame fish were described as comprising the bulk of the Clear Lake fishery (Puckett 1972). The Lake County Mosquito Abatement District conducted surveys between 1961 and 1963 examining the relationship between fish and midges. These surveys identified CLH as the third most abundant fish in the lake.

Comment [TT16]: I don't mean to sound critical, but when we're trying to assess the status of a population, not sampling it is not a sound approach. ++

1 The majority of CLH were captured in the littoral and profundal zones using gill nets.
 2 However, the limnetic zone was not sampled since midges do not occur in this area. A
 3 total of 1,229 fish was taken during these surveys (Cook et al. 1964).
 4
 5 Field notes from CDFG biologists in 1955 note CLH runs with large numbers in Kelsey
 6 Creek (CDFG 1955). Similar notes from 1956 indicate spawning CLH in Kelsey Creek
 7 as numbering in the hundreds and Seigler Creek containing 400 CLH for every 100 feet
 8 of stream above the Anderson Brothers ford (CDFG 1956). CLH were the second most
 9 abundant fish caught during various gill net surveys in the lake at that time (Lindquist et
 10 al. 1943). Surveys conducted between 1938 and 1941, for examination of fish and gnat
 11 interactions, describe the runs of Sacramento splittail (*Ptychocheilus grandis*) and CLH
 12 as numbering in the tens of thousands (Lindquist et al. 1943). A photograph from 1890
 13 depicts a spawning run so thick that CLH formed a blanket across the creek (Figure 6).
 14 Early stories from the area describe fish runs so thick that streams were difficult to ford
 15 by horses and wagons, and residents shoveled spawning fish to bring home for hog
 16 feed (Rideout 1899). The volume of dead fish found during spawning runs on Clear
 17 Lake tributaries created a stench that was intolerable to lakeshore residents (Dill and
 18 Cordone 1997). It is not entirely clear if spawning runs such as those depicted in Figure
 19 6 occurred every year or fluctuated based on tributary flows, but it is likely they
 20 fluctuated in a similar fashion to what was observed during the past decade of CCCLH
 21 spawning surveys. Regardless, the body of evidence lends support for claims of CLH
 22 as common and the most abundant fish in Clear Lake during the late nineteenth and
 23 early twentieth centuries (Coleman 1930; Jordan and Gilbert 1894).
 24
 25



26
 27
 28 **Figure 6.** Photo from 1890s depicting spawning CLH being stranded in Kelsey
 29 Creek.
 30

1 **FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE**

3 **Present or Threatened Modification or Destruction of Habitat**

5 **Wetland Habitat Loss**

7 Wetlands provide critical rearing habitat for juvenile fishes native to Clear Lake (Geary
8 1978; CDFG 2012). Prior to the arrival of European settlers in the mid-1800s, Clear
9 Lake was surrounded by large tracts of wetlands. Throughout the expansion of
10 European settlements around the lake, the wetland habitat was drained and filled to
11 provide urban and agricultural lands. Currently, the Clear Lake watershed contains over
12 16,000 acres of land dedicated to agricultural production (Lake County Department of
13 Agriculture 2011; Forsgen Associates Inc. 2012). Comparisons of historical versus
14 current wetland habitat reveal a loss of approximately 85%, from 9,000 acres in 1840 to
15 1,500 acres by 1977 (Week 1982; Bairrington 1999; Suchanek et al. 2002; ; Lake
16 County Department of Public Works 2003; Giusti 2009; CEPA 2012). Loss of wetland
17 habitat coupled with competition for existing habitat with introduced fishes has led to a
18 decline in available rearing habitat for juvenile CLH (Week 1982).

19 **Spawning Habitat Exclusion and Loss**

21 **Dams, Barriers, and Diversions**

23 Cache Creek Dam was constructed at the outlet of Clear Lake in 1915, and Yolo County
24 Flood Control and Water Conservation District (YCFCWCD) manipulates the lake water
25 level several feet seasonally to allow for diversions for irrigation (CDWR 1975). Clear
26 Lake is allowed to fluctuate on a yearly basis, a maximum of 7.56 feet above a mean
27 level plane referred to as the "Rumsey gage" (CDWR 1975). The effects of lake water
28 manipulations on CLH populations have not been quantified. Manipulation of water
29 levels in the Clear Lake watershed likely results in decreased water quality, a reduction
30 in spawning and rearing habitat, and increased risk of predation (Converse et al. 1998;
31 Wetzel 2001; Gafny et al. 2006; Cott et al. 2008; Hudon et al 2009). All of these
32 impacts can lead to the extinction of native species that evolved in lakes free of habitat
33 modifications resulting from impoundment structures (Wetzel 2001). Impounded
34 systems also tend to be dominated by non-native species (Moyle and Light 1996).

36 CLH spawn in low-gradient tributary streams to Clear Lake. All of the tributary streams
37 to Clear Lake have been altered (Appendix C) to various degrees by dams, barriers,
38 and diversions. Stream alterations can block migratory routes and impeded
39 passage decrease stream flows necessary for adults to reach spawning areas and for
40 larval fish to gain access to the lake for spawning. The result can be direct loss of
41 spawning and rearing habitat, loss of nursery areas or loss of access to these areas,
42 increases in predation, competition from non-native aquatic species, and decreased
43 water quality (Murphy 1948 and 1951; Moyle 2002;). A limited physical habitat analysis
44 survey was conducted in 2013 on Adobe, Kelsey, Manning, Middle, and Scotts creeks.
45 Results of the survey indicate all of the creeks had low Index of Biological Integrity (IBI)

Comment [TT17]: All these factors don't have strong links to CLH decline. What are the physical functional links to each one?

Comment [TT18]: flood control, highway construction, groundwater use and vegetation.

Comment [TT19]: How is this linked in the tributary streams?

Comment [TT20]: How does a physical habitat survey end up with an IBI score? This would be a biological survey.

1 scores and are either partially or not supportive of aquatic life (Mosley 2013). Examples
2 of alterations to Clear Lake tributaries that have impacted CLH include agricultural
3 irrigation pumps and diversions, aggregate mining activity, flood control structures, road
4 crossings, bridge aprons, and off-highway vehicle (OHV) use (McGinnis and Ringelberg
5 2008).

6
7 Adobe Creek, Highland Creek, Middle Creek, Clover Creek, and Kelsey Creek have
8 experienced a reduction in fish spawning habitat since the installation of dams and
9 increased irrigation (Murphy 1951; Macedo 1994; McGinnis and Ringelberg 2006). A
10 barrier assessment was completed in 2006 for Middle Creek and the Kelsey Creek fish
11 ladder (McGinnis and Ringelberg 2006). The assessment found physical barriers to fish
12 migration were associated with bridge aprons and weirs as well as habitat barriers from
13 historical gravel operations (McGinnis and Ringelberg 2006). The Kelsey Creek fish
14 ladder was found unsuitable for passage of CLH. The jump heights and velocities at the
15 ladder were determined to be too great for CLH (McGinnis and Ringelberg 2006).
16 Spawning observations by CCCLH from 2005 to 2013 witnessed fish stranded below
17 multiple barriers within the watershed (CCCLH 2013).

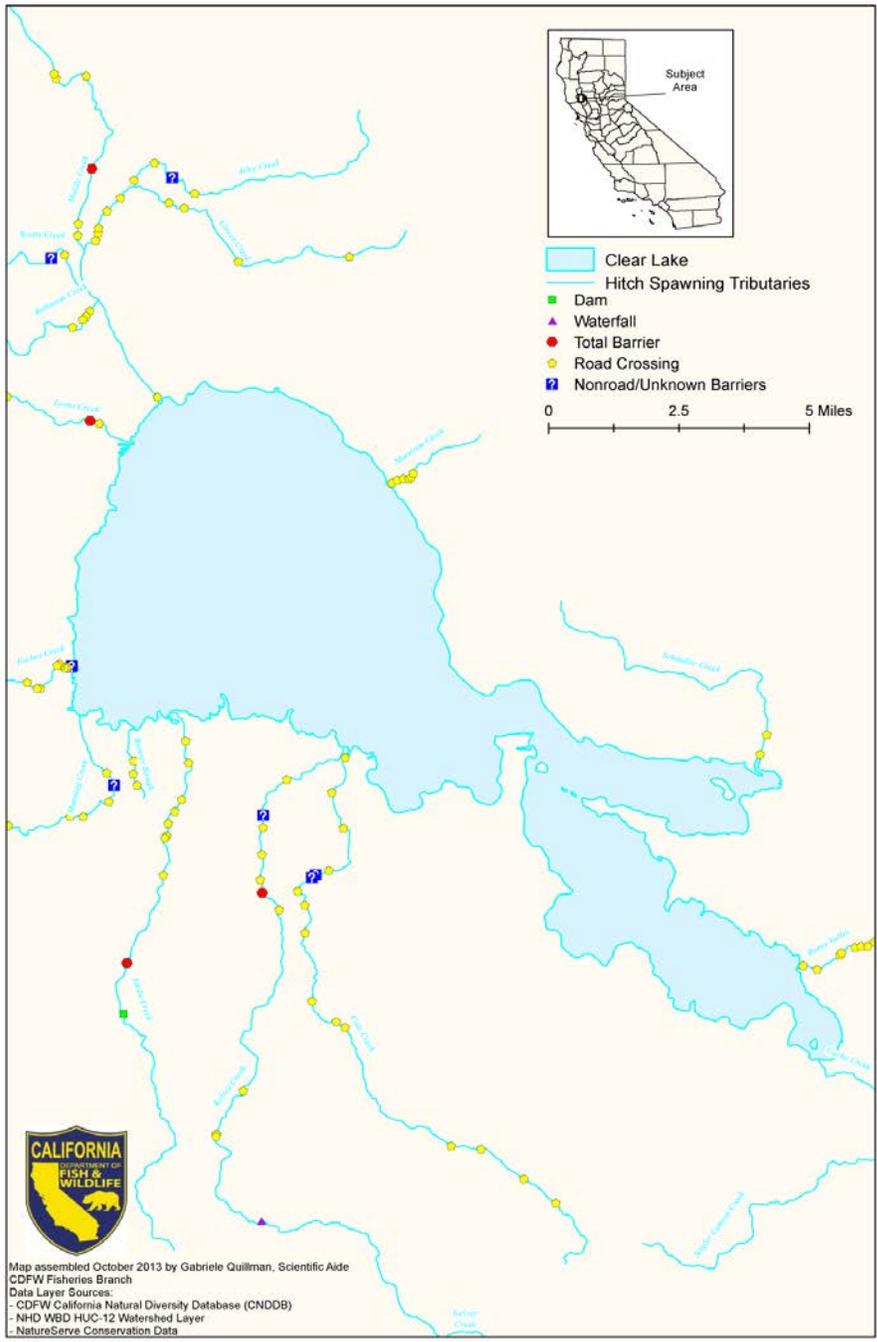
Comment [TT21]: A reduction in habitat or a reduction in access to habitat – or both? This distinction is critical to the analysis.

18
19 Many Clear Lake tributaries are no longer used for spawning or have reduced spawning
20 runs as a result of artificial structures that continue to impede spawning migrations
21 (Figure 7). While some operational and physical modifications to these structures have
22 been implemented over the years, they continue to ~~adversely impact~~
23 ~~migrating spawning~~ CLH from accessing spawning habitat, especially during dry years
24 when spring stream flows are low.

Comment [TT22]: Define habitat barriers vs. physical barriers. The Kelsey Creek fish ladder was known not to pass hitch in the 1970s – or is this a different ladder than what was present then?

25
26 In preparation of this report, the Department estimated the loss of CLH spawning and
27 rearing habitat due to constructed barriers and impediments within the tributaries to
28 Clear Lake (Figure 7). The barrier assessment determined the approximate locations of
29 barriers and estimated miles of stream habitat as determined from the California Native
30 Diversity Database, CDFW Geographic Information System, CDFW Fish Passage
31 Assessment Database, California GIS street layer, and Google Earth Maps. Using that
32 data, the Department estimated 180 ~~river-stream~~ miles were historically available to
33 spawning CLH and that barriers have eliminated or reduced access to ~~greater more~~
34 than 92% of the historically available spawning habitat. Physical barriers, such as the
35 footings of bridges, low water crossings, dams, pipes, culverts, and water diversions in
36 Kelsey, Scotts, Middle, Clover, and other creeks interrupt or eliminate migration to
37 spawning areas (McGinnis and Ringelberg 2008). Appendix C contains a list of several
38 tributaries and some of their associated barriers.

Comment [TT23]: The channels shown on Figure 7 include segments of many creeks that would not have been used by CLH because they are either too far from the lake or are not low gradient streams. What criteria were used to screen for potential access?



1
 2
 3

Figure 7. Clear Lake hitch spawning barriers located on tributaries throughout the watershed.

1
2 Water is frequently diverted from Clear Lake tributaries, during the CLH spawning
3 season, under riparian rights associated with land ownership in the watershed. These
4 water diversions consist of direct diversion from surface water intake pumps and from
5 shallow off-channel wells that capture groundwater underflow from adjacent channels.
6 The primary purpose of water diversions from Clear Lake tributaries is for agricultural
7 production and frost protection. Water diversions for frost protection have been shown
8 to temporarily reduce in-stream flow by as much as 95% (Deitch et al. 2009). Natural
9 flow regimes are thought to favor the success of native fishes over non-native fishes
10 (Marchetti and Moyle 2001). The impact of diversion on CLH spawning tributaries is
11 poorly understood. In some tributaries, water diversion has contributed to early drying
12 of stream reaches and desiccation of CLH eggs masses and newly hatched juveniles
13 (Macedo, R., personal communication, November 25, 2013, unreferenced).
14 Additionally, significant flow reductions can lead to increased water temperatures,
15 reduced available aquatic habitat, altered or decreased biodiversity, increases in non-
16 native species, and alterations to fish assemblages (Marchetti and Moyle 2001; Bunn
17 and Arthington 2002; Bellucci et al. 2011).

18
19 The impacts of spawning habitat alterations to CLH may be inferred by the fate of
20 another native Clear Lake fish that required tributaries for spawning; the Clear Lake
21 splittail was last recorded in 1972 (Puckett 1972). The Clear Lake splittail formerly
22 spawned later in the season than did CLH, and the drying up of tributaries contributed to
23 their demise (Moyle 2002). All stream spawners had “declined precipitously” by 1944
24 (Murphy 1951). Therefore, earlier drying of tributaries by both natural and
25 anthropogenic processes likely impacts the CLH population.
26

Comment [TT24]: This is a key piece of information that should be used to structure an analysis around flow persistence in the tributaries. It is buried here and should be brought forward as a key concern earlier in the document and revisited here.

27 **Dredging and Mining**

28
29 Since the first European settlers arrived at Clear Lake and began gravel mining and
30 dredging operations, there have been documented deleterious effects on the watershed
31 (Suchanek et al. 2002). Field notes from CDFG personnel conducting stocking
32 assessments documented Kelsey Creek so loaded with silt from gravel operations that
33 creek visibility was zero (CDFG 1955). Smaller scale mining and dredging in tributary
34 streams has occurred since early settlement and has altered the amount, quality, and
35 distribution of stream gravels (Thompson et al. 2013). In some tributaries, gravel
36 extraction has resulted in the incising and channelizing of the streams and stream level
37 changes by as much as 15 feet (Suchanek et al. 2002; Eutenier, D. April 17, 2013
38 comment letter). After 1965 about one million metric tons of gravel products per year
39 were removed from the watershed until the partial moratorium on aggregate mining in
40 1981 (Richerson et al. 1994). Gravel was removed from Clear Lake tributaries to
41 provide road base for new roads created to accommodate the expanding population of
42 the area (Suchanek et al. 2002). Currently, approximately 58 acres in the Clear Lake
43 watershed are used for mining purposes (Forsgren Associates Inc. 2012).
44

Comment [TT25]: How much is in-stream mining?

45 Many areas along the tributaries to Clear Lake were channelized in response to
46 frequent flooding during the late winter and early spring (Maclanahan et al. 1972; U.S.
47 Army Corps of Engineers 1974). As a result of gravel extraction and channelization,

1 some areas were covered with riprap or confined by levees to prevent further erosion
2 and flooding. Erosion problems have contributed to sediment entering Clear Lake and
3 providing increased phosphorous loads that impair water quality (Richerson et al. 1994).
4 Gravel extraction results in channelization and down cutting of the stream bank, a
5 decrease in suitable spawning habitat, and increasing flow velocity and amount of
6 coarse material that passes through the system (Brown et al. 1998).

Comment [TT26]: Levees can also result in downcutting by increasing stage and shear stress on the bed during floods.

7 **Water Quality Impacts**

8
9 The Clear Lake watershed has seen a significant increase in the amount of
10 contaminants entering the lake over the past 75 years (Richerson et al. 1994). An
11 increase in agriculture and mining, and a shift to an urban environment, has resulted in
12 adverse water quality impacts in the lake (Mioni et al. 2011; California Environmental
13 Protection Agency [CEPA] 2012).

Comment [TT27]: This section is large and discusses many attributes related to WQ. I suggest some subheadings as appropriate.

14 **Sediment and Nutrients**

15
16
17 Erosion from construction, dredging, mining, agriculture, OHV use, grazing, and
18 urbanization has resulted in increased sediment loads to the Clear Lake watershed
19 (Forsgren Associates Inc. 2012). Increased sediment loads transport nutrient rich soil,
20 particularly phosphorous, into Clear Lake. Increased sediment loads also -and- reduce
21 spawning habitat quality by increasing substrate “embeddedness” (Mosley 2013).
22 During the late 1990s and early 2000s soil erosion and sedimentation became an
23 increasing problem as existing agricultural lands were converted to vineyards (Forsgren
24 Associates Inc. 2012). From 2002 to 2011 vineyard acreage in the Clear Lake
25 watershed increased from approximately 5,500 acres to 8,000 acres (Lake County
26 Department of Agriculture 2011).

27
28 Development and expansion of extensive agriculture in the Clear Lake watershed
29 during the late 1890s until present day reclaimed the lake’s natural wetland filtration
30 system for agricultural use. An increase in agricultural production and a decrease in
31 wetland filtration increased nutrient flows into Clear Lake. Wetland reclamation projects
32 altered the transport of sediment and nutrients, particularly phosphorous, into Clear
33 Lake, resulting in an increase in noxious cyanobacteria blooms that cover the lake in
34 warmer months (Suchanek et al. 2002). As a result of continued water quality issues,
35 Clear Lake was added to the Clean Water Act Section 303(d) list of impaired water
36 bodies in 1988 (CEPA 2010 and 2012). In recent years, noxious cyanobacteria blooms
37 have at a minimum remained constant and may have increased (CEPA 2012).

38 **Food Web**

39
40
41 Cyanobacteria blooms have occurred at Clear Lake since the mid-1900s. Studies
42 indicate an increase in phosphorous was the driver behind water quality impairments
43 and noxious cyanobacteria blooms (Horne 1975; Richerson et al. 1994; CEPA 2012).
44 The blooms originally consisted primarily of *Microcystis*, but in recent years the blooms
45 have been attributed to both *Microcystis* and *Lyngbya*. These taxa represent both non-
46 nitrogen fixing (*Microcystis*) and nitrogen fixing (*Lyngbya*) cyanobacteria and raise
47 concerns that both phosphorous and nitrogen entering the lake need to be controlled

1 (Mioni et al. 2011; CEPA 2012). Cyanobacteria blooms have the ability to both directly
2 and indirectly impact CLH by direct interference with the growth of *Daphnia*, a limnetic
3 organism that is a food source for adult CLH, and interference with food web efficiency.
4 No studies have been conducted at Clear Lake to quantify the impact of cyanobacteria
5 blooms on the ecosystem, but studies conducted at other water bodies with varying
6 degrees of cyanobacteria blooms provide information on their impacts to the aquatic
7 environment. Cyanobacteria blooms reduce the amount of light penetration in the water
8 column and cause a reduction in producers that are unable to reposition themselves to
9 gain more light (Havens 2008). Organisms such as epiphyton, benthic algae, and
10 rooted vascular plants have a reduced ability to function in the ecosystem as a result of
11 cyanobacteria blooms. As the bacteria alter the nutrient cycle of the lake they replace
12 the producers in space and mass. The expanding bacteria begin to deplete CO₂ from
13 the water body, which increases pH and reduces growth of other producers (Havens
14 2008). The decreased CO₂ and increased pH can create surface scums and result in
15 mortality of fishes, including CLH. In the summer of 1969, a large fish die off, due to
16 heavy cyanobacteria growth and low oxygen levels, was reported at Clear Lake. An
17 estimated 170,000 fish died, consisting primarily of carp, CLH, and blackfish (CDFG
18 News Release 1969). Sub lethal and lethal effects of toxins released during
19 cyanobacteria blooms are also seen in fish and their associated food web (Havens
20 2008).

Comment [TT28]: Some parallels with the Delta on food web dynamics here?

21
22 On September 19, 2007, the U.S. Environmental Protection Agency (EPA) approved a
23 control program as a nutrient Total Maximum Daily Load (TMDL) for Clear Lake with the
24 goal of reducing point and non-point source phosphorous entering the lake (CEPA
25 2012). Sources for phosphorous entering the lake include agricultural and urban runoff,
26 timber harvest, road maintenance, construction, gravel mining, dredging, and fire.
27 Additional amounts of nutrients from home fertilizers, marijuana grows, sewer, and
28 septic systems cannot be quantified.

30 Pesticides and Herbicides

31
32 To allow for increased yields on agricultural land and to prevent nuisance insect species
33 around the lake, pesticides became commonplace during the early and mid-1900s. For
34 many decades the Clear Lake gnat, a primary food source for CLH, was targeted with
35 pesticides to reduce its population. Between 1949 and 1957, the Clear Lake gnat was
36 targeted with the pesticide dichlorodiphenyldichloroethane (DDD). During these years it
37 is estimated that 99 percent of the gnat larvae in the lake were killed. Concentrations of
38 DDD were magnitudes higher in invertebrates, fish, and birds than in the surrounding
39 water in which they were found (Lindquist and Roth 1950; Rudd 1964). Sampling
40 conducted during the late 1950s identified CLH, as well as other fish species,
41 contaminated with DDD (Hunt and Bischoff 1960). Contamination levels ranged from
42 5.27 to 115 parts per million (ppm) for edible flesh of sampled fishes (Hunt and Bischoff
43 1960). CLH were at the lower level of DDD contamination for Clear Lake fishes at 10.9
44 to 28.1 ppm for edible flesh content (Hunt and Bischoff 1960). The results of DDD in
45 the Clear Lake watershed resulted in the first major ecological disaster at the lake and
46 the first records of pesticide bioaccumulation in the wildlife of the lake (Suchanek et al.
47 2002).

1 Following the resurgence of gnat populations in response to growing resistance to DDD,
2 two additional measures were taken to reduce the gnat population. Gnat eggs were
3 targeted with a petroleum product, and adult gnats were targeted at roosting locations
4 with Malathion. Additional applications of methyl parathion were also made in 1962
5 (Suchanek et al. 2002). Clear Lake gnats are still present at the lake, but populations
6 are significantly reduced from historical levels. The likely cause of the reduced
7 population of gnats is introduced fishes, primarily inland silversides (Suchanek et al.
8 2002). In 2010 and 2012 Clear Lake gnat populations reached levels not seen in
9 decades. These gnat population booms appeared to coincide with years of low
10 population levels of inland silversides (Scott, J. 2013 personal communication, Aug 1,
11 2013, unreferenced). Qualitative sampling data on CLH does not allow for a direct
12 comparison of CLH numbers in years with increases in the gnat population.

13
14 In recent years, two herbicides, Komeen™ (copper sulfate) and SONAR™ (fluridone),
15 have been used extensively to manage the *Hydrilla verticillata* infestation at the lake.
16 Applied concentrations of Komeen™ do not kill fish directly; however, the impacts to
17 macroinvertebrates may indirectly impact CLH populations (Bairrington 1999). These
18 systemic herbicides also pose a threat to non-target vascular aquatic plants, such as
19 tules and submerged vegetation, which juvenile CLH require for rearing habitat. As
20 noted previously, there has already been a significant reduction in wetland habitat
21 around the lake, and any additional reductions would further limit the amount of habitat
22 available for CLH. Initial studies indicate a reduction in tule habitat following SONAR™
23 applications (Bairrington 1999). Environmental monitoring of eradication activities in
24 1996 and 1997 found that invertebrate species declined within the treatment area but
25 rebounded quickly following the toxicity decay of the herbicide (Bairrington 1999). Post-
26 treatment electrofishing surveys noted an increase in the number and abundance of fish
27 species (Bairrington 1999).

28 29 Mercury

30
31 Mining operations within the watershed contributed to sulphur and mercury
32 contamination in Clear Lake. The Sulphur Bank Mercury Mine began operations in
33 1865 and ended in 1957 (Osleger et al. 2008; Giusti 2009) Originally the mine focused
34 on extracting sulphur, but as operations continued into the late 1920s and the sulphur
35 was found to be contaminated with mercury sulfide, operations switched to extracting
36 mercury from the large-scale open-pit mine (Giusti 2009). As a result of contamination,
37 the mine was classified as an EPA Superfund Site in 1990 (Suchanek et al. 1993). The
38 mine is thought to have contaminated the lake with both mercury and arsenic
39 (Suchanek et al. 1993). Studies have found the mercury concentrations in sediment to
40 be high (over 400 ppm) in the vicinity of the mine, decreasing as distance from the mine
41 increases (Suchanek et al. 2002). The mine continues to produce low pH acid mine
42 drainage that delivers sulfate to the lake. Over the past decade, the EPA has taken
43 several actions to remediate contamination from the mine. These include erosion
44 control measures, removal of contaminated soil, storm water diversion, and well
45 capping (U.S. Environmental Protection Agency 2012).

46
47 During the 1970s, elevated concentrations of mercury were found in the fish of the lake
48 (Curtis 1977). Mercury contamination can lead to significant impacts to the reproductive

1 success of fishes and can result in reduced brain function, altered size and function of
2 gonads and reduced gamete production (Sandheinrich and Miller 2006; Crump and
3 Trudeau 2009). In 2003, a mercury TMDL was developed for Clear Lake to reduce
4 methylmercury in fish by reducing overall mercury loads to Clear Lake (CEPA 2010).
5 Levels of mercury found in fish, including CLH, are between 0.06 and 0.32 µg/g (CEPA
6 2002). Concentrations of mercury present in Clear Lake fishes have resulted in health
7 advisories on their consumption, but are below acute toxicity thresholds (Harnly et al.
8 1997). Mercury levels are close to or within the effect thresholds for reproduction and
9 growth for fathead minnow (0.32 to 0.62 µg/g) and rainbow trout (National Oceanic and
10 Atmospheric Administration [NOAA] 2011). Concentrations with no effect on rainbow
11 trout growth and development are 0.02 to 0.09 µg/g (NOAA 2011). Lacking specific
12 studies on CLH, based on surrogate effect levels for fathead minnows and rainbow
13 trout, it is reasonable to suspect that CLH may be experiencing sub lethal chronic and
14 reproductive effects from mercury contamination.
15

16 **Overexploitation**

17

18 **Commercial Harvest**

19

20 Commercial fish harvest at Clear Lake ~~has been occurring from since~~ the early 1900
21 ~~through 2001.~~ Harvested fish were distributed to fish markets in California for sale for
22 human consumption and animal feed. Prior to 1941, the majority of commercial
23 operations centered on harvesting catfish (*Ictalurus* or *Ameiurus* spp.) from the lake.
24 Although exact numbers are unavailable, it is likely that large numbers of catfish were
25 taken during this period (Bairrington 1999). In 1942 commercial harvest of catfish was
26 banned at Clear Lake. Beginning in the 1930s commercial harvest focused on
27 Sacramento blackfish (*Orthodon microlepidotus*), a native species, and common carp
28 (*Cyprinus carpio*), a non-native species. From 1932 to 1962 the annual average catch
29 rate was 295,000 pounds for the commercial fishery (Bairrington 1999). A ratio of
30 1.33:1 for blackfish to carp was the average during commercial fishing operations
31 (Bairrington 1999). In 1976 the only recorded capture and sale of CLH for commercial
32 purposes was submitted to the Department, a total of 1,550 pounds was reported
33 captured and sold at market that year (CDFW Commercial Fisheries Data). This is the
34 only instance in the records of CLH being captured for commercial sale, primarily due to
35 lack of interest and low sale price for the species (CDFW Commercial Fisheries Data).
36 By 1960 commercial fishing operators were required to count and release all bycatch
37 from commercial operations. CLH were found in large numbers some years and were
38 recorded and returned to the lake when captured (Figure 5; CDFW Commercial
39 Fisheries Data). The Department has received no commercial permit applications for
40 operations on Clear Lake over the past several years. The lack of permit applications
41 indicates that at this time commercial fishing operations at Clear Lake have ceased
42 (CDFW Commercial Fishing Permit Data).
43

44 **Cultural Harvest**

45

1 Clear Lake hitch are culturally significant to several Pomo tribes that inhabit the Clear
2 Lake watershed. Two Pomo tribes fought a war over Kelsey Creek and its important
3 CLH supply (Barrett 1906; Kniffen 1939). Historically, large runs of CLH provided a
4 staple food source for the local tribes (RREC 2011). During spawning runs, CLH were
5 captured by constructing a series of dams in the creeks from which the fish were then
6 scooped with baskets. The fish were cured to provide a food source throughout the year
7 (Kniffen 1939). Historical accounts from tribal members speak of CLH being easy to
8 find as they spawned in large numbers in the tributaries to the lake (Scotts Valley Band
9 of Pomo Indians historical accounts 2013). There are no estimates of the number of
10 CLH that were taken for cultural harvest during any specific timeframe. However, an
11 account from a tribal member indicates that, historically, a single family may have taken
12 a couple thousand fish during the spawning runs (Big Valley EPA 2013). Tribal
13 accounts indicate the harvest of CLH continued until the decline in spawning runs in the
14 mid-1980s (Big Valley EPA 2013). Prior to designation of CLH as a candidate species
15 for listing, regulations in the Clear Lake watershed allowed for the harvest of CLH in
16 spawning tributaries by hand or hand-held dip net. In 2013 the Department issued
17 CESA Memoranda of Understanding (Fish and Game Code, § 2081(a)) to three tribes
18 to authorize collection of CLH for scientific research and public education (Kratville, D.
19 personal communication, October 7, 2013, unreferenced).
20

21 **Predation and Competition**

22
23 Non-native fish introductions into Clear Lake date back as far as the late 1800s (Dill and
24 Cordone 1997). Prior to the introduction of non-native fish species, between 12 and 14
25 native fish species occupied Clear Lake (Bairrington 1999; Moyle 2002; Thompson et al.
26 2013). Currently, approximately ten native species and 20 non-native species inhabit
27 the lake (Bairrington 1999; Thompson et al. 2013). Over the past 100 years one native
28 species, thicketail chub (*Gila crassicauda*), has gone extinct and two native species,
29 hardhead (*Mylopharodon conocephalus*), and Clear Lake splittail, have been extirpated
30 from the lake. Sacramento perch (*Archoplites interruptus*), has not been captured in
31 sampling efforts since 1996 (Bairrington 1999; CDFW Commercial Fisheries Data;
32 Thompson et al. 2013). The majority of non-native species introductions have been
33 conducted by the Department, various local agencies, and angling groups in an effort to
34 increase sport fishing opportunities. Introductions of fish at Clear Lake have been
35 warmwater sport fish (black bass, sunfish (*Lepomis* spp.), catfish, etc.) or forage
36 species for piscivorous sport fish. The Department has not stocked fish in Clear Lake in
37 the past decade. The four fish species listed below were introduced without
38 authorization from the Department (Bairrington 1999; Rowan J. personal
39 communication, October 10, 2013, unreferenced). Inland silverside, threadfin shad,
40 smallmouth bass (*Micropterus dolomieu*), and pumpkinseed (*Lepomis gibbosus*) were
41 introduced to provide forage for other game fishes, provide Clear Lake gnat control, or
42 as part of a new sport fishery (Anderson et al. 1986; Dill and Cordone 1997; Bairrington
43 1999). Non-native game fishes comprise nearly 100 percent of the sport catch from the
44 lake. Incidental captures of native species occur infrequently and are rarely recorded
45 during creel and tournament surveys (Rowan J. personal communication, October 10,
46 2013, unreferenced).
47

Comment [TT29]: I found no hardhead in the stream surveys conducted in the basin in 1975-76.

Comment [TT30]: But what's happened to the black bass population over the past 10 years – are there more, large bass compared to pre-2000?

1 Non-native fish introductions can have significant impacts on native fish species. Inland
2 silverside and threadfin shad are thought to compete directly with CLH for food
3 resources (Geary and Moyle 1980; Anderson et al. 1986; Bairrington 1999). All three
4 species are limnetic foragers that rely on macroinvertebrates for food. There are no
5 direct comparisons, but years with declines in threadfin shad and inland silverside are
6 thought to coincide with increases in CLH numbers, and years with decreased threadfin
7 shad and inland silverside result in increased young of year recruitment for other native
8 and non-native species (Rowan J. personal communication, October 10, 2013, [redacted]
9 unreferenced). Competition for juvenile rearing habitat has increased with the reduction
10 in wetland habitat and increase in non-native fish species. Rearing habitat is essential
11 for CLH recruitment to any year class. A reduction in recruitment leads to a decrease
12 in spawning adults in the following years. A species with highly fluctuating population
13 trends, such as CLH, is particularly vulnerable to population level impacts in years with
14 reduced recruitment. Piscivorous fish species such as largemouth bass (*Micropterus*
15 *salmoides*) prey directly on both juvenile and adult CLH. Although no comprehensive
16 diet studies have been done, incidental data indicate that CLH are found in the
17 stomachs of piscivorous species in the lake (Moyle et al. in progress). Omnivorous
18 species such as catfish (*Ameiurus* spp.) are known to prey on various life stages of
19 native fishes. It is suggested that the introduction of catfish to Clear Lake may have
20 played a role in the decline of native fish species (Dill and Cordone 1997). The
21 introduction of catfish was described, by Captain J.D. Dondero of the Division of Fish
22 and Game, as having solved the problem of large spawning runs of fish dying in
23 tributaries to Clear Lake and that the population of nongame fish diminished following
24 their introduction (Dill and Cordone 1997). Jordan and Gilbert (1894) also describe
25 catfish as being destructive to the spawn of other species. The rates at which CLH are
26 consumed in relation to other prey species and the amount of CLH consumed are
27 unknown. It is likely that during years when alternative prey abundance is low, CLH
28 predation increases (Eagles-Smith et al. 2008).

Comment [TT31]: Could this be done for this report?

Comment [TT32]: This statement needs a reference.

Comment [TT33]: Are we looking at a species similar to splittail in the Central Valley, where it goes along at low levels in many years, then has a good spawn and really booms for several years, before returning to background numbers? This is the key question – is it a boom and bust fish or something different.

30 Disease and Parasites

31
32 Disease outbreaks in fishes have been known to occur at Clear Lake. The outbreaks
33 are primarily koi herpes virus (KHV) and it affects introduced carp and goldfish. Native
34 minnows, including CLH, show no effects from KHV. Fish fungi (*Saprolegnia* spp.) have
35 been observed on fishes captured in Clear Lake and results from physical injury or
36 infection. CLH are susceptible to fish fungi but it is not readily observed in captured
37 fish. All fish in Clear Lake are susceptible to anchor worms (*Lernaea* spp.) and heavy
38 infestations can lead to mortality. No CLH with heavy anchor worm infestations have
39 been observed during CDFW fishery surveys at Clear Lake (Rowan J. personal
40 communication, October 10, 2013, unreferenced). The Big Valley Rancheria Band of
41 Pomo Indians has documented light loads of anchor worms occurring on CLH (Big
42 Valley Rancheria 2012 and 2013).

44 Other Natural Occurrences or Human Related Activities

45 Climate Change

46

1 It is likely that native fishes in California will be vulnerable to physical and chemical
2 changes as a result of climate change (Moyle et al. 2012). Research has shown that
3 the annual mean temperature in North America has increased between 1955 and 2005
4 and is predicted to continue increasing in the future (Field et al. 1999; Hayhoe et al.
5 2004); however, it varies across North America, is more pronounced in spring and
6 winter, and has affected daily minimum temperatures more than daily maximum
7 temperatures (Field et al. 2007). In general, climate change models for California
8 indicate an increase in overall air temperature, decreased and warmer rainfall, and an
9 increase in overall water temperatures (California Climate Change Center [CCCC]
10 2012). Cold storms are expected to decrease, giving way to warmer storms that create
11 earlier run-off and less water storage capabilities (Field et al. 1999; Hayhoe et al. 2004;
12 CCCC 2012). Climate change in the Clear Lake watershed is likely to cause some
13 changes to the interannual variability in rainfall. The change in rainfall variability would
14 likely increase the occurrence of drought and flood years (Clear Lake Integrated
15 Watershed Management Plan [CLIWMP] 2010). Expected climate change impacts to
16 California and the Clear Lake watershed will be significant during annual CLH spawning
17 cycles. CLH require winter and spring storms that provide suitable spawning flows in
18 the tributaries of Clear Lake. A shift in timing, temperature, and amount of runoff could
19 significantly impact the ability of CLH to successfully spawn. A climate driven change in
20 the Clear Lake watershed could result in the loss of spawning habitat, reduced access
21 to spawning habitat, stranding of spawning and juvenile fish, and egg desiccation.
22

23 A report on the projected effects of climate on California freshwater fishes, prepared for
24 the California Energy Commission's California Climate Change Center, determined CLH
25 to be critically vulnerable to impacts from climate change (Moyle et al. 2012). The
26 report evaluated criteria such as population size, population trends, range, lifespan, and
27 vulnerability to stochastic events to identify the degree of vulnerability of each fish
28 species. The Intergovernmental Panel on Climate Change has stated that of all
29 ecosystems, freshwater ecosystems will have the highest proportion of species
30 threatened with extinction due to climate change (Kundzewicz et al. 2007). Freshwater
31 lake species are more susceptible to extirpation because they are unable to emigrate
32 should habitat changes occur (CA Natural Resources Agency 2009).
33

34 **Recreational Activities**

35
36 The natural resources of the Clear Lake watershed are a tremendous recreational
37 resource for residents and visitors to Lake County. As the largest freshwater lake
38 wholly in California, with opportunities for multiple aquatic recreational activities, the
39 lake receives tens of thousands of visitors per year. According to 2008 data acquired
40 from Lake County quagga mussel (*Dreissena rostriformis*) inspection sticker application
41 forms; there were 11,230 boats that visited the lake that year. Jet skis and pleasure
42 boats accounted for 41 percent of the boating activity at the lake (CLIWMP 2010).
43

44 Permanent structures, associated with boat docks, boat ramps, and swimming beaches,
45 have reduced littoral zone habitat around the lake. These structures require clearing of
46 littoral zone habitat to maintain access for recreational boaters and swimmers. It is
47 estimated that there are over 600 private boat docks and boat ramps on the lake

1 shoreline. In addition to reducing littoral zone habitat these structures provide additional
2 habitat for non-native sport fish, such as largemouth bass, that prey on CLH.

3
4 Recreational and tournament angling generate a significant amount of the activity in the
5 Clear Lake aquatic environment. In 2008, 18 percent of all boats entering the lake
6 identified their recreational activity as angling (CLIWMP 2010). In a single year creel
7 survey conducted in 1988 by the Department, CLH comprised two percent of the
8 recreational sport catch (Macedo 1991).

9
10 The number of angling tournaments, primarily targeting largemouth bass, has drastically
11 increased over the last three decades in response to Clear Lake's reputation as a
12 premiere sport fishery. Between 2001 and 2008 the number of angling tournaments
13 increased from 98 to 208 per year (Rowan J. personal communication, October 10,
14 2013, unreferenced). It is believed that recreational and tournament anglers' capture
15 CLH incidentally while angling. The impact to CLH from the increase in angling
16 tournaments is unknown, but is likely negligible because tournament anglers do not
17 target CLH and bycatch would be an inadvertent snagging on an artificial lure, a rare
18 occurrence.

19 **REGULATORY AND LISTING STATUS**

20 **Federal**

21
22 On September 25, 2012 the Center for Biological Diversity petitioned the U.S. Fish and
23 Wildlife Service (USFWS) to list CLH as endangered or threatened under the federal
24 Endangered Species Act (ESA). As of the publication of this status review there has
25 been no action taken on the petition by USFWS.

26
27 The U.S. Forest Service (USFS) lists CLH as a sensitive species. USFS sensitive
28 species are those plant and animal species identified by a regional forester that are not
29 listed or proposed for listing under the federal ESA for which population viability is a
30 concern.

31 **State**

32
33 The Department designated CLH as a Species of Special Concern (SSC) in 1994. A
34 SSC is a species, subspecies, or distinct population of an animal native to California
35 that currently satisfies one or more of the following (not necessarily mutually exclusive)
36 criteria:

- 37 • Is extirpated from the State or, in the case of birds, in its primary seasonal or
38 breeding role;
- 39 • Is listed as Federally, but not State, threatened or endangered;
- 40 • Is experiencing, or formerly experienced, serious (noncyclical) population
41 declines or range restrictions (not reversed) that, if continued or resumed, could
42 qualify it for State threatened or endangered status;
- 43 • Has naturally small populations exhibiting high susceptibility to risk from any
44 factor(s) that if realized, could lead to declines that would qualify it for State
45 threatened or endangered status.

1
2 The intent of designating a species as a SSC is to:
3 • Focus attention on animals at conservation risk by the Department, other State,
4 local and Federal government entities, regulators, land managers, planners,
5 consulting biologists, and others;
6 • Stimulate research on poorly known species;
7 • Achieve conservation and recovery of these animals before they meet California
8 Endangered Species Act criteria for listing as threatened or endangered.
9 There are no provisions in the Fish and Game Code that specifically prohibit take of
10 CLH or protect its habitat.
11

12 **Other Rankings**

13
14 The American Fisheries Society ranks CLH as vulnerable, meaning the taxon is in
15 imminent danger of becoming threatened throughout all or a significant portion of its
16 range (Jelks et al. 2011).

17 **EXISTING MANAGEMENT EFFORTS**

18 19 **Resource Management Plans**

20
21 An increase in resource management efforts throughout the Clear Lake watershed has
22 benefitted CLH, and several plans and strategies are in place to assist in reducing the
23 threats to CLH.
24

25 The Clear Lake Integrated Watershed Management Plan (2010) was prepared by two
26 resource conservation districts and provides details of past and current resource
27 management within the Clear Lake watershed. The plan seeks to identify opportunities
28 to improve and protect the health and function of the watershed and identifies specific
29 implementation actions to improve and protect watershed resources. Recommended
30 actions are prioritized on a timeline. As funding allows, implementation of these actions
31 will be undertaken by various non-governmental organizations (NGO) and local, state,
32 and federal agencies that share an interest in promoting the health and function of the
33 watershed. Multiple action items listed in the plan would benefit CLH and their habitats.
34 Several tributaries to Clear Lake have completed Watershed Assessment plans as well.
35 These include Kelsey Creek Watershed Assessment (2010), Middle Creek Watershed
36 Assessment (2010), and Scotts Creek Watershed Assessment (2010). These plans
37 were all completed by Lake County Water Resources Division for West and East Lake
38 Resource Conservation Districts.
39

40 With adoption of the TMDL for Clear Lake, several projects are in process or have been
41 completed to reduce the amount of phosphorous entering the lake. Specifically, the
42 Middle Creek Flood Damage Reduction and Ecosystem Restoration Project seeks to
43 reduce the amount of phosphorous entering the lake by 40 percent (CEPA 2012). Lake
44 County and the California Department of Transportation have implemented several best
45 management practices (BMPs) for managing storm water runoff to reduce the amount

1 of phosphorous and other contaminants that enter the lake. Both the USFS and Bureau
2 of Land Management (BLM) have undertaken projects to reduce nutrients entering the
3 lake as a result of off-highway vehicles and other land uses. BLM, in coordination with
4 Scotts Valley Band of Pomo Indians, received a grant to implement the Eightmile Valley
5 Sediment Reduction and Habitat Enhancement Project Design. Controlling sediment
6 from Eightmile Valley is crucial to controlling the amount of nutrients entering the lake.
7 Many of these projects are still in design or early implementation and it will be several
8 years before changes in nutrient loads within the lake can be observed and studied.

9
10 The adverse effects from an increase in sedimentation as a result of conversion of
11 various types of agricultural land to vineyard resulted in the formation of the Erosion
12 Prevention and Education Committee (EPEC). The EPEC is a group of county
13 agencies and private entities that provide educational outreach regarding erosion
14 control and water quality protection. In addition, the Lake County Grading Ordinance
15 was approved in 2007 and requires grading permits and Erosion Control and Sediment
16 Detention Plans for projects with the probability of resulting in increased sedimentation
17 (Forsgren Associates, Inc. 2012).

18
19 Concerns over the reduction in habitat quality resulting from gravel mining prompted
20 Lake County to adopt an Aggregate Resources Management Plan in 1994. The plan
21 called for a moratorium on gravel mining in several tributaries to Clear Lake. The
22 implementation of gravel mining regulations has resulted in reduced in-stream and bank
23 erosion and increased riparian habitat along the creeks (CEPA 2008).

24
25 To prevent further destruction of wetland habitat along the lake shoreline, in 2000 and
26 2003 amendments, Lake County adopted Section 23-15 of the Clear Lake Shoreline
27 Ordinance that prohibits the destruction of woody species and tules. In addition to the
28 ordinance, there is a no net-loss requirement for commercial, resort, and public
29 properties that seek to clear vegetation from areas along the shoreline (CLIWMP 2010).

30
31 RREC produced an Adaptive Management Plan (HAMP) for the Clear Lake Hitch,
32 *Lavinia exilicauda chi* (RREC 2011). The HAMP describes the current status of CLH
33 habitat and problems for habitat recovery. The habitat assessments are included in a
34 management plan that identifies action items, issues of uncertainty, stakeholder
35 involvement, sustainability, and plan amendment procedures. The RREC is currently in
36 the process of revising the HAMP.

37
38 The Department has created or approved two Conceptual Area Protection Plans
39 (CAPP) for the Clear Lake Watershed. The creation of a CAPP for an area allows the
40 Department, as well as local and federal agencies, and NGOs, to apply for land
41 acquisition funding from the Wildlife Conservation Board. The first, the Clear Lake
42 CAPP, was approved in 2002 and addresses land acquisition needs in the area of
43 Middle Creek. The plan focuses on protecting wetland and riparian habitat for the
44 benefit of natural resources. The second CAPP, Big Valley Wetlands, is currently in
45 development with possible approval in 2014. The Big Valley Wetlands CAPP focuses
46 on land acquisitions in the western portion of the Clear Lake watershed for the purpose
47 of protecting wetland and riparian habitat. Both CAPP's will benefit CLH in the
48 protection of riparian and wetland habitat critical for spawning and rearing CLH. Land

1 acquisitions that seek to protect and restore existing CLH habitat should create a stable
2 environment for CLH populations.

3
4 The Department published a Clear Lake Fishery Management Plan in 1999 (Bairrington
5 1999). The plan provides a review of past and present biological information for Clear
6 Lake. The primary focus of the plan is to maintain fishery resources of the lake and
7 enhance recreational fishing opportunities. The plan identifies areas of controversy
8 between various stakeholder groups in the watershed, and states that “adapting to the
9 biological and social settings at Clear Lake involves a variety of compromises between
10 these groups and the non-angling groups who wish to ensure the well-being of Clear
11 Lake’s native fish species.” The plan identifies the decline in native fish species at
12 Clear Lake as being detrimental both socially and biologically. No specific guidelines
13 are given for addressing impacts to native species, but restoration of spawning habitat
14 and natural flow regimes are discussed as critical for native species survival.
15

16 **Monitoring and Research**

17
18 In 2013 the Department attempted to conduct a status assessment of the CLH
19 population present in Cole and Kelsey creeks. Sampling produced too few fish to
20 facilitate a statistically valid mark and recapture study. As a result, a population
21 estimate was not completed. The Department has proposed additional funding in 2014
22 to begin a multi-year mark-recapture study to determine a statistically valid population
23 estimate or index of CLH.
24

25 The CCCLH has been conducting annual spawning observations since 2005. A simple
26 protocol is followed that identifies the time, observer, and number of CLH observed.
27 Volunteers have put in hundreds of hours monitoring CLH spawning runs during this
28 time period. Although not quantitative, the surveys provide a glimpse into the number of
29 spawning CLH and how successful spawning is in a particular season. Results of these
30 surveys are included in Appendices A and B and summarized in Section 4.1 and 4.2
31 above.

32 **Habitat Restoration Projects**

33
34 In recent years, local, state, and federal agencies have begun implementing actions to
35 aid in the protection and restoration of Clear Lake wetland habitat. The Middle Creek
36 Flood Damage Reduction and Ecosystem Restoration Project will restore up to 1,400
37 acres of wetland habitat around Middle Creek and Rodman Slough, essentially doubling
38 the amount of existing wetland habitat in the watershed (CLIWMP 2010).
39

40 **Impacts of Existing Management Efforts**

41
42 To date, existing management efforts have focused on CLH habitat restoration in the
43 watershed. Wetland restoration projects that would significantly benefit CLH have been
44 proposed and have been or will be implemented through the Middle Creek Flood
45 Damage Reduction and Ecosystem Restoration Project and the two CAPPs that cover
46 portions of the watershed. Wetland restoration is expected to aid in increasing

1 spawning success and juvenile recruitment into the population. Increased wetland
2 acreage would enhance filtration of tributary waters resulting in decreased amounts of
3 nutrients entering the lake and an increase in the water table. The increased water
4 table will help maintain surface flow in tributaries, resulting in suitable spawning habitat
5 being maintained throughout the spawning season. The Clear Lake Shoreline
6 Ordinance has resulted in a “no net loss” of shoreline wetland habitat around the lake
7 since its enactment. However, because these wetland restoration projects are either
8 recent or yet to be implemented, a thorough assessment of direct and indirect impacts
9 to CLH populations cannot be included in this status review.

Comment [TT34]: Linkages to cause/effect are unclear. Increased groundwater elevations would only help to maintain surface flows if they were located at sites where flows are limiting access. Seems that a different approach to management of the lake level would do the same thing.

10
11 Establishment of TMDLs for mercury and nutrients has led to a reduction in inputs and
12 an increase in monitoring efforts in the Clear Lake watershed. Past and future steps by
13 the federal government will reduce mercury contamination resulting from the Sulphur
14 Bank Mercury Mine. Most of the identified initial actions for cleanup have been
15 implemented. The focus will now be on two long-term projects to address waste pile
16 and lake sediment cleanup, which should result in significant reductions in mercury
17 contamination in the watershed. Nutrient loads entering Clear Lake have been
18 addressed by several measures including wetland restoration, BMPs for storm water
19 runoff, and erosion control measures. Many of these projects are in the early stages of
20 implementation, and a thorough assessment of impacts to CLH is yet to be been
21 completed. It is likely that reduced mercury and nutrient loads in Clear Lake will result
22 in a significant benefit to CLH.

23 **SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF CLEAR LAKE** 24 **HITCH IN CALIFORNIA**

25
26 CESA directs the Department to prepare this report regarding the status of CLH based
27 upon the best scientific information available to the Department. CESA’s implementing
28 regulations identify key factors that are relevant to the Department’s analyses.
29 Specifically, a “species shall be listed as endangered or threatened ... if the Commission
30 determines that its continued existence is in serious danger or is threatened by any one
31 or any combination of the following factors: (1) present or threatened modification or
32 destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease;
33 or (6) other natural occurrences or human-related activities.” (Cal. Code Regs., tit. 14, §
34 670.1 (i)(1)(A)).

35
36 The definitions of endangered and threatened species in the Fish and Game Code
37 provide guidance to the Department’s scientific determination. An endangered species
38 under CESA is one “which is in serious danger of becoming extinct throughout all, or a
39 significant portion, of its range due to one or more causes, including loss of habitat,
40 change in habitat, over exploitation, predation, competition, or disease.” (Fish & G.
41 Code, § 2062). A threatened species under CESA is one “that, although not presently
42 threatened with extinction, is likely to become an endangered species in the foreseeable
43 future in the absence of special protection and management efforts required by
44 [CESA].” (*Id.*, § 2067).

1 The preceding sections of this status review report describe the best scientific
2 information available to the Department, with respect to the key factors identified in the
3 regulations. The Department's scientific determinations regarding these factors as peer
4 review begins are summarized below.
5

6 **Present or Threatened Modification or Destruction of Habitat**

7

8 Beginning with the arrival of European settlers in the mid-1800s, alterations to habitats
9 in the watershed have directly impacted the ability of CLH to survive. Habitats
10 necessary for both spawning and rearing have been reduced or severely decreased in
11 suitability in the past century resulting in an observable decrease in the overall
12 abundance of CLH and its habitat. Spawning tributaries have been physically altered by
13 a combination of dams, diversions, and mining operations that have altered the course
14 and timing of spring flows and the amount and quality of spawning habitat available for
15 CLH. Dams create barriers to CLH passage that reduce the amount of available
16 spawning habitat while altering the natural flow regime of tributaries. Water diversions
17 in tributaries have resulted in decreased flows during critical spawning migrations for
18 CLH. Loss of eggs, juvenile, and adult fish due to desiccation and stranding from water
19 diversions are likely a significant impact on CLH populations. Gravel mining removed
20 large amounts of spawning substrate during peak operations in the mid-1900s.
21 Spawning substrate has been restored slowly after gravel mining was discontinued in
22 the majority of the watershed. Water quality impacts to the watershed have resulted in
23 Clear Lake being listed as an impaired water body and led to the establishment of
24 TMDLs for both mercury and nutrients for the lake. It is unclear to what extent the water
25 quality impacts are affecting CLH populations. The Department considers modification
26 and destruction of habitat a significant threat to the continued existence of CLH.

27 **Overexploitation**

28

29 Harvest of CLH has occurred by both Pomo tribes and commercial fishery operators at
30 Clear Lake. Historic accounts from tribal members indicate that significant amounts of
31 CLH were harvested during spawning runs. In recent years, the amount of harvest by
32 the Pomo has been minimal, and the CLH are used strictly for educational and cultural
33 reasons. Since the early 1990s commercial fishery operations have been required to
34 return all CLH captured to the lake. Prior to that, CLH had not been regularly harvested
35 for sale. It is likely that incidental catch during commercial harvest operations resulted
36 in mortality of some CLH. However, there is no information indicating that
37 overexploitation threatens the continued existence of CLH.

38 **Predation**

39

40 Direct predation of CLH by fish, birds, and mammals is known to occur in suitable
41 habitats within the watershed. Spawning runs are vulnerable to predation from birds
42 and mammals as fish migrate upstream and become stranded at various locations.
43 Stranding occurs both naturally and as a result of habitat modifications described
44 above. Non-native fishes prey directly on different life stages of CLH in all occupied
45 habitats. CLH have been found during stomach content analyses of largemouth bass.
46 Incidental observations indicate that largemouth bass may target CLH as the CLH stage

1 at the entrance to ascend spawning tributaries in early spring. Other introduced fishes,
2 such as catfish species, also prey on CLH. A detailed diet study on introduced fishes is
3 necessary to determine the extent of predation from introduced fishes. There is
4 scientific information suggesting that predation by introduced fishes threatens the
5 continued existence of CLH.

6 **Competition**

7
8 The extent of impacts on CLH from competition with other aquatic species is poorly
9 understood. Studies conducted on diet analysis of CLH indicate that there is
10 competition between CLH and other macroinvertebrate consuming fish species,
11 primarily inland silversides and threadfin shad. Observations by Department biologists
12 and others indicate that CLH populations fluctuate on alternating cycles with inland
13 silverside populations. CLH directly compete with other native and non-native fishes for
14 juvenile rearing habitat. The majority of fishes in Clear Lake utilize near shore wetland
15 habitat for juvenile rearing. With the decrease in wetland habitat over the past century,
16 there is increased competition for the remaining habitat. Although no formal studies
17 have been completed, it is likely that competition for resources threatens the continued
18 existence of CLH.

19 **Disease**

20 There are no known diseases that are significant threats to the continued existence of
21 CLH.

22 **Other Natural Occurrences or Human-related Activities**

23
24 Expected climate change impacts to California and the Clear Lake watershed will be
25 significant during annual CLH spawning cycles. CLH require winter and spring storms
26 that provide suitable spawning flows in the tributaries of Clear Lake. A shift in timing,
27 temperature, and amount of runoff could significantly impact the ability of CLH to
28 successfully spawn. A report on the projected effects of climate on California
29 freshwater fishes determined CLH to be critically vulnerable to impacts from climate
30 change.

31
32 Numerous recreational activities take place in Clear Lake each year. The majority of
33 recreational activities pose no significant threat to the survival of CLH. However, it is
34 believed that recreational and tournament anglers' capture CLH incidentally, at a low
35 rate. The extent of impacts to CLH from angling is unknown, but likely do not threaten
36 the continued existence of CLH.

37 **SUMMARY OF KEY FINDINGS**

38
39 At present time, the species can be found in portions of its historic habitat and
40 qualitative surveys indicate a variable interannual population. Based on qualitative
41 survey efforts to date a population estimate or index of CLH is not attainable. Without a
42 current population or index for CLH it is necessary to estimate impacts not based on a

Comment [TT35]: Let's be clear on what we're calling this habitat – Is this inundated shallow water with emergent vegetation? Does it meet the definition of a wetland for regulatory purposes or is it permanently inundated shallow water habitat?

Comment [TT36]: I think this is a weak summary statement. The document refers to OHV use in the Middle Creek and Scotts Creek watersheds as a source of sediment yet discounts what could be more watershed wide impacts while focusing on the relatively inconsequential bycatch from sport anglers. I don't think too many hitch will take a bass lure.

1 set baseline but rather against trends seen in abundance and distribution in sampling
2 efforts over the past half century.
3

4 It will be imperative for the Department and the conservation community to study and
5 monitor the population of CLH over the next decade. A review of the scientific
6 determinations regarding the status of CLH indicates there are significant threats to the
7 continued existence of the species, particularly related to historical and ongoing habitat
8 modification, predation from introduced species, and competition. Many of these
9 threats are currently or in the near future being addressed by existing management
10 efforts. Monitoring impacts from existing management efforts will be imperative to
11 assessing the future status of CLH.

12 **RECOMMENDATION FOR PETITIONED ACTION**

13
14 CESA directs the Department to prepare this report regarding the status of CLH in
15 California based upon the best scientific information available. CESA also directs the
16 Department based on its analysis to indicate in the status report whether the petitioned
17 action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd.
18 (f)). The Department includes and makes its recommendation in its status report as
19 submitted to the Commission in an advisory capacity based on the best available
20 science.

21
22 Based on the criteria described above, the scientific information available to the
23 Department does/does not indicate that CLH are threatened with extinction and likely to
24 become an endangered species in the foreseeable future. [The listing recommendation
25 will be provided in this report after the Department receives, evaluates, and incorporates
26 peer-review comments as appropriate.]

27 **PROTECTION AFFORDED BY LISTING**

28
29 It is the policy of the State to conserve, protect, restore and enhance any endangered or
30 any threatened species and its habitat. (Fish & G. Code, § 2052.) If listed as an
31 endangered or threatened species, unauthorized "take" of CLH will be prohibited,
32 making the conservation, protection, and enhancement of the species and its habitat an
33 issue of statewide concern. As noted earlier, CESA defines "take" as hunt, pursue,
34 catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (*Id.*, § 86.) Any
35 person violating the take prohibition would be punishable under State law. The Fish and
36 Game Code provides the Department with related authority to authorize "take" under
37 certain circumstances. (*Id.*, §§ 2081, 2081.1, 2086, 2087 and 2835.) As authorized
38 through an incidental take permit, however, impacts of the taking on CLH caused by the
39 activity must be minimized and fully mitigated according to State standards.

40
41 Additional protection of CLH following listing would also occur with required public
42 agency environmental review under CEQA and its federal counter-part, the National
43 Environmental Policy Act (NEPA). CEQA and NEPA both require affected public
44 agencies to analyze and disclose project-related environmental effects, including
45 potentially significant impacts on endangered, rare, and threatened special status

Comment [TT37]: To summarize:

1) Pretty sound evidence for substantial physical habitat changes to the lake and surrounding stream system. Greatly reduced access to spawning habitat, altered and diminished stream flows reduce ability for fish to successfully spawn or transport larvae back to the lake. This could be more strongly demonstrated by looking at flow records where they are available and plotting the first date of some index flow that would relate to disconnection with the lake. Can an index to lake level be developed as an indicator of connectivity between streams and the lake. I think this evidence would be very valuable in establishing a change in physical habitat.

Also, some basic biology on CLH is needed to identify how long spawners are in the stream before they either return to the lake or die. This info would then be used to quantify run abundance.

2) Also it's clear that shallow water shoreline habitat has been reduced in acreage and quality around the lake, and there are some links to larval rearing and this habitat, but it's not strong as presented. Examination of historic aerial photographs may provide hard evidence of trends in reduction of shoreline habitat. One item that needs explanation is that both of these habitat issues (stream connectivity and shorelines habitats) have been long-occurring issues – so, why are they now becoming critical? The stream connectivity issue is decades old, but has yet to be resolved. The largest single piece of evidence for listing under CESA is the long term decline in the size of the adult spawning runs.

3) There is some evidence that the lake rearing habitat has been altered – through the introduction of predators and competitors – and possible alteration of the food web, but this is difficult to tie down to specifics.

4) It doesn't look like exploitation has necessarily been an issue – the commercial catch data, in fact, shows no downward trend through 2001. Excessive harvest could limit recovery in the future.

5) Contaminants are questionable as there are no smoking guns and no solid evidence that links contaminants to CLH decline.

Mercury is not a recent contaminant to the lake and CLH have persisted, sometimes in abundance, during this exposure.

I think the Status Review does an adequate job of vetting the breadth of potential causes that are active in the lake basin on CLH but it doesn't do as good a job as possible in nailing down specific cause/effect relationships. I recommend looking at flow recession curves on tributaries and seeing if this data provides any evidence for flows/spawning relationships either being less flow, flow of shorter duration (starting later and/or ending sooner). How do these new flows relate to the access issues? Can these two factors be used to develop better linkages to population level effects?

1 species. Under CEQA’s “substantive mandate,” for example, state and local agencies
2 in California must avoid or substantially lessen significant environmental effects of their
3 projects to the extent feasible. With that mandate and the Department’s regulatory
4 jurisdiction generally, the Department expects related CEQA and NEPA review will likely
5 result in increased information regarding the status of CLH in California as a result of,
6 among other things, updated occurrence and abundance information for individual
7 projects. Where significant impacts are identified under CEQA, the Department expects
8 project-specific required avoidance, minimization, and mitigation measures will also
9 benefit the species. State listing, in this respect, and required consultation with the
10 Department during state and local agency environmental review under CEQA, is also
11 expected to benefit the species in terms of related impacts for individual projects that
12 might otherwise occur absent listing.

13
14 If CLH are listed under CESA, it may increase the likelihood that State and federal land
15 and resource management agencies will allocate additional funds towards protection
16 and recovery actions. However, funding for species recovery and management is
17 limited, and there is a growing list of threatened and endangered species.

18 **MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES**

19
20 Current data on CLH suffers from being largely anecdotal and qualitative in nature.
21 Studies designed to provide quantitative data on CLH populations and the factors that
22 affect the ability of CLH to survive and reproduce are necessary for species
23 management. The following management recommendations were generated by
24 Department staff with considerations from local agencies, non-profits, and interested
25 parties.

- 26
27 • Derive a statistically valid population estimate or index allowing assessment of
28 impacts to the overall population and provide a baseline to maintain a
29 sustainable population level.
- 30 • Conduct a thorough assessment of barriers to fish movement on primary
31 spawning streams and provide recommendations for restoration actions on
32 substantial barriers.
- 33 • Complete a detailed analysis of spawning habitat in primary spawning streams
34 and provide recommendations for restoration actions.
- 35 • Implement identified restoration activities to increase available spawning habitat
36 for CLH.
- 37 • Conduct a review of reservoir operations at Highland Springs, Adobe Creek, and
38 Kelsey Creek detention dams to assess water release operations that may be
39 impacting CLH, development and implementation of guidelines for minimizing
40 impacts.
- 41 • Conduct an in stream flow analysis of primary spawning tributaries to determine
42 impacts of water diversions on stream flows, particularly during spawning
43 season.
- 44 • Coordinate with landowners, stakeholders, and permitting agencies on
45 developing strategies for reducing in stream diversions during spawning season.

- 1 • Determine the value of wetland habitat in the watershed pertaining to
2 survivorship of juvenile CLH and make appropriate recommendations on
3 restoration or modification.
4 • Analyze food web interactions of CLH and non-native fish to determine potential
5 impacts to CLH.
6 • Conduct a diet analysis of predatory fish species to determine the extent of their
7 impact on CLH.
8 • Conduct creel surveys to gain a better understanding of CLH capture rates
9 during both recreational and tournament angling.
10 • Develop a comprehensive monitoring program to assess both native and non-
11 native fish populations and their distribution in the watershed.
12 • Identify habitats within the watershed that may be suitable for CLH
13 translocations.
14 • Coordinate the above research and restoration efforts with interested
15 stakeholders in the watershed.
16 • Develop an outreach program to provide updates to stakeholders on recovery
17 and management efforts.

18 **PUBLIC RESPONSE**

19
20 *Note to Reviewer.* Public response will be finalized after the Department receives,
21 evaluates, and incorporates peer-review comments as appropriate.

22 **PEER REVIEW**

23
24 *Note to Reviewer.* Peer review will be finalized after the Department receives,
25 evaluates, and incorporates peer-review comments as appropriate.
26
27

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

LITERATURE CITED

Aguilar, A. and J. Jones. 2009. Nuclear and Mitochondrial Diversification in two Native California Minnows: Insights into Taxonomic Identity and Regional Phylogeography. *Molecular Phylogenetics and Evolution* 51 (2): 373-381.

Anderson, N.L., D.L. Woodward and A.E. Colwell. 1986. Pestiferous dipterans and two recently introduced aquatic species at Clear Lake. *Proceedings of the California Mosquito Vector Control Association*. 54:163-167.

Anderson, N.L., 1989. Letter to Rick Macedo containing notes and data from LCVCD sampling efforts.

Avise, J.C. and F.J. Ayala. 1976. Genetic differentiation in speciose versus depauperate phylads: Evidence from the California minnows. *Evolution* 30:46-58.

Barrett, S.A., 1906. *The Ethno-Geography of the Pomo and Neighboring Indians*. University of California Publications in American Archeology and Ethnology. Vol 6 No. 1.

Bairrington, P., 1999. CDFG Clear Lake Fishery Management Plan.

Bellucci, C. J., Becker, M., & Beauchene, M. (2011). Characteristics of macroinvertebrate and fish communities from 30 least disturbed small streams in Connecticut. *Northeastern Naturalist*, 18(4), 411-444.

1 Big Valley EPA, 2013. Hitch interview notes with families of Big Valley Rancheria and
2 Elem Indian Colony.
3
4 Big Valley Rancheria, 2012. Hitch *Lavinia exilicauda* Chi Hopkirk ecology and water
5 quality studies in Big Valley sub-basin creeks in 2012.
6
7 Big Valley Rancheria, 2013. Big Valley sub-basin creek water quality, quantity, and
8 Hitch *Lavinia exilicauda* Chi Hopkirk ecology program. Spring, 2013.
9
10 Brown, A.V., M.M. Little, and K.B. Brown, 1998. Impacts of gravel mining on gravel bed
11 streams. *Transactions of the American Fisheries Society*. 127:979-994.
12
13 Bunn, S.E., and A.H. Arthington, 2002. Basic Principles and Ecological Consequences
14 of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol.
15 30:4. Pp 492-507.
16
17 California Climate Change Center, 2012. Our Changing Climate 2012 Vulnerability and
18 Adaptation to the Increasing Risks from Climate Change in California.
19
20 California Department of Fish and Game, 1955-1956. Field notes on Kelsey and Seigler
21 Creeks.
22
23 California Department of Fish and Game, 1961-2001. Commercial Catch data for Clear
24 Lake
25
26 California Department of Fish and Game, 1969. News Release on Fish Dieoffs at Clear
27 Lake.
28
29 California Department of Fish and Game, 1988. Clear Lake Electrofishing Survey, April
30 2, 1987 Memorandum.
31
32 California Department of Fish and Game, 2012. Electrofishing data, Memorandum in
33 progress.
34
35 California Department of Fish and Wildlife, 2013. Report to the Fish and Game
36 Commission Evaluation of the Petition from the Center for Biological Diversity to List
37 Clear Lake Hitch (*Lavinia exilicauda chi*) as a Threatened Species under the California
38 Endangered Species Act.
39
40 California Department of Fish and Wildlife, 2013. Commercial Fisheries Data from catch
41 records.
42
43 California Department of Fish and Wildlife, 2013. Commercial Operators permit
44 applications.
45
46 California Department of Fish and Wildlife, April 24, 2013. Press Release – CDFW
47 Seeks Public Comment and Data Regarding Clear Lake Hitch.
48

1 California Department of Water Resources. 1975. Clear Lake Water Quality Data.
2
3 California Natural Resources Agency, 2009. California Climate Adaptation Strategy
4 Discussion Draft.
5
6 California Environmental Protection Agency RWQCBCVR, 2002. Clear Lake TMDL for
7 Mercury Staff Report.
8
9 California Environmental Protection Agency RWQCBCVR, 2008, Monitoring and
10 Implementation Plan Clear Lake Mercury and Nutrient TMDL's.
11
12 California Environmental Protection Agency RWQCBCVR, 2010. Clear Lake Mercury
13 Total Maximum Daily Load Update.
14
15 California Environmental Protection Agency RWQCBCVR, 2012. Clear Lake Nutrient
16 Total Maximum Daily Load Control Program 5-year Update.
17
18 California Regulatory Notice Register, 2012. No. 41-Z. p.1501
19
20 California Regulatory Notice Register, 2013. No. 12-Z. p.488
21
22 Center for Biological Diversity, 2012. Petition to List Clear Lake Hitch (*Lavinia exilicauda*
23 *chi*) as Threatened under the California Endangered Species Act. 58 pp.
24
25 Chi Council for the Clear Lake Hitch (CCCLH). 2013. Hitch spawning survey results,
26 2005-2013. Available at <http://lakelive.info/chicouncil/>
27
28 Clear Lake Integrated Watershed Management Plan, February 2010. Prepared for West
29 Lake and East Lake Resource Conservation Districts.
30
31 Coleman, G.A. 1930. A biological survey of Clear Lake, Lake County. *Calif. Fish and*
32 *Game* 16: 221-227.
33
34 Converse, Y.A., C.P. Hawkins and R. A. VALDEZ, 1998. Habitat Relationships of
35 Subadult Humpback Chub in the Colorado River through Grand Canyon: Spatial
36 Variability and Implications of Flow Regulation. *REGULATED RIVERS: RESEARCH &*
37 *MANAGEMENT* 14: 267-284
38
39 Cook, S. F., Jr., J. D. Connors, and R. L. Moore, 1964. The impact of the fishery on the
40 midges of Clear Lake, Lake County, CA, *Annals of the Entomological Society of*
41 *America*, Vol. 57, pp. 701-707.
42
43 Cott, P. A., Sibley, P. K., Somers, W. M., Lilly, M. R., & Gordon, A. M. (2008). A
44 REVIEW OF WATER LEVEL FLUCTUATIONS ON AQUATIC BIOTA WITH AN
45 EMPHASIS ON FISHES IN ICE-COVERED LAKES1. *Journal of the American Water*
46 *Resources Association*, 44(2), 343-359.
47
48 Cox, B., 2007. CDFG Clear Lake Fishery Surveys Summary Report.

1
2 Curtis T.C. 1977. Pesticide Laboratory report. California Department of Fish and Game,
3 E.P. No. P-133. 3pp.
4
5 Crump, KL and VL Trudeau, 2009. Mercury-induced reproductive impairment in fish.
6 *Environmental Toxicology and Chemistry*. 28(5):895-907.
7
8 Deitch, M.J., G.M. Kondolf, and A.M. Merenlender. 2009. Hydrologic impacts of
9 smallscale instream diversions for frost and heat protection in the California wine
10 country. *River Research and Applications*, Volume 25, Issue 2, pages 118-134.
11
12 Dill, W. A., and A. J. Cordone. 1997. Fish Bulletin 178. History and Status of Introduced
13 Fishes in California 1871-1996. California. Fish and Game. 414 pp.
14
15 Eagles-Smith, C.A., T.H. Suchanek, A.E. Colwell, N.L. Anderson, and P.B. Moyle. 2008.
16 Changes in fish diets and food web mercury bioaccumulation induced by an invasive
17 planktivorous fish. *Ecological Applications* 18(Supplement): A213–A226.
18
19 Ewing, B., 2013. Summary of the Clear Lake Hitch Population Estimate for Cole and
20 Kelsey Creeks, Lake County.
21
22 Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller,
23 1999. *Confronting Climate Change in California: Ecological Impacts on the Golden*
24 *State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of
25 America, Washington, DC.
26
27 Field, C.B., L.D. Mortsch,, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W.
28 Running and M.J. Scott, 2007: North America. *Climate Change 2007: Impacts,*
29 *Adaptation and Vulnerability. Contribution of Working Group II to the Fourth*
30 *Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry,
31 O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge
32 University Press, Cambridge, UK, 617-652.
33
34 Forsgren Associates Inc, 2012. Clear Lake Watershed Sanitary Survey 2012 Update
35 Final.
36
37 | Franson, S. 2013. Summary of Spring 20-13 Field Monitoring with Locations chosen for
38 observing egg and larval development of Clear Lake Hitch (*Lavinia exilicauda chi*).
39
40 Gafny, S., A. Gasith, and M. Goren 2006. Effect of water level fluctuation on shore
41 spawning of *Mirogrex terraesanctae* (Steinitz), (Cyprinidae) in Lake Kinneret,
42 Israel. *Journal of Fish Biology* vol 41:6 pages 863-871
43
44 Geary, R.E. 1978. Life history of the Clear Lake hitch (*Lavinia exilicauda chi*).
45 Unpublished Master's Thesis, University of California, Davis. 27 pp.
46

- 1 Geary, R.E. and P.B. Moyle. 1980. Aspects of the ecology of the hitch, *Lavinia*
2 *exilicauda* (Cyprinidae), a persistent native cyprinid in Clear Lake, California.
3 Southwest. Nat. 25:385-390.
4
- 5 Giusti, G. 2009. Human Influences to Clear Lake, California A 20th Century History.
6
- 7 Harnly, M., S. Seidel, P. Rojas, R. Fornes, P. Flessel, D. Smith, R. Kreutzer, and L.
8 Goldman. 1996. Biological monitoring for mercury within a community with soil and fish
9 contamination. *Environmental Health Perspectives*, Vol. 105:4, 424-429.
10
- 11 Havens, K.E. 2008. Cyanobacterial Harmful Algal Blooms: State of the Science and
12 Research Needs. Chapter 33: Cyanobacteria blooms: effects on aquatic ecosystems.
13 Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser,
14 S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S.
15 Kalkstein, J. Lenihan, C.K. Lurch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004.
16 Emissions pathways, climate change, and impacts on California. Proceedings of the
17 National Academy of Science 101:12422-12427.
18
- 19 Hopkirk, J.D. 1973. Endemism in fishes of the Clear Lake region of central California.
20 University of California Publications in Zoology 96: 160 pp.
21
- 22 Horne, A.J. 1975. The Effects of Copper, Major and Minor Nutrient Element
23 Additions, and Lake Water Movements on Blue-Green Algal Bloom Development in
24 Clear Lake.
25
- 26 Hudon, C., Armellin, A., Gagnon, P., & Patoine, A. (2010). Variations in water
27 temperatures and levels in the St. Lawrence River (quebec, canada) and potential
28 implications for three common fish species. *Hydrobiologia*, 647(1), 145-161.
29
- 30 Hunt, E.G. and A.I. Bischoff. 1960. Inimical effects on wildlife or periodic DDD
31 applications to Clear Lake. California Fish and Game 46:91-106.
32
- 33 Jelks, H L., Stephen J. Walsh, Noel M. Burkhead, Salvador Contreras-Balderas,
34 | Edmundo,
35 Diaz-Pardo, Dean A. Hendrickson, John Lyons, Nicholas E. Mandrak, Frank
36 McCormick, Joseph S. Nelson, Steven P. Platania, Brady A. Porter, Claude B. Renaud,
37 Juan Jacobo Schmitter-Soto, Eric B. Taylor & Melvin L. Warren Jr. (2008): Conservation
38 Status of Imperiled North American Freshwater and Diadromous Fishes, Fisheries,
39 33:8, 372-407.
40
- 41 Jordan, D.S., and C.H. Gilbert. 1894. List of Fishes Inhabiting Clear Lake, California.
42 Bulletin of the United States Fish Commission, Vol. XIV.
43
- 44 Kelsey Creek Watershed Assessment, February 2010. Prepared for East Lake and
45 West Lake Resource Conservation Districts.
46
- 47 Kimsey, J.B. and L.O. Fisk. 1960. Keys to the freshwater and anadromous fishes of
48 California. Calif. Fish Game 46:453-79.

1
2 Kniffen, F.B. 1939. Pomo Geography. University of California Publications in American
3 Archaeology and Ethnology. Vol. 36 No. 6 pp. 353-400.
4
5 Kratville, D. October 7, 2013. Email correspondence on CESA MOU's issued for CLH.
6
7 Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T.
8 Oki, Z. Sen and I.A. Shiklomanov, 2007: Freshwater resources and their management.
9 *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working*
10 *Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate*
11 *Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.
12 Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.
13
14 Lake County Department of Agriculture, 2011. Crop Report
15
16 Lake County Department of Public Works Water Resources Division, 2003. Clear Lake
17 Wetlands Geographic Information Systems Data User Manual.
18
19 Lake County Vector Control District, 2013. Copy of verified Beach Seine 1987-2010 CL
20 Hitch with notes.
21
22 Lindquist, A.W., C.D. Deonier, and J.E. Hanley. 1943. The relationship of fish to the
23 Clear Lake gnat, in Clear Lake, California. Calif. Fish Game 29:196-202.
24
25 Lindquist, A.W. and A.R. Roth. 1950. Effect of dichlorodiphenyl dichloroethane on larva
26 of the Clear Lake gnat in California. *Journal of Economic Entomology* 43:328-332.
27
28 Macclanahan, J., E. W. Danley, H. F. Dewitt, and W. Wolber. 1972[app]. Flood control
29 project maintenance and repair, 1971 inspection report. California Department of Water
30 Resources Bulletin 149-71.
31
32 Macedo, R., 1991. Creel Survey at Clear Lake, California March – June, 1988. CDFG
33 Administrative Report No. 91-3.
34
35 Macedo, R. 1994. Swimming Upstream Without a Hitch. *Outdoor California*:
36 January/February 1994.
37
38 Marchetti, M.P. and P.B. Moyle, 2001. Effects of flow regime on fish assemblages in a
39 regulated California stream. *Ecological Applications*. 11(2). Pp. 530-539.
40
41 McGinnis, D. and E. Ringelberg. 2006. Lake County Fish Barrier Assessment. Technical
42 Memo.
43
44 Middle Creek Watershed Assessment, February 2010. Prepared for West Lake
45 Resource Conservation District.
46

- 1 Miller, R.R. 1945. A new cyprinid fish from Southern Arizona, and Sonora, Mexico, with
2 description of a new subgenus of *Gila* and a review of related species. *Copeia*
3 1945:104-110.
4
- 5 Miller, R.R. 1963. Synonymy, characters and variation of *Gila crassicauda*, a rare
6 California minnow, with an account of its hybridization with *Lavinia exilicauda*. *California*
7 *Fish and Game* 49 (1): 20-29.
8
- 9 Mioni, C., R. Kudela, and D. Baxter. 2011. Harmful cyanobacteria blooms and their
10 toxins in Clear Lake and the Sacramento-San Joaquin delta (California). Central Valley
11 Regional Water Quality Control Board: 10-058-150.
12
- 13 Moyle, P.B. and M. Massingill. 1981. Hybridization between hitch, *Lavinia exilicauda*,
14 and Sacramento blackfish, *Orthodon microlepidotus*, in San Luis Reservoir, California.
15 *California Fish Game* 67:196-198.
16
- 17 Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. *Fish*
18 *Species of Special Concern in California*, 2nd edition.
19
- 20 Moyle, P.B. and T. Light, 1996. Fish Invasions in California: Do Abiotic Factors
21 Determine Success? *Ecology* 77:1666-1670.
22
- 23 Moyle, P. B. 2002. *Inland Fishes of California*. Berkeley: University of California Press.
24
- 25 Moyle, PB., JD Kiernam, PK Crain and RM Quinones, 2012. Projected Effects of Future
26 Climates on Freshwater Fishes of California. A White Paper from the California Energy
27 Commission's California Climate Change Center.
28
- 29 Moyle P.B., J.V Katz, and R.M. Quinones. In review. *Fish Species of Special Concern*
30 *for California*. Prepared for California Department of Fish and Game, Sacramento
31
- 32 Murphy, G.I. 1948. Notes on the biology of the Sacramento hitch (*Lavinia e. exilicauda*)
33 of Clear Lake, Lake County, California. *Calif. Fish Game* 34:101-110.
34
- 35 Murphy, G.I. 1951. The fishery of Clear Lake, Lake County, California. *Calif. Fish and*
36 *Game* 37: 439-484.
37
- 38 National Oceanic and Atmospheric Administration, 2011. Table 2. Toxicity associated
39 with mercury in tissues (ug/g) wet weight.
40
- 41 Nicola, S.J. 1974. The life history of the hitch, *Lavinia exilicauda* Baird and Girard, in
42 Beardsley Reservoir, California. *Inland Fish. Admin. Rep.* 74-6:1-16.
43
- 44 Osleger, D.A., R.A. Zierenberg, T.H. Suchanek, J.S. Stoner, S. Morgan, and D.P.
45 Adam. 2008. Clear Lake sediments: anthropogenic changes in physical sedimentology
46 and magnetic response. *Ecological Applications* 18 (Supplement): A239-A256.
47
- 48 Puckett, L., 1972. CDFG Memorandum-Fisheries Survey Clear Lake, Lake County.

1
2 Richerson P.J., T.H. Suchanek, and S.J. Why. 1994. The Causes and Control of Algal
3 Blooms in Clear Lake, Clean Lakes Diagnostic/Feasibility Study for Clear Lake,
4 California. Prepared for USEPA Region IX.
5
6 Ridout, W.L. 1899. A Fish Jam on Kelsey Creek. *Overland Monthly and Out West*
7 *Magazine*. Volume 34, Issue 202. p. 333.
8
9 Robinson Rancheria Environmental Center (RREC). 2011. Draft Adaptive Management
10 Plan for the Clear Lake Hitch, *Lavinia exilicauda chi*. Available
11 at <http://www.robinsonrancheria.org/environmental/water.htm>.
12
13 Rowan, J., 2008. CDFG Clear Lake, Lake County Memorandum.
14
15 Rudd, R.L. 1964. *Pesticides and the Living Landscape*. University of Wisconsin Press,
16 Madison, WI.
17
18 Sandheinrich, MB. And KM Miller, 2006. Effects of dietary methylmercury on
19 reproductive behavior of fathead minnows (*Pimephales promelas*). *Environmental*
20 *Toxicology and Chemistry*. 25(11):3053-3057.
21
22 Scotts Creek Watershed Assessment, February 2010. Prepared for West Lake
23 Conservation District.
24
25 Scotts Valley Band of Pomo Indians, 2013. Historical accounts provided to CDFW by
26 Steve Elliott and Wanda Quitiquit.
27
28 State of California Fish and Game Commission, March 11, 2013. California Fish and
29 Game Commission Notice of Findings
30
31 State of California Fish and Game Commission, October 2, 2012. California Fish and
32 Game Commission Notice of Receipt of Petition
33
34 Suchanek, T.H., P.J. Richerson, L.A. Woodward, D.G. Slotton, L.J. Holts and C.E.
35 Woodmansee. 1993. Ecological Assessment of the Sulphur Bank Mercury Mine
36 Superfund Site, Clear Lake, California: A Survey and Evaluation of Mercury In:
37 Sediment, Water, Plankton, Periphyton, Benthic Invertebrates and Fishes Within the
38 Aquatic Ecosystem of Clear Lake, California. Phase 1- Preliminary Lake Study Report.
39 Prepared for EPA-Region IX, Superfund Program. 113 pp., plus 2 attachments.
40
41 Suchanek, T.H., P.J. Richerson, D.C. Nelson, C.A. Eagles-Smith, D.W. Anderson, J.J.
42 Cech, Jr., G. Schladow, R. Zierenberg, J.F. Mount, S.C. McHatton, D.G. Slotton, L.B.
43 Webber, A.L. Bern and B.J. Swisher. 2002. Evaluating and managing a multiply-
44 stressed ecosystem at Clear Lake, California: A holistic ecosystem approach.
45 "Managing For Healthy Ecosystems: Case Studies," CRC/Lewis Press. pp. 1233-1265.
46
47 Swift, C. 1965. Early development of the hitch, *Lavinia exilicauda*, of Clear Lake,
48 California. Calif. Fish Game 51:74-80.

1
2 Thompson, L.C., G.A. Giusti, K.L. Weber, and R.F. Keiffer. 2013. The native and
3 introduced fishes of Clear Lake: a review of the past to assist with decisions of the
4 future. California Fish and Game 99(1):7-41.
5
6 U.S. Army Corps of Engineers. 1974[app]. Flood plain information: Big Valley streams
7 (Manning, Adobe, Kelsey, and Cole Creeks), Kelseyville, California. Department of
8 the Army, Sacramento District, Corps of Engineers, Sacramento, California, USA.
9
10 U.S. Environmental Protection Agency, 2012. Sulphur Bank Mercury Mine News
11 Release – EPA to Begin Construction of Test Covers in Clear Lake.
12
13 Week, L., 1982. Habitat Selectivity of Littoral Zone Fishes at Clear Lake, CDFG
14 California. Administrative Report No. 82-7.
15
16 Wetzel, R.G., 2001. Limnology lake and River Ecosystems, 3rd ed. Pg. 834.
17
18 Winder, M., J. Reuter and G. Schladow, 2010. Clear Lake Report: Clear Lake Historical
19 Data Analysis.
20
21
22
23

24 **Appendix A.** Summary graphs of spawning observations between 2005 and 2013
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

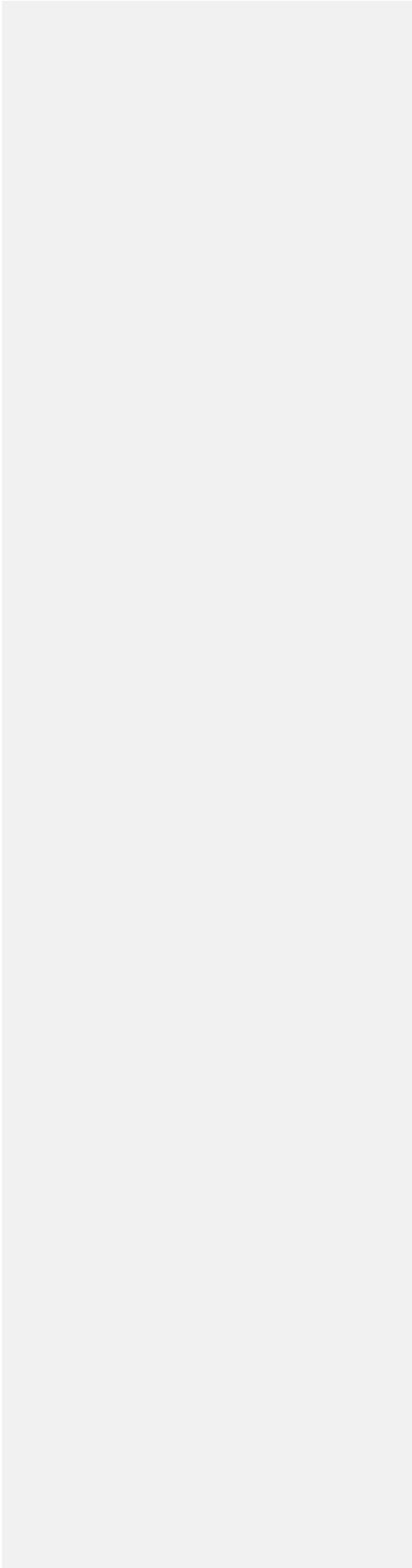
Appendix B. Figures depicting CLH observations on spawning tributaries

DRAFT

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

Appendix C. Description of barriers associated with CLH spawning tributaries

DRAFT



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

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

Adobe Creek: There is a flood control dam on Adobe Creek above Bell Hill Road that is impassable to CLH. There are two culverts on Adobe Creek that are mitigation barriers to spawning CLH when the water flows and velocity are not too great, but these culverts block CLH migration.

Alley Creek: Alley Creek has been channeled and diverted into Clover Creek. Alley Creek historically supported CLH runs. During some time and under certain conditions migrating CLH can access Alley Creek via the Clover channel bypass, but not when the diversion has silt or sand obstructing it.

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, CLH 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 usually becomes a complete barrier when filled with gravel and sediment.

Forbes Creek: Forbes Creek has a concrete storm water diversion structure that impedes and at times blocks CLH passage.

1 Kelsey Creek: On Kelsey Creek, the main barriers to CLH migration are a detention
2 dam 2 to 3 miles upstream of Clear Lake, and the Main Street Bridge in Kelseyville. The
3 rock and concrete weir constructed at the base of the Main Street Bridge is a barrier to
4 the passage of CLH (Peter Windrem, personnel communication, 2012). The structure
5 has a fish ladder which is nonfunctional and the site is nonetheless a total barrier to
6 CLH (McGinnis and Ringelberg, 2008). The Kelsey Creek detention structure below
7 Dorn Crossing has retractable gates which can be opened during the CLH spawning
8 season. However, altered flow patterns and slight increases in the slope of the
9 streambed have been enough to reduce the number of spawning CLH that can pass
10 through the detention structure and move upstream. Also, rock riprap situated below the
11 retention dam seems to have impeded the upstream migration of CLH and needs to be
12 modified to provide a clear channel for fish transit. A number of drop-structures in
13 Kelsey Creek intended for gravel aggradation impede migration. Some of these do not
14 seem to impede CLH passage under current conditions, but CLH navigate them with
15 difficulty especially on the downstream passage. Further upstream, culverts that once
16 tended to clog with debris and block fish migration at the Merritt Road crossing have
17 been removed and replaced by a bridge that poses no impediment to CLH passage.
18

19 Lyons Creek: A high culvert on Lyons Creek at Lakeshore Drive prevents CLH from
20 moving upstream. Lyons Creek also has a concrete barrier at the County's Juvenile Hall
21 facility that completely prevents fish passage.
22

23 Manning Creek: A dam upstream of known CLH spawning areas in the lower reaches
24 of Manning Creek may prevent CLH from spawning further upstream.
25

26 Middle Creek: On Middle Creek, a rock and concrete weir at the Rancheria Road
27 Bridge has been a total fish passage barrier for CLH. Remedial work has been done
28 downstream, with more weirs installed in an effort to elevate the gradient so that CLH
29 could surmount the barrier and work was done to improve their stability after high flows,
30 but it remains to be seen if this will allow CLH passage. Similar weirs to capture and
31 hold gravel were installed many years ago in Adobe Creek and Kelsey Creek that do
32 not impede CLH passage, but there is concern the installed weirs on Middle Creek may
33 be potential barriers to CLH. A downstream weir at Rancheria Road is a partial barrier
34 and improperly sized rip rap at this location acts as partial migration barrier (McGinnis
35 and Ringelberg 2008). CLH were seen recently at Middle Creek Bridge and Highway 20
36 and although there are no obvious barriers, they did not appear to be able to navigate
37 the swift currents there due to the lack of resting pools. If CLH could surmount
38 Rancheria Bridge, many additional miles of spawning grounds would be accessible to
39 CLH up to areas south of Hunter Bridge, where habitat suitability ends because the
40 channel is braided and shallow due to gravel mining.
41

42 Scotts Creek: On Scotts Creek, a rock and concrete weir at the Decker Bridge is a total
43 barrier to the passage of CLH. As water levels have been lower, a barrier at the lower
44 end of Tule Lake is problematic for fish passage to Tule Lake and its tributary
45 Mendenhall Creek, Scotts Creek and tributaries, Bachelor Valley/Witter Springs area
46 tributaries, and Blue Lakes and tributaries. There is a one-way flow gate on the Blue
47 Lakes outlet at Scotts Creek that prevents CLH from entering Blue Lakes.
48

- 1 Seigler Canyon Creek: There are two barriers to CLH migration into Seigler Canyon
- 2 Creek, an exposed sewer pipe and a road crossing. The sewer pipeline which crosses
- 3 Seigler Canyon Creek for Anderson Marsh State Park was modified in the 1990s and
- 4 completely blocks CLH access to that creek, once a major spawning tributary.

DRAFT

Page	Line	Reviewer Comment	Department Response
7	37	or in streams tributary to the Lake?	Accepted- The Department has not found any evidence of hybrids in tributaries.
7	44	Not shown in Fig 1.	Accepted- Figure 1 has been corrected.
8	Figure 1	The map shows stream systems tributary to Clear Lake and does not include the entire watershed. Note that the Cache Creek outflow channel from Clear Lake is not labeled as such.	Accepted- Figure 1 has been corrected.
9	41-43	I've observed spawning mid channel too – and some of these eggs will “eddy out” in the margins. Also note that large volumes of eggs may deplete stream margin areas of oxygen resulting in the mortality of large numbers of eggs	Accepted- Spawning mid-channel has been added to document.
10	3-4	I would restate saying that larvae must move downstream to the lake before the stream flow disconnects with the lake (the stream may still be flowing at upstream locations).	Accepted
10	25-27	This is a strong statement of a cause-effect given it is an unreferenced P-C.	Accepted- Statement was removed based on multiple peer review comments.
10	28-35	Not all tribs are of equal value to spawning. Some of the small channels will only flow during wet years (many of the short tribs on the east side) while others offer some spawning habitat nearly every year (these used to be Seigler, Kelsey, and Middle Cks)	Accepted- Clarification on spawning tributaries added to paragraph.
11	29-30	Has rainfall been linked to streamflows that sustain CLH reproductive success? Are there other data to use besides rainfall (streamflow, lake level, number of passage flow days in representative creeks for adults migrating out of the lake and for larvae moving downstream)? The Status Review is lacking in analysis of hydrology.	Accepted- Information on lake levels and stream flows has been added to the document.
11	37-38	This is conclusion jumping – Consider the factors at work here 1) there's the qualitative nature of the data, 2) some of the CLH data may not be linked to rainfall (juvenile or adult abundance may be lagged one or more years, or 3) there could be compensatory survival in years of high reproductive success, only so many larvae will survive to juvenile or adult life stages.	Accepted- Rainfall information was removed and additional information on stream flows and lake levels was added.
12	Figure 2	These data are all discrete and should be graphed with bars, not lines. I suggest not combining with rainfall it's too confusing in one graph. I question if total rainfall is a good measure for cause-effect. As an example, in 1997, all the rainfall came in January, so spawning conditions later were not that good. Are there other factors to examine in more detail such as lake level during the spawning period? Streamflow volume and persistence are other factors to examine in the individual streams or in index streams. Also juvenile and adult fish should be lagged by an appropriate time step if you're looking at linkages between good spawning conditions relating to strong cohort years.	Accepted- Figure revised
12	Figure 2	Can you include other notable events, such as construction of the detention dam on Kelsey Creek, or other such known features?	No Change- Figure would be too difficult to understand with more information in it. Data will be analyzed to see if additional figures are necessary.
13	8-9	suggested edit "Of those fish, 300 to 400 CLH were found below the Kelsey Creek detention dam."	Accepted
13	12-13	As is wording implies the fish are only in the stream for a day, which is not the case. Suggest edit "CLH counts of 1,000 to 5,000 fish"	Accepted
14	6-8	Do TFS and Inland Silversides populations show similar patterns in abundance to CLH? These are not stream spawners, so would reflect more lake conditions for larval/juv rearing, vs. conditions for spawning. Has this been examined?	Accepted- Information has been added on Mississippi silverside, threadfin shad, and CLH abundance.
14	23-24	It is of interest that these high abundance years were drought years (1987-1992) in California	Noted.
15	5-11	Do we have metadata on seining dates, locations or methods that may influence the catch of CLH?	Noted- The dataset is being evaluated for further use. Information on times, locations, sample methods, etc. was not consistently provided over the duration of harvest.
16	23-26	I don't mean to sound critical, but when we're trying to assess the status of a population, not sampling it is not a sound approach. ++	Noted- The sample design was for general fish surveys not CLH surveys.
18	27-30	All these factors don't have strong links to CLH decline. What are the physical functional links to each one?	Rejected- All of these factors are discussed in the Factors Affecting the Ability to Survive and Reproduce section as impacting CLH.
18	37-38	flood control, highway construction, groundwater use and vegetation.	Accepted- Paragraph reworded
18	38-40	suggested edit "Stream alterations can block migratory routes and impeded passage necessary for adults to reach spawning areas and for larval fish to gain access to the lake."	Accepted- Paragraph reworded

18	41	suggested edit "The result can be direct loss of spawning and rearing habitat, loss of nursery areas or loss of access to these areas,"	Accepted- Paragraph reworded
18	42	How is this linked in the tributary streams?	Accepted- Wording removed.
18	43-45	How does a physical habitat survey end up with an IBI score? This would be a biological survey.	Accepted- Sentence reworded
19	8	A reduction in habitat or a reduction in access to habitat – or both? This distinction is critical to the analysis. Define habitat barriers vs. physical barriers. The Kelsey Creek fish ladder was known not to pass hitch in the	Accepted- Sentence reworded
19	11-17	1970s – or is this a different ladder than what was present then?	Accepted- Sentence reworded, it is the same ladder with minor modifications.
19	22-24	suggested edit "they continue to prevent migrating CLH from accessing spawning habitat,"	Accepted
19	31-34	The channels shown on Figure 7 include segments of many creeks that would not have been used by CLH because they are either too far from the lake or are not low gradient streams. What criteria were used to screen for potential access? suggested edit "the Department estimated 180 stream miles were historically available to spawning CLH and that barriers have eliminated or reduced access to more than 92% of the historically available spawning	Noted- The analysis was conducted based on the Departments best knowledge of what could have been historically occupied by CLH. As recommended later by the Department a complete habitat analysis of tributaries needs to be conducted.
19	32-34	habitat .	Accepted
21	5	suggested edit "wells that capture underflow from adjacent channels." This is a key piece of information that should be used to structure an analysis around flow persistence in the tributaries. It is buried here and should be brought forward as a key concern earlier in the document and revisited here.	Accepted
21	19-25		No Change- The previous paragraph describes impacts to CLH and concludes with a comparison to Clear Lake splittail.
21	34	suggested edit "has altered the amount, quality, and distribution of stream gravels"	No Change- The Department has no documentation for the quality of stream gravels.
21	42-43	How much is in-stream mining?	Accepted- Additional information added.
22	4-6	Levees can also result in downcutting by increasing stage and shear stress on the bed during floods.	Noted.
22	7	This section is large and discusses many attributes related to WQ. I suggest some subheadings as appropriate.	Accepted.
22	20-21	suggested edit "Increased sediment loads also reduce spawning habitat quality by increasing substrate “embeddedness” (Mosley 2013).	Accepted.
23	1-7	Some parallels with the Delta on food web dynamics here?	Noted.
25	20-21	suggested edit "Commercial fish harvest at Clear Lake occurred from the early 1900s through 2001."	Accepted
26	29	I found no hardhead in the stream surveys conducted in the basin in 1975-76.	Accepted- Hardhead removed based on peer review comments
26	35-38	But what’s happened to the black bass population over the past 10 years – are their more, large bass compared to pre-2000?	Noted- The black bass population at Clear Lake goes through cycles of many smaller fish to fewer larger fish on regular cycles.
27	4-8	Could this be done for this report?	Noted- Data on Mississippi silverside and threadfin shad numbers was not provided to the Department.
27	9-10	This statement needs a reference.	Accepted- Sentence reworded to remove definitive nature of statement.
27	11-14	Are we looking at a species similar to splittail in the Central Valley, where it goes along at low levels in many years, then has a good spawn and really booms for several years, before returning to background numbers? This is the key question – is it a boom and bust fish or something different.	Noted- Although historical data does not support a boom and bust lifestyle for CLH it appears based on recent trends that they have become that way based on impacts to survival.
32-33	46-5	Linkages to cause/effect are unclear. Increased groundwater elevations would only help to maintain surface flows if they were located at sites where flows are limiting access. Seems that a different approach to management of the lake level would do the same thing.	Noted- Lake levels are a function of deliveries downstream of the outlet dam. Wetland restoration would be a permanent action that would result in long term benefits.
35	14	Let’s be clear on what we’re calling this habitat – Is this inundated shallow water with emergent vegetation? Does it meet the definition of a wetland for regulatory purposes or is it permanently inundated shallow water habitat?	Accepted- Wetlands are described at first mention in the wetlands section.

35	32-36	<p>I think this is a weak summary statement. The document refers to OHV use in the Middle Creek and Scotts Creek watersheds as a source of sediment yet discounts what could be more watershed wide impacts while focusing on the relatively inconsequential bycatch from sport anglers. I don't think too many hitch will take a bass lure.</p>	No Change- Sedimentation is covered in the water quality section even for those activities that are human related.
36	24-26	<p>1) Pretty sound evidence for substantial physical habitat changes to the lake and surrounding stream system. Greatly reduced access to spawning habitat, altered and diminished stream flows reduce ability for fish to successfully spawn or transport larvae back to the lake This could be more strongly demonstrated by looking a flow records where they are available and plotting the first date of some index flow that would relate to disconnection with the lake. Can an index to lake level be developed as an indicator of connectivity between streams and the lake. I think this evidence would be very valuable in establishing a change in physical habitat. Also, some basic biology on CLH is needed to identify how long spawners are in the stream before they either return to the lake or die. This info would then be used to quantify run abundance.</p>	Noted.
36	24-26	<p>2) Also it's clear that shallow water shoreline habitat has been reduced in acreage and quality around the lake, and there are some links to larval rearing and this habitat, but it's not strong as presented. Examination of historic aerial photographs may provide hard evidence of trends in reduction of shoreline habitat. One item that needs explanation is that both of these habitat issues (stream connectivity and shorelines habitats) have been long-occurring issues – so, why are they now becoming critical? The stream connectivity issue is decades old, but has yet to be resolved. The largest single piece of evidence for listing under CESA is the long term decline in the size of the adult spawning runs.</p>	Noted.
36	24-26	<p>3) There is some evidence that the lake rearing habitat has been altered – through the introduction of predators and competitors – and possible alteration of the food web, but this is difficult to tie down to specifics.</p>	Noted.
36	24-26	<p>4) It doesn't look like exploitation has necessarily been an issue – the commercial catch data, in fact, shows no downward trend through 2001. Excessive harvest could limit recovery in the future.</p>	Noted.
36	24-26	<p>5) Contaminants are questionable as there are no smoking guns and no solid evidence that links contaminants to CLH decline. Mercury is not a recent contaminant to the lake and CLH have persisted, sometimes in abundance, during this exposure.</p>	Noted.
36	24-26	<p>I think the Status Review does an adequate job of vetting the breadth of potential causes that are active in the lake basin on CLH but it doesn't do as good a job as possible in nailing down specific cause/effect relationships. I recommend looking at flow recession curves on tributaries and seeing if this data provides any evidence for flows/spawning relationships either being less flow, flow of shorter duration (starting later and/or ending sooner). How do these new flows relate to the access issues? Can these two factors be used to develop better linkages to population level effects?</p>	Noted.