

California Department of Fish and Wildlife  
North Central Region  
Sierra District

Summary of the 2021 Clear Lake Hitch Survey  
on Clear Lake

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## Summary

In an effort to evaluate the Clear Lake Hitch (*Lavinia exilicauda chi*) (HCH-C) fishery in Clear Lake, we conducted a Schnabel and Schumacher-Eschmeyer mark-recapture survey from March 16, 2021 through May 19, 2021. We collected a total of 348 HCH-C this season, compared to 184 in 2019 and 431 in 2020 (Ewing 2019, 2020). A record drought from 2012–2016, combined with below average rainfall in 2020 and 2021 (California Department of Water Resources 2021), may be reasons for the low number of HCH-C we collected in 2021. With Clear Lake experiencing low lake level conditions during the 2021 survey, it is likely that many HCH-C were not accessible to sample. Much of the shoreline we had historically sampled was too shallow to get our electrofishing boat in to access. It is unknown how many HCH-C may have been collected if we were able to sample the entire shoreline of our transects. We will use the data from this survey, in conjunction with the 2022–2023 data, to monitor the status of this fishery. Also, we will incorporate data collected from previous surveys to the overall study to help manage the fishery.

## Introduction

The objectives of this survey were to:

- Determine the number of HCH-C spawning in Holiday Harbor, Konocti Casino Harbor, Clear Lake State Park, and Soda Bay
- Determine the average size of HCH-C spawning in Clear Lake
- Collect population data with which to compare past and future survey efforts

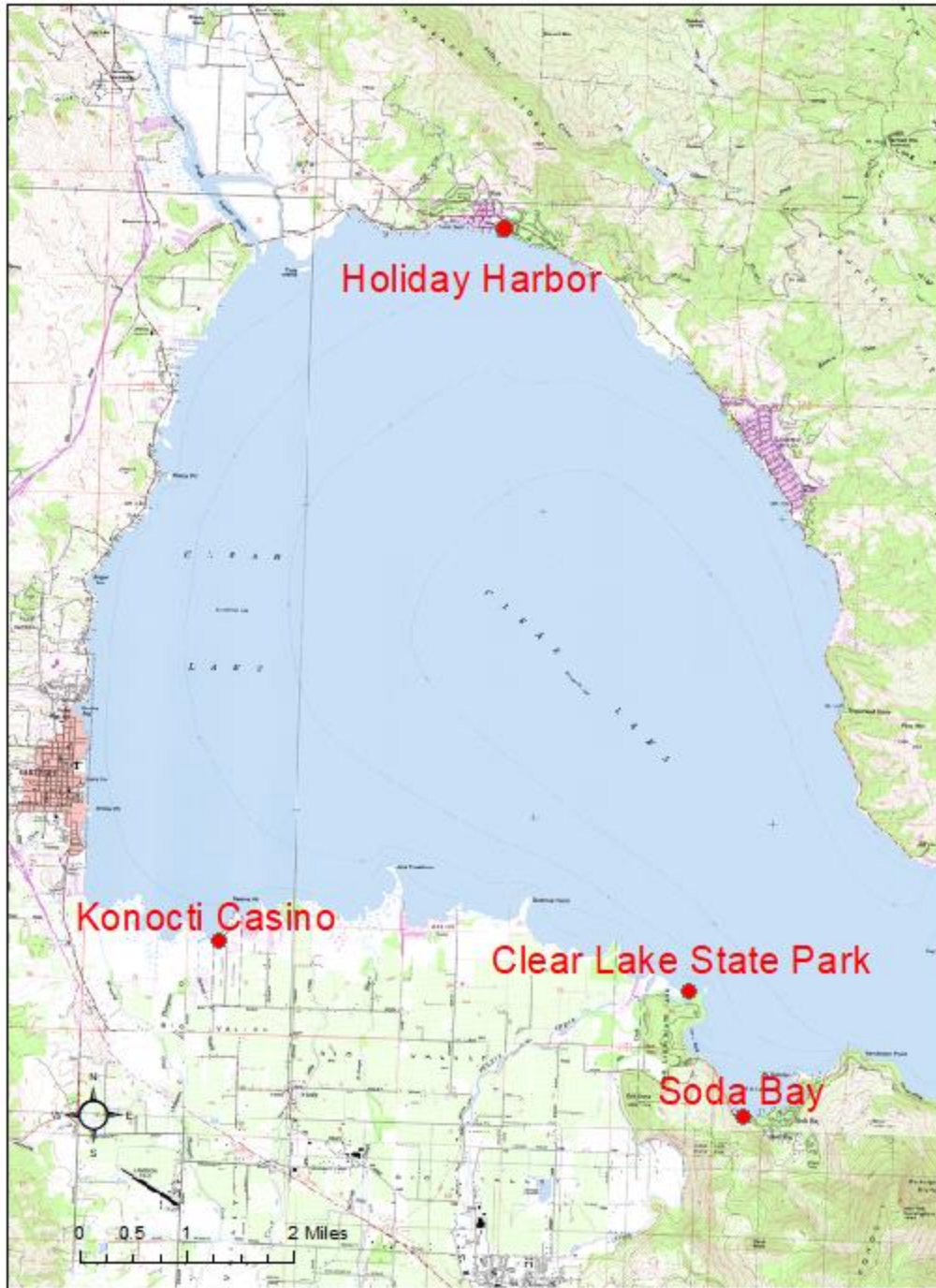
In September of 2012, The Center for Biological Diversity submitted a petition to the California Department of Fish and Wildlife (CDFW) to list the HCH-C as threatened under the California Endangered Species Act (CESA) (Fish and Game Code, 2050). In August 2014, the California Fish and Game Commission voted to list the HCH-C as threatened under CESA.

In 2013, CDFW conducted a survey in two tributaries to Clear Lake, Cole and Kelsey Creeks, to estimate the abundance and distribution of HCH-C (Ewing 2013). This estimate was done to assist in the status review process under CESA. From 2014–

2017, CDFW conducted surveys in Adobe and Kelsey Creeks to estimate the abundance and distribution of HCH-C (Ewing 2014, 2015, 2016, 2018). CDFW is currently gathering information on the HCH-C to allow for informed decisions on future fisheries management at Clear Lake.

This report aims to present a more accurate estimate of population size with 95% confidence intervals, mean length, catch per unit effort (CPUE), population estimate, and numbers of HCH-C seen for the survey period. The estimate of population size with accompanying confidence intervals was based on multiple mark and recapture survey efforts.

Holiday Harbor, Konocti Casino, Soda Bay, and Clear Lake State Park are four historically HCH-C spawning areas in Clear Lake (**Figure 1**).



**Figure 1.** Locations of Holiday Harbor, Konocti Casino, Clear Lake State Park, and Soda Bay boat electrofishing transects, all of which we sampled in Spring, 2021.

## Methods and Materials

In estimating the population of HCH-C in these historic spawning areas, CDFW considered the populations to be “closed” with the Schnabel Method (SM) and Schumacher-Eschmeyer Method (SEM) to be used as the statistical analysis. These two methods were used to further solidify CDFW’s confidence in the population estimate. According to Krebs (1999) and Seber (1982), the following assumptions must be met for the estimates to be reliable:

- (a) The population is closed, so that  $N$  (the population) is constant
- (b) All animals have the same probability of being caught in the first sample
- (c) Marking does not affect the catchability of an animal.
- (d) The second sample is a simple random sample, i.e. each of the possible samples has an equal chance of being chosen.
- (e) Animals do not lose their marks in the time between the two samples.
- (f) All marks are reported on recovery in the second sample.

We conducted 10 sampling efforts to mark and recapture HCH-C on Clear Lake. We only calculated population estimates for HCH-C collected in Holiday Harbor, Konocti Casino Harbor, Clear Lake State Park, and Soda Bay.

Each electrofishing sampling effort took one to two days, using one boat. We conducted electrofishing using an 18-foot Smith-Root SR electrofishing boat. We used pulsed DC current (2-6 amps) to “stun” the fish. Due to COVID–19 restrictions in 2021, the crew consisted of only two forward netters and one boat operator. We navigated the boat in a continuous line parallel to shore. We netted HCH-C under galvanotaxis and placed the fish in a holding tank to recover. We made efforts to capture all shocked HCH-C; however, sometimes HCH-C eluded capture on the outer edge of the electrical field.

The start and stop times for time spent electrofishing were recorded. Water temperatures were also recorded at each effort. We measured the first 100 HCH-C collected, regardless of the site where they were collected, in total length (inches, in.) (**Figure 2**). We marked all HCH-C that were 5.0 in. (127 mm) and greater in total length with a single hole punch on the upper caudal fin, using a handheld hole puncher. We marked HCH-C less than 5.0 in. total length with a small caudal fin clip. We used the

latter marking technique on smaller fish to minimize harm during this delicate life stage. We used hole punch and fin clip markings techniques because they are temporary marks that would remain identifiable throughout the three-month survey. After the field portion of the surveys, we later calculated the mean total length, CPUE, relative population estimate, and numbers of HCH-C collected.



**Figure 2.** Juvenile HCH-C being measured (S. Newton, 3/13/14).

## Results

### Holiday Harbor

In 2021, we collected 18 HCH-C from Holiday Harbor compared to 97 in 2020 (Ewing 2020) and two in 2019 (Ewing 2019). We marked 17 HCH-C with a single hole punch and we did not collect any hole punch recaptures. We marked one HCH-C with a fin clip and we did not collect any fin clip recaptures. Of the 10 sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2021, average total length for HCH-C we collected in Holiday Harbor was 12.3 in., compared to 8.2 in. in 2020 and 9.6 in. in 2019. In 2021, CPUE was 0.13 fish per minute compared to 1.47 in 2020 and 0.03 fish per minute in 2019.

### Konocti Casino Harbor

In 2021, we collected 218 HCH-C and a portion measured in Konocti Casino

Harbor compared to 199 in 2020 (Ewing 2020) and 27 in 2019 (Ewing 2019). We marked 214 HCH-C with a single hole punch and we collected two, hole punch recaptures. We marked two HCH-C with a fin clip and we did not collect any fin clip recaptures. Of the 10 sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2021, average total length for HCH-C we collected in Konocti Casino Harbor was 12.8 in., compared to 9.9 in. in 2020 and 11.2 in. in 2019. In 2021, CPUE was 0.73 fish per minute compared to 1.11 fish per minute in 2020 and 0.13 fish per minute in 2019.

### **Clear Lake State Park**

In 2021, we collected 112 HCH-C in Clear Lake State Park, compared to 34 in 2020 (Ewing 2020) and 155 in 2019 (Ewing 2019). All HCH-C we collected were marked with a single hole punch and we did not collect any hole punch recaptures. Of the 10 sampling efforts, we did not document any initial mortalities. In 2021, CPUE was 0.28 fish per minute compared to 0.09 in 2020 and 0.23 fish per minute in 2019.

### **Soda Bay**

In 2021, we did not collect any HCH-C in Soda Bay compared to 171 in 2020 (Ewing 2020) and zero in 2019 (Ewing 2019). Unlike the other three sites we sampled in 2021, where we sampled each site 10 times, we only sampled Soda Bay eight times. Due to high angler usage during two of the sampling dates, we chose not to sample Soda Bay to respect the angler's space.

Overall, we collected 348 HCH-C in 2021 (**Table 1**) compared to 431 in 2020 and 184 in 2019. In 2021, average total length of HCH-C was 12.7 in compared to 8.5 in. in 2020 and 12.2 in. in 2019.

**Table 1.** Mark-recapture sample data for 2021. Ct = Total number of individuals caught in sample t. Rt = Number of individuals already marked when caught in sample t. Ut = Total number of individuals caught and marked for first time in sample t. Mt = Total number of individuals marked in the population at sample t.

| Date               | Ct  | Rt | Ut  | Mt  |
|--------------------|-----|----|-----|-----|
| 3/16 and 3/17/2021 | 1   |    | 1   |     |
| 3/24 and 3/25/2021 | 6   | 0  | 6   | 1   |
| 3/31/2021          | 89  | 0  | 89  | 7   |
| 4/7/2021           | 48  | 0  | 48  | 96  |
| 4/14/2021          | 55  | 0  | 55  | 144 |
| 4/21/2021          | 71  | 0  | 71  | 199 |
| 4/29/2021          | 58  | 0  | 58  | 270 |
| 5/5/2021           | 16  | 1  | 15  | 328 |
| 5/12/2021          | 3   | 1  | 2   | 343 |
| 5/19/2021          | 1   | 0  | 1   | 345 |
| Total              | 348 | 2  | 346 |     |

The SM resulted in a HCH-C population estimate for the four sampled sites of 24,784 (95% C.I. 7,414 -139,628). The 2021 SM estimate doubled the SM estimate from 2020 (n = 12,770). The SEM resulted in a lower estimate of 16,126 (95% C.I. 4,773 and NA). The 2021 SEM estimate was also an increase from the 2020 SEM estimate of 15,195. However, due to the combination of low recaptures, number of total marked HCH-C, and low number of surveys, an inaccurate upper confidence value was obtained for the SEM, which resulted in an error in the upper 95% confidence interval estimate (i.e. NA, Not Applicable).

## Discussion

CDFW was able to calculate a relative population for HCH-C in 2021 and 2020. However, we could not derive a comparison to results from 2019 because we did not detect any HCH-C in 2019. The number of HCH-C we collected in 2021 was below the number collected in 2020 and still below what we had anticipated collecting.

Due to the below average rainfall totals for Clear Lake and the low lake elevation,



many HCH-C may have tried to spawn in other areas of Clear Lake with more deep-water refuge. A large percentage of the shoreline transects that we sampled in 2020 and earlier were dry and not accessible by the electrofisher in 2021. This may have been one of the reasons why more HCH-C were collected in 2020 than 2021. Historically these four sampling locations have held thousands of HCH-C, thus the reason they were chosen for sampling. It is possible the record drought that California experienced from 2012–2016 as well as the dry 2020–2021 season may have negatively impacted the HCH-C spawning. Many of the tributaries that would have normally held suitable water during the spawning season, were unsuitable or dry during the low-water years. The negative side-effects of the 2012–2016 drought and the 2020–2021 year now may be showing the impacts it had on the HCH-C. The decrease of juvenile HCH-C collected in 2021 compared to 2020 may also suggest that one year's cohort was absent (Moyle 2002).

Regardless of the low HCH-C numbers collected, CDFW was able to gather an estimate for a second consecutive year and this information will be used for comparison to future years.

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