**California Department of Fish and Wildlife**

**North Central Region**

**Sierra District**

# Summary of the 2024 Clear Lake Hitch Survey on Clear Lake

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(T.Woodruff, Spring, 2024)

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## Summary

To evaluate the Clear Lake Hitch (*Lavinia exilicauda chi*) (HCH-C) fishery in Clear Lake, the California Department of Fish and Wildlife (CDFW) conducted a Schnabel and Schumacher-Eschmeyer mark-recapture survey from March 11, 2024 through May 15, 2024. We collected a total of 969 HCH-C in 2024, compared to 1000 HCH-C in 2023, 357 in 2022, 348 in 2021, 431 in 2020, and 184 in 2019 (Ewing 2019, 2020, 2021, 2023a, 2023b). An average rainfall in the winter of 2024 (California Department of Water Resources 2024) combined with the high lake level, may explain the high numbers of HCH-C observed by CDFW in 2024 compared to numbers observed from 2019–2022 and relative numbers historically seen. With Clear Lake experiencing full lake level conditions during the 2024 surveys, it is likely that many HCH-C were accessible to sample. Much of the shoreline we had historically sampled within our four transects prior to 2022 was deep enough for electrofishing boat access, likely causing more HCH-C to be collected. The data from this survey will be used in conjunction with future and past data, to monitor the status of this fishery and inform adaptive management actions.

## Introduction

In September of 2012, The Center for Biological Diversity submitted a petition to 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.

Since 2019, relative population surveys have been conducted in Holiday Harbor, Konocti Casino, Soda Bay, and Clear Lake State Park (**Figure 1**) and are intended to meet the following objectives:

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 using a multiple mark-recapture method

- Determine the average size of HCH-C spawning in Clear Lake by measuring the first 100 HCH-C
- Collect population data with which to compare past and future survey efforts

Given the size of Clear Lake, the entire shoreline is not able to be efficiently sampled, therefore sample sections were chosen based on spawning observations in the lake.

This report aims to present a relative estimate of population size with 95% confidence intervals, mean length, catch per unit effort (CPUE), 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.

Although HCH-C prefer to spawn in Clear Lake tributaries, Holiday Harbor, Konocti Casino, Soda Bay, and Clear Lake State Park are four historically HCH-C spawning areas in Clear Lake (**Figure 1**). These locations were chosen due to past spawning observations seen as well as the inability to survey the entire Clear Lake shoreline.

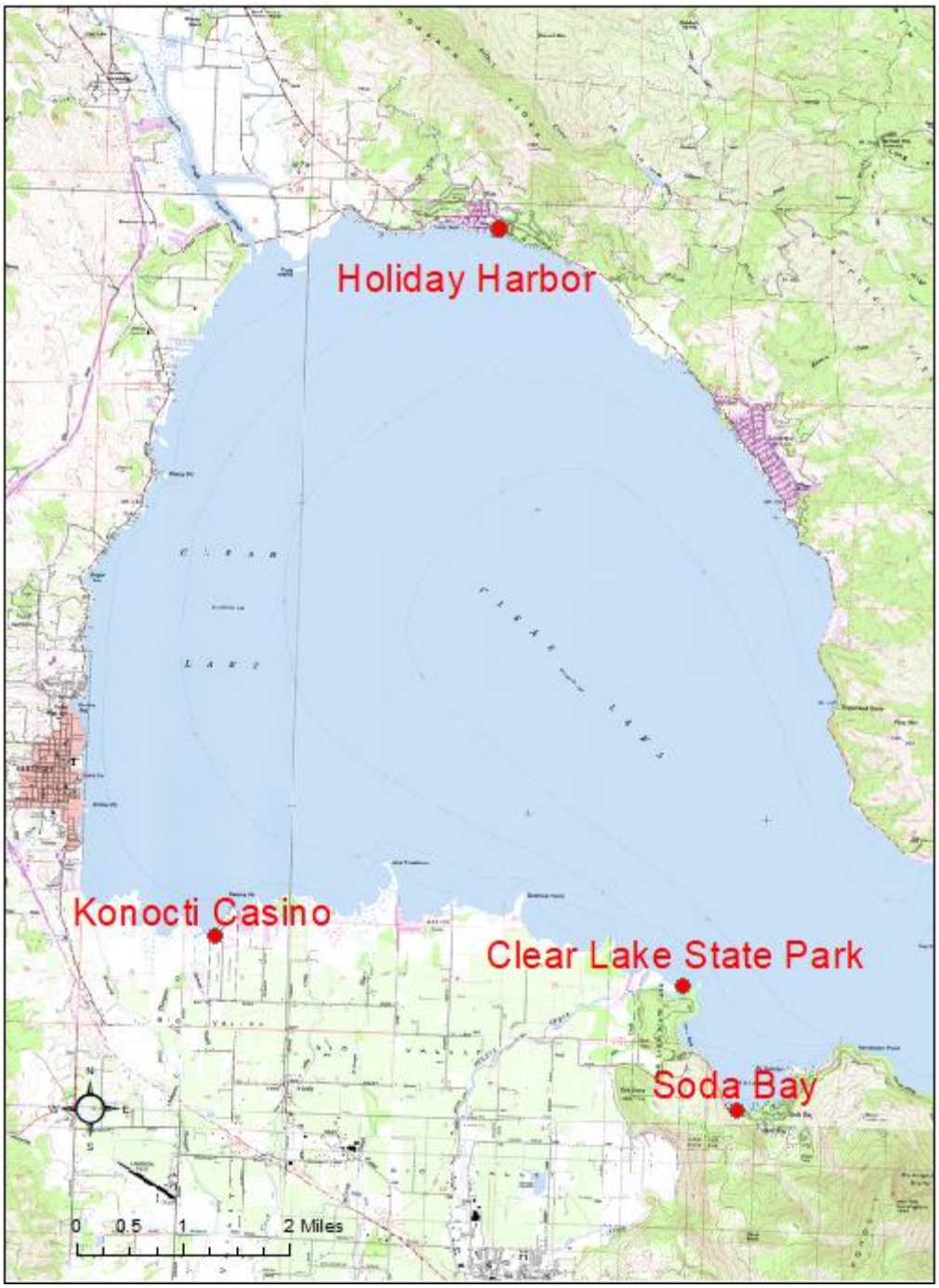


**Figure 1**. Locations of Holiday Harbor, Konocti Casino, Clear Lake State Park, and Soda Bay boat electrofishing transects, all of which we sampled in Spring, 2024.

## 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) used for 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 nine sampling efforts to mark and recapture HCH-C on Clear Lake. Population estimates were calculated for HCH-C collected in Holiday Harbor, Konocti Casino Harbor, Clear Lake State Park, and Soda Bay.

Each sampling effort took one to two days, using one 18-foot Smith-Root SR electrofishing boat using pulsed DC current (2-6 amps) to stun the fish. The crew consisted of two forward netters, zero to three staff by livewell, 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.

We recorded start and stop times for time spent electrofishing and water temperatures for each effort. We measured the first 100 HCH-C collected in total length (inches, in), (**Figure 2**), 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 (**Figure 3**), and 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. Both techniques were used because they are temporary marks that would remain identifiable throughout the three-month survey. After the field portion of the surveys, we

calculated the mean total length, catch per unit effort (CPUE), relative population estimate, and numbers of HCH-C collected.


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

**Figure 3.** HCH-C being marked with hole-punch in caudal fin (T. Woodruff, Spring 2024).

## Results

### *Holiday Harbor*

In 2024, we collected 65 HCH-C in Holiday Harbor, compared to 150 in 2023 (Ewing 2023b), four in 2022 (Ewing 2023a), 18 in 2021 (Ewing 2021), 97 in 2020 (Ewing 2020)

and two in 2019 (Ewing 2019) (**Figure 4**). We marked 63 HCH-C with a single hole punch and did not collect any hole punch recaptures. We marked two HCH-C with a fin clip and did not collect any fin clip recaptures. Of the nine sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2024, 32 HCH-C were measured. The average total length for HCH-C we collected in Holiday Harbor was 9.4 in. compared to 6.5 in. in 2023, 4.75 in. in 2022, 12.3 in. in 2021, 8.2 in. in 2020 and 9.6 in. in 2019 (**Figure 5**). In 2024, CPUE was 0.62 fish per minute compared to 1.09 fish per minute in 2023, 0.06 fish per minute in 2022, 0.13 in 2021, 1.47 in 2020, and 0.03 fish per minute in 2019 (**Figure 7**).

### *Konocti Casino Harbor*

In 2024, we collected 158 HCH-C in Konocti Casino Harbor, compared to 143 in 2023 (Ewing 2023b), 65 in 2022 (Ewing 2023a), 218 in 2021 (Ewing 2021),199 in 2020 (Ewing 2020) and 27 in 2019 (Ewing 2019) (**Figure 4**). We marked 146 HCH-C with a single hole punch and did not collect any hole punch recaptures. We marked 12 HCH-C with a fin clip and did not collect any fin clip recaptures. Of the nine sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2024, 37 HCH-C were measured. The average total length for HCH-C we collected in Konocti Casino Harbor was 6.2 in., compared to 7.1 in. in 2023, 9.6 in. in 2022, 12.8 in. in 2021, 9.9 in. in 2020, and 11.2 in. in 2019 (**Figure 5**). In 2024, CPUE was 0.39 fish per minute, compared to 0.40 in 2023, 0.53 in 2022, 0.73 in 2021, 1.11 in 2020, and 0.13 in 2019 (**Figure 7**).

### *Clear Lake State Park*

In 2024, we collected 726 HCH in Clear Lake State Park, compared to 570 in 2023 (Ewing 2023b), 115 in 2022 (Ewing 2023a), 112 HCH-C in 2021 (Ewing 2021), 34 in 2020 (Ewing 2020), and 155 in 2019 (Ewing 2019) (**Figure 4**). We marked 700 HCH-C with a single hole punch and did not collect any hole punch recaptures. We marked 26 HCH-C with a fin clip and did not collect any fin clip recaptures. Of the nine sampling efforts, we did not document any initial mortalities with processing HCH-C. In 2024, 34 HCH-C were measured. The average total length for HCH-C we collected in Clear Lake

State Park was 12.2 in. compared to 8.8 in. in 2023, 13.0 in. in 2022, 12.0 in. in 2021, and 12.3 in. in 2019 (**Figure 5**). No HCH-C were measured in 2020 due to the first 100 HCH-C being measured at other sites. In 2024, CPUE was 0.73, compared to 0.64 in 2023, 0.43 in 2022, 0.28 fish in 2021, 0.09 in 2020, and 0.23 fish per minute in 2019 (**Figure 7**).

### *Soda Bay*

In 2024, we collected 20 HCH-C in Soda Bay, compared to 137 in 2023 (Ewing 2023b), 173 in 2022 (Ewing 2023), zero in 2021 (Ewing 2021), 171 in 2020 (Ewing 2020) and zero in 2019 (Ewing 2019) (**Figure 4**). We marked 17 HCH-C with a single hole punch and did not collect any hole punch recaptures. We marked three HCH-C with a fin clip and did not collect any fin clip recaptures. Of the nine sampling efforts, we did not document any initial mortalities with processing HCH-C. In 2024, 17 HCH-C were measured. The average total length for HCH-C we collected in Soda Bay was 5.4 in., compared to 5.1 in. in 2023 and 5.5 in in 2022 (**Figure 5**). No HCH-C were measured in 2020 due to the first 100 HCH-C being measured at other sites. In 2024, CPUE was 0.15 fish per minute, compared to 1.05 fish per minute in 2023, 1.66 in 2022, and 3.00 in 2020 (**Figure 7**). No HCH-C were captured in 2021 or 2019.

Overall, we collected 969 HCH-C in 2024 compared to 1000 in 2023, 357 in 2022, 348 in 2021, 431 in 2020, and 184 in 2019 (**Figure 4**). In 2024, the average total length was 8.6 in., compared to 8.0 in. in 2023, 7.1 in. in 2022, 12.7 in. in 2021, 8.5 in. in 2020, and 12.2 in. in 2019 (**Figure 6**).

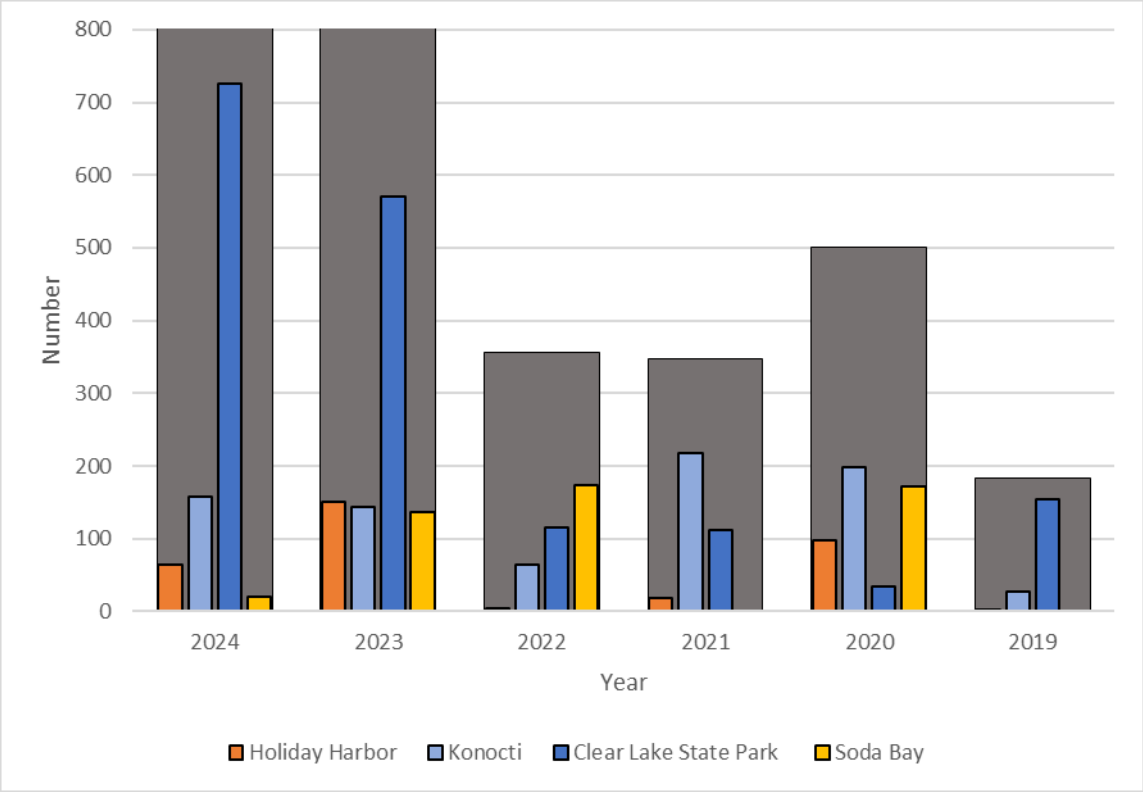


**Figure 4.** Total number of Clear Lake Hitch collected by location and year.

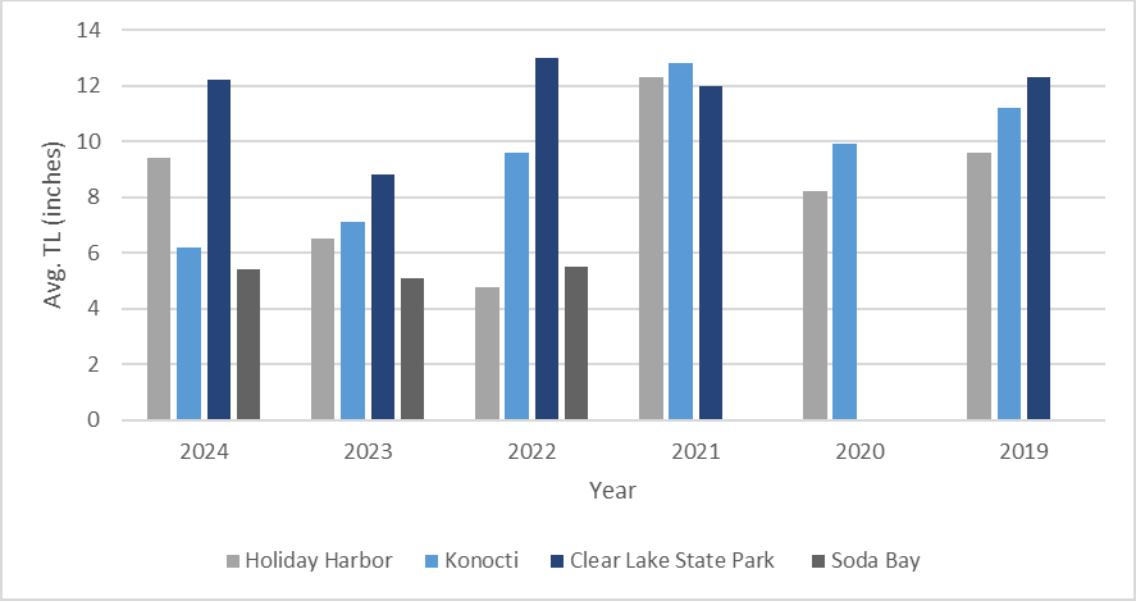


**Figure 5.** The average total length of Clear Lake Hitch measured in inches. No HCH-C were captured at Soda Bay in 2019 and 2021. No HCH-C were measured at Clear Lake State Park or Soda Bay in 2020.

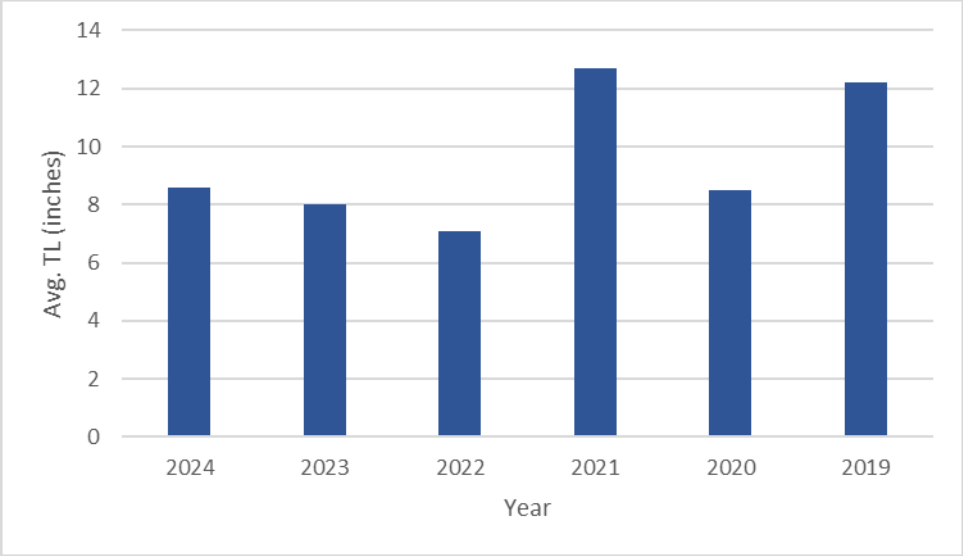


**Figure 6.** The average total length of Clear Lake Hitch measured in inches at all sampling locations.

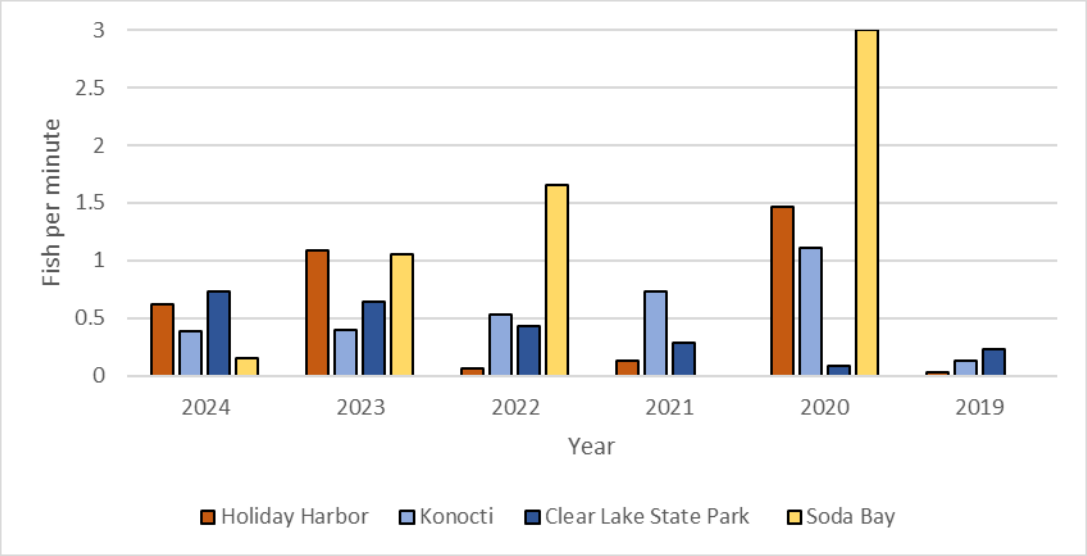


**Figure 7.** Catch per Unit Effort by location from 2019-2024.

Due to no recaptures being collected in 2024, a relative population estimate could not be made. In 2023, the SM estimate was 393,750 (95% C.I. 73,971 - 7,720,588). The 2023 SM estimate was more than the 2022 estimate of 25,983, 24,784 in 2021, and 12,770 in 2020. The 2023 SEM also resulted in a higher estimate of 1,289,481 (95% C.I. 282,618 and NA compared to the 2022 estimate of 45,849, 16,126 in 2021, and 15,195 in 2020 (**Table 1, Figure 8**). The SM and SEM results both used the proportion of marked, collected, and recaptured individuals to estimate population size, however they differ on how they use these numbers statistically. By using two different statistical methods, we hope to obtain a relative number that aids in how the HCH-C population is doing.

**Table 1**. Mark-recapture sample data for 2024. 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 |
|---|---|---|---|---|
| 3/11/2024 | 9 | | 9 | |
| 3/20 and 3/21/2024 | 69 | 0 | 69 | 9 |
| 3/27 and 3/28/2024 | 8 | 0 | 8 | 78 |
| 4/2/2024 | 34 | 0 | 34 | 86 |
| 4/8 and 4/9/2024 | 6 | 0 | 6 | 120 |
| 4/24 and 4/25/2024 | 366 | 0 | 366 | 126 |
| 5/1 and 5/2/2024 | 126 | 0 | 126 | 492 |
| 5/8 and 5/9/2024 | 29 | 0 | 29 | 618 |
| 5/14 and 5/15/2024 | 322 | 0 | 322 | 647 |
| Total | **969** | **0** | **969** | |

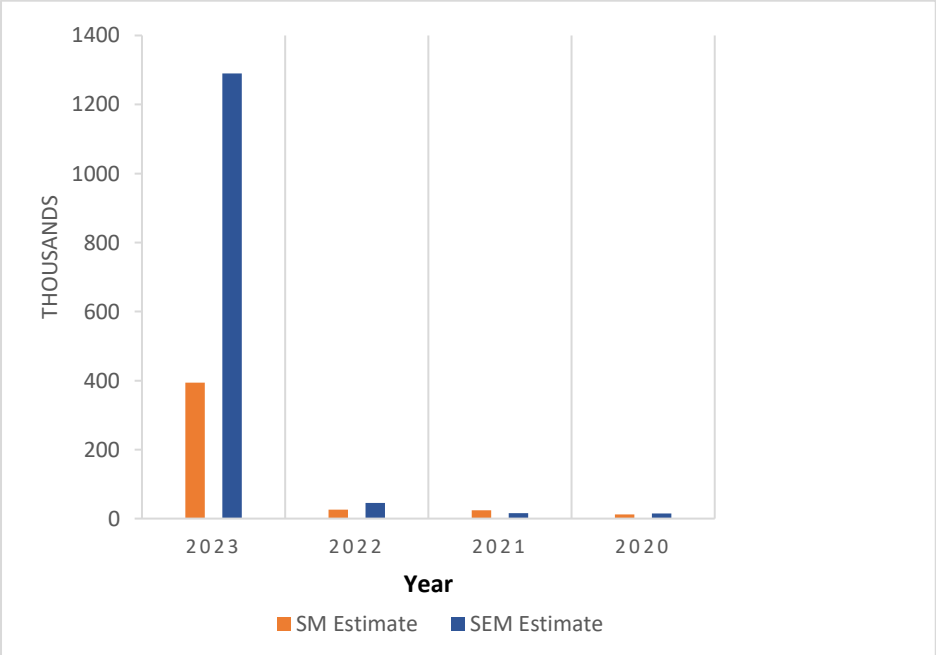


**Figure 8.** SM and SEM estimates from 2020-2023.

## Discussion

CDFW was able to calculate a relative population estimate for HCH-C from 2020−2023, however, we could not derive a comparison to results from 2024 and 2019 because we did not collect any HCH-C recaptures in either of those years. Even from 2020-2023, with the low recaptures collected, the confidence intervals were greater than hoped. The number of HCH-C we collected in 2024 was the second greatest number collected in the six years of surveys, but below what we had hoped to collect after how many HCH-C were collected in 2023.

The 2024 rainfall totals for Clear Lake brought the lake to full lake capacity, making HCH-C sampling more efficient than in previous years where the lake level was low. A large percentage of the shoreline transects that we sampled in 2020 and earlier were accessible in 2023 and 2024 where they were not in 2021 and 2022. This may have been a contributing factor to the second consecutive year of the increased number of HCH-C collected. Historically, thousands of HCH-C have been observed at these four sampling sites, thus the reason they were chosen for sampling. Survey data, fish

rescues, and observations of the tributaries suggest the record drought that California experienced from 2012–2016 as well as the dry 2020–spring and 2022 season negatively impacted the HCH-C tributary 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. Although HCH-C prefer to spawn in Clear Lake tributaries, the number of HCH-C collected in 2023 and 2024 suggests the in-lake spawning in Clear Lake and Tule Lake has contributed to positive recruitment. The number of juveniles collected in 2024 (n=43) was a large decrease from 2023 (n=126) and below the six-year average of 55. During May surveys in the 2024 season, Clear Lake began experiencing a very large algae bloom which affected much of the sampling area (**Figure 9**). This made spotting any fish, particularly small fish, very difficult and may have contributed to the decrease in juveniles collected. The large number of HCH-C seen in 2024 at the State Park may have been due to HCH-C utilizing tributary flow entering Clear Lake at the State Park. The other three sampling sites don't have tributaries and the advantage of the tributary flows and are more susceptible to egg predation by Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*).

**Figure 9**. Algae bloom in Soda Bay on May 14, 2024 (A. Balleto, 5/14/2024).

Although no HCH-C were recaptured, the high numbers collected is a positive sign compared to some of the previous years. This information will be used for comparison

to future years.

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