California Department of Fish and Wildlife

North Central Region

Sierra District

Summary of the 2025 Clear Lake Hitch Survey on Clear Lake

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(T.Woodruff, Spring, 2025)

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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 13, 2025, through May 20, 2025. We collected a total of 2776 HCH-C in 2025, compared to 969 HCH-C in 2024, 1000 in 2023, 357 in 2022, 348 in 2021, 431 in 2020, and 184 in 2019 (Ewing 2019, 2020, 2021, 2023a, 2023b, 2024). An average rainfall in the winter of 2025 (California Department of Water Resources 2025) combined with the high lake level for a third consecutive year, may explain the record high numbers of HCH-C observed by CDFW in 2025. With Clear Lake experiencing full lake level conditions during the 2025 surveys, it is likely that many HCH-C were accessible to sample. 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:

- Determine the number of HCH-C spawning in Holiday Harbor, Konocti Casino Harbor, Clear Lake State Park, and Soda Bay using a mark-recapture method with multiple recapture events
- 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 cannot 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 historical HCH-C spawning areas in Clear Lake (**Figure 1**). These locations were chosen due to past spawning observations.

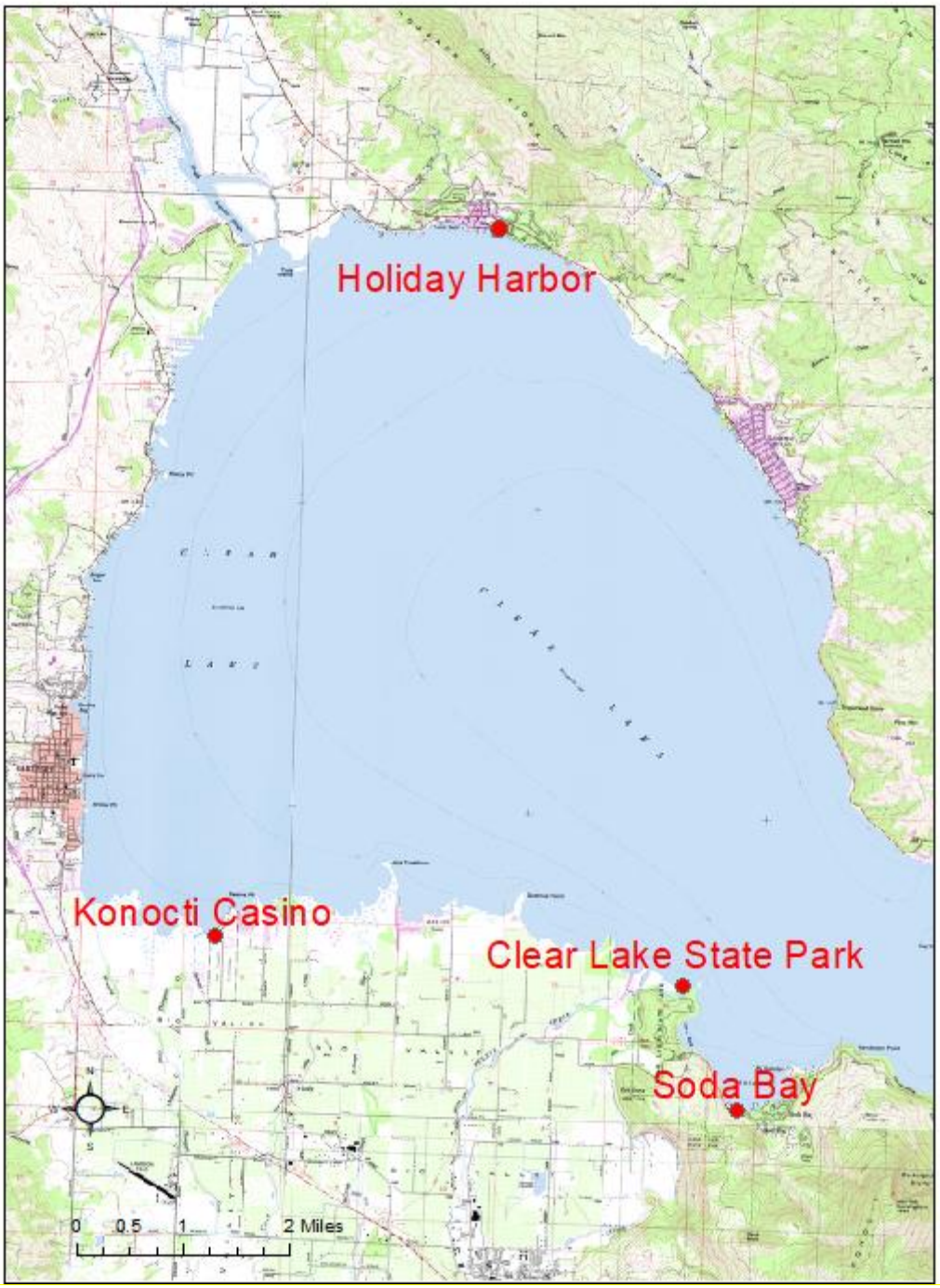

Figure 1. Locations of Holiday Harbor, Konocti Casino, Clear Lake State Park, and Soda Bay boat electrofishing transects, all of which we sampled in Spring, 2025.

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 10 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 five staff by the 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, regardless of site, collected for the season in total length (inches, in), (**Figure 2**), marked all HCH-C with a single hole punch on the upper caudal fin, using a handheld hole puncher (**Figure 3**). This marking technique was used because it is a temporary mark 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. Adult HCH-C being measured (T. Woodruff).

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

Results

Holiday Harbor

In 2025, we collected 391 HCH-C in Holiday Harbor, compared to 65 in 2024 (Ewing 2024), 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 390 HCH-C and collected one recapture. No juvenile HCH-C (< 5 in.) were collected. Of the nine sampling efforts, we documented two initial mortalities associated with processing HCH-C. Due to high winds, we were not able to sample Holiday Harbor on March 27. In 2025, 89 HCH-C were measured. The average total length for HCH-C we collected in Holiday Harbor was 9.4 in. compared to identical 9.4 in. in 2024, 6.5 in. in 2023, 4.8 in. in 2022, 12.3 in. in 2021, 8.2 in. in 2020 and 9.6 in. in 2019 (**Figure 5**). In 2025, CPUE was 3.03 fish per minute compared to 0.62 fish per minute in 2024, 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 2025, we collected 1,107 HCH-C in Konocti Casino Harbor, compared to 158 HCH-C in 2024 (Ewing 2024), 143 in 2023 (Ewing 2023b), 65 in 2022 (Ewing 2023a), 218 in 2021 (Ewing 2021),129 in 2020 (Ewing 2020) and 27 in 2019 (Ewing 2019) (**Figure 4**). We marked 1,105 HCH-C and collected two recaptures. One juvenile HCH-C was collected. Of the 10 sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2025, two HCH-C were measured. The average total length for HCH-C we collected in Konocti Casino Harbor was 8.8 in., compared to 6.2 in 2024, 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 2025, CPUE was 1.86 fish per minute, compared to 0.39 fish per minute in 2024, 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 2025, we collected 1,278 HCH in Clear Lake State Park, compared to 726 in 2024, 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 1,274 HCH-C and collected four recaptures. No juvenile HCH-C were collected. Of the 10 sampling efforts, we did not document any initial mortalities with processing HCH-C. In 2025, 17 HCH-C were measured. The average total length for HCH-C we collected in Clear Lake State Park was 11.1 in., compared to 12.2 in 2024, 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 1.15, compared to 0.73 in 2024, 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 2025, we collected zero HCH-C in Soda Bay compared to 20 HCH-C in 2024 (Ewing 2024), 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**).

Overall, we collected 2,776 HCH-C in 2025 compared to 969 HCH-C in 2024, 1000 in 2023, 357 in 2022, 348 in 2021, 431 in 2020, and 184 in 2019 (**Figure 4**). In 2025, the average total length was 9.5 in., compared to 8.6 in. in 2024, 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**).

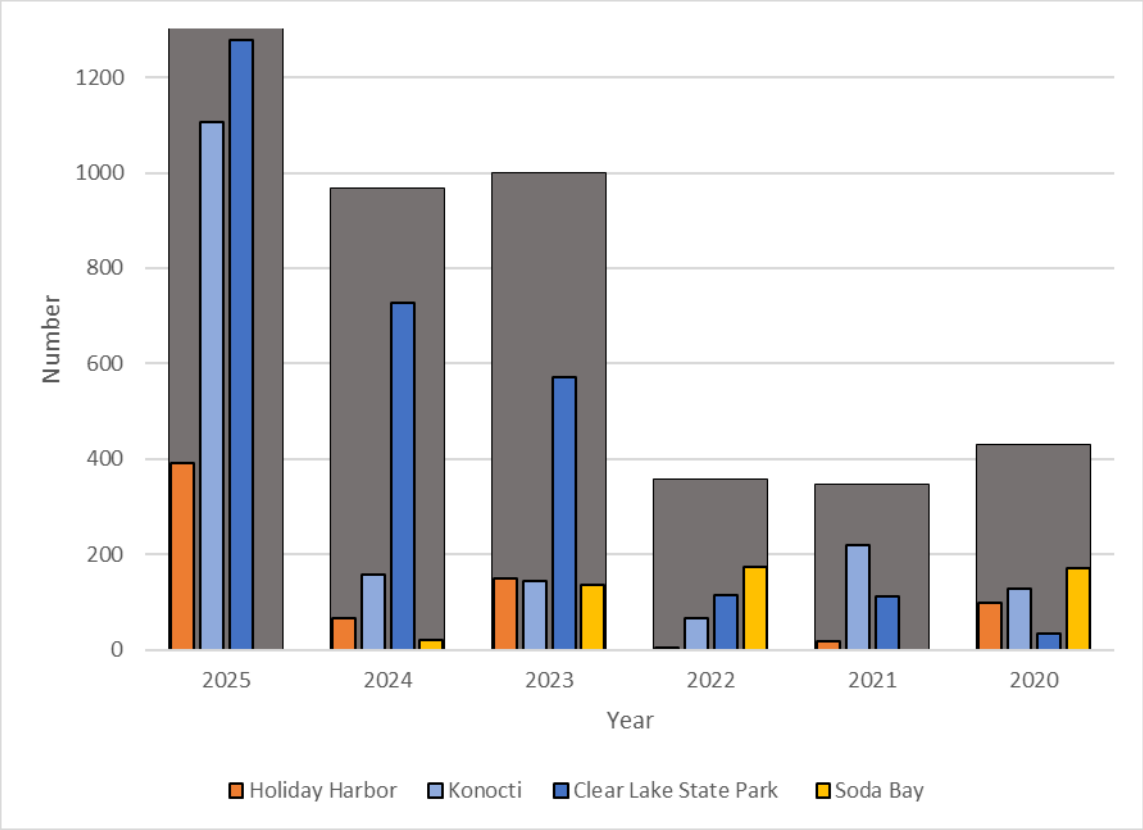

Figure 4. Total number of Clear Lake Hitch collected by location and year.

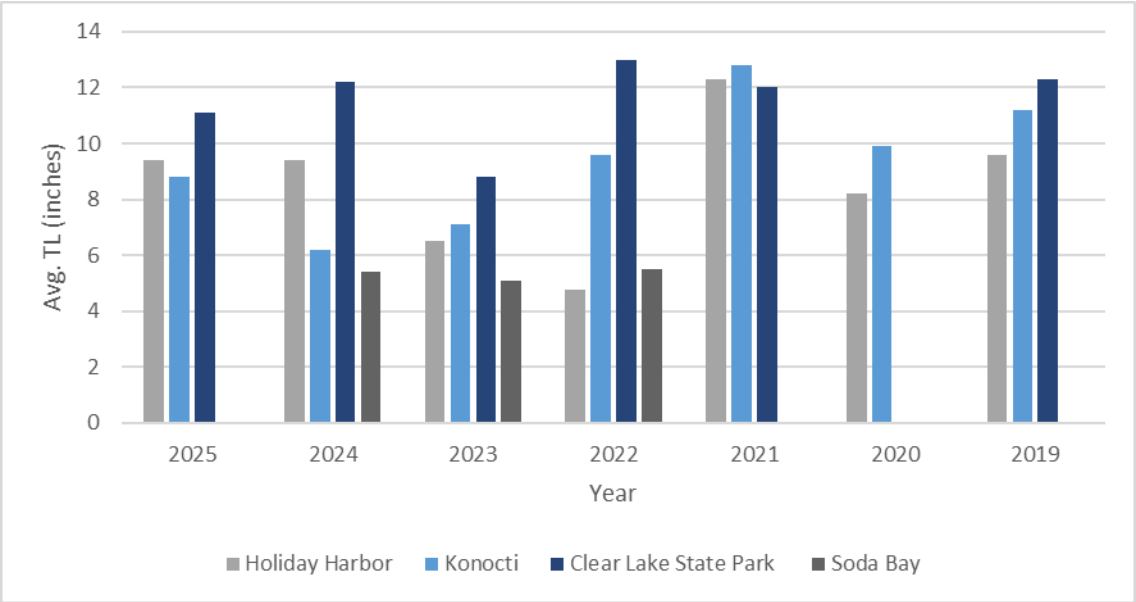

Figure 5. The average total length of Clear Lake Hitch measured in inches. No HCH-C were captured at Soda Bay in 2019, 2021, and 2025. No HCH-C were measured at Clear Lake State Park or Soda Bay in 2020.

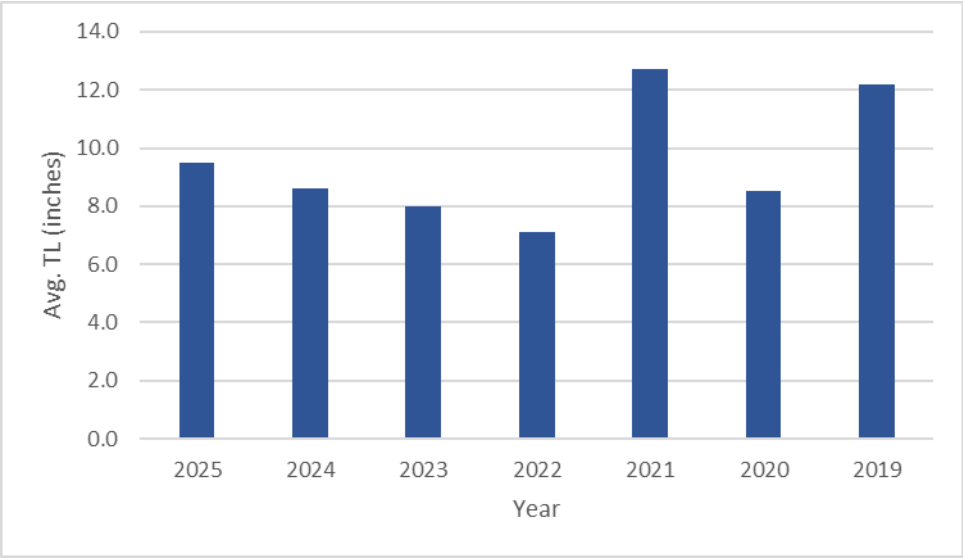

Figure 6. The average total length of Clear Lake Hitch measured in inches at all sampling locations.

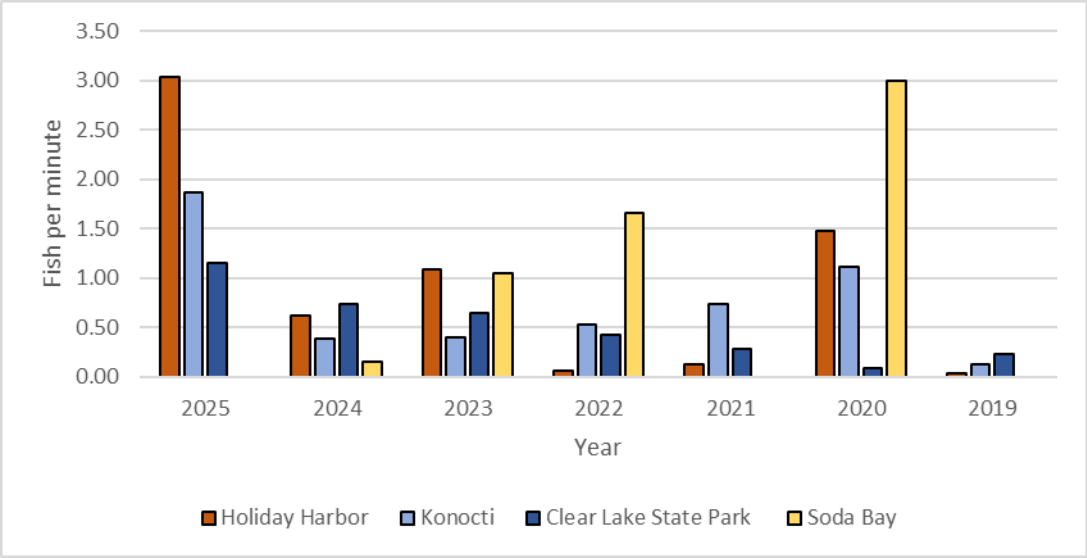

Figure 7. Catch per Unit Effort by location from 2019-2025.

The SM resulted in a relative HCH-C population estimate for the four sampled sites of 454,764 (95% C.I. 231,264 – 969,056). In 2023, the SM estimate was 393,750 (95% C.I. 73,971 - 7,720,588), compared to 25,983 in 2022, 24,784 in 2021, and 12,770 in 2020. The 2025 SEM resulted in a lower estimate of 604,274 (95% C.I. 319,544 and 5,546,328), compared to 1,289,481 (95% C.I. 282,618 and NA) in 2023, 45,849 in 2022,

16,126 in 2021, and 15,195 in 2020 (**Table 1, Figure 8**). Due to no recaptures being collected in 2024 and 2019, a relative population estimate could not be made. 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 2025. 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
3/13/2025	88		88	
3/18 and 3/19/2025	18	0	18	88
3/26 and 3/27/2025	77	0	77	106
4/1 and 4/2/2025	4	0	4	183
4/15 and 4/16/2025	556	0	556	187
4/23 and 4/24/2025	630	3	627	743
4/29 and 4/30/2025	332	2	330	1370
5/7 and 5/8/2025	631	1	630	1700
5/13 and 5/14/2025	210	1	209	2330
5/19 and 5/20/2025	230	0	230	2539
Total	**2776**	**7**	**2769**	

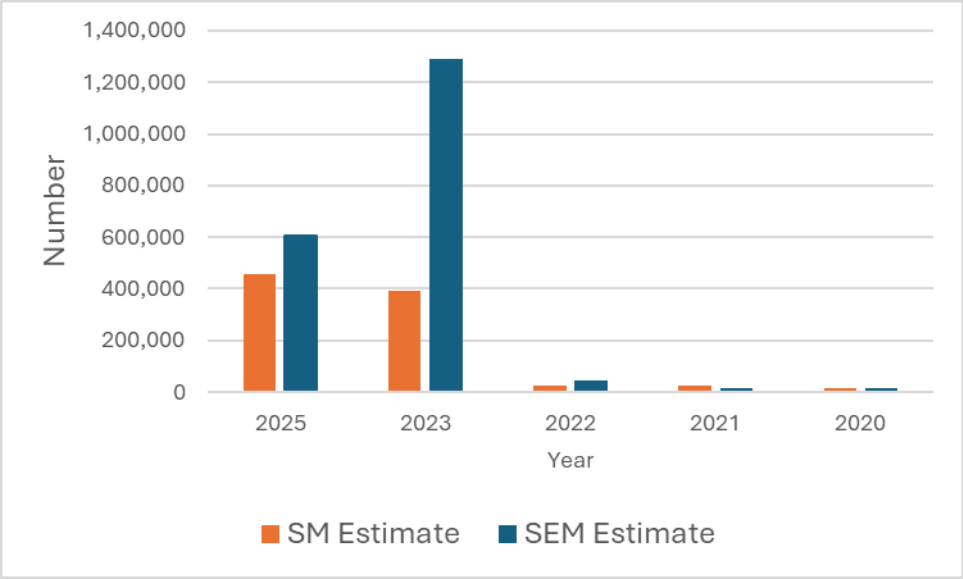

Figure 8. SM and SEM estimates from 2020-2025.

Discussion

CDFW was able to calculate a relative population estimate for HCH-C from 2020−2023, and 2025; however, the wide confidence intervals indicate a high level of uncertainty in the estimates suggesting the true population size may vary significantly from the estimated value. 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; therefore, population estimates were not calculated. The recapture rates in 2025 and in previous years have been low. Low captures rates can lead to bias and inaccurate population estimates that may not capture the true size of the population effectively; however, regardless of the uncertainty in the population estimate the number of HCH-C collected in 2025 was by far the greatest number collected in the seven years of surveys and provided a positive sign for the HCH-C population and much needed optimism.

The 2025 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 2023-2025 where they were not in 2021 and 2022. This may have been a contributing factor to the third 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 from 2023-2025 suggests the in-lake spawning in Clear Lake and Tule Lake has contributed to positive recruitment. However, the number of juveniles collected in 2025 (n=1) was a large decrease from 2024 (n=43) and 2023 (n=126) and below the seven-year average of 47. During the entire survey period in the 2025 season, Clear Lake experienced a large increase in the Threadfin shad (*Dorosoma petenense*) population within much of the sampling area (**Figure 9**). This made spotting small fish, particularly small HCH-C, very difficult and may have contributed to the decrease in juveniles collected. The greatest number of HCH-C seen in 2025 was at the State Park and 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 are more susceptible to egg predation by Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*). This was the second consecutive year that Carp and Goldfish that were removed from the four sample sites. In 2024, the HCH-C to Carp ratio was 2.78, but increased to 11.35 in 2025. In 2024, the HCH-C to Goldfish ratio was 5.07, but decreased very slightly to 4.76. These values indicate the ongoing Carp/Goldfish removal by Rojas Fisheries, Robinson Rancheria, Carp bowfishing tournaments, and CDFW may be assisting with HCH-C survival. Continued removal efforts are planned in 2026 and beyond and will be monitored for results.

Figure 9. Threadfin Shad in Soda Bay on April 16, 2025 (M Rojas Jr.).

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