California Department of Fish and Wildlife

North Central Region

Sierra District

Summary of the 2026 Clear Lake Hitch Survey on Clear Lake

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(A. Balletto, Spring, 2026)

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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 9, 2026, through May 21, 2026. We collected a total of 2957 HCH-C in 2026, compared to 2776 in 2025, 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, 2025). An average rainfall in the winter of 2026 (California Department of Water Resources 2026) combined with the high lake level for a fourth consecutive year, may explain the record high numbers of HCH-C observed by CDFW in 2026. With Clear Lake experiencing full lake level conditions during the 2026 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 listed 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 feasibly sampled with

current resources, 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**).

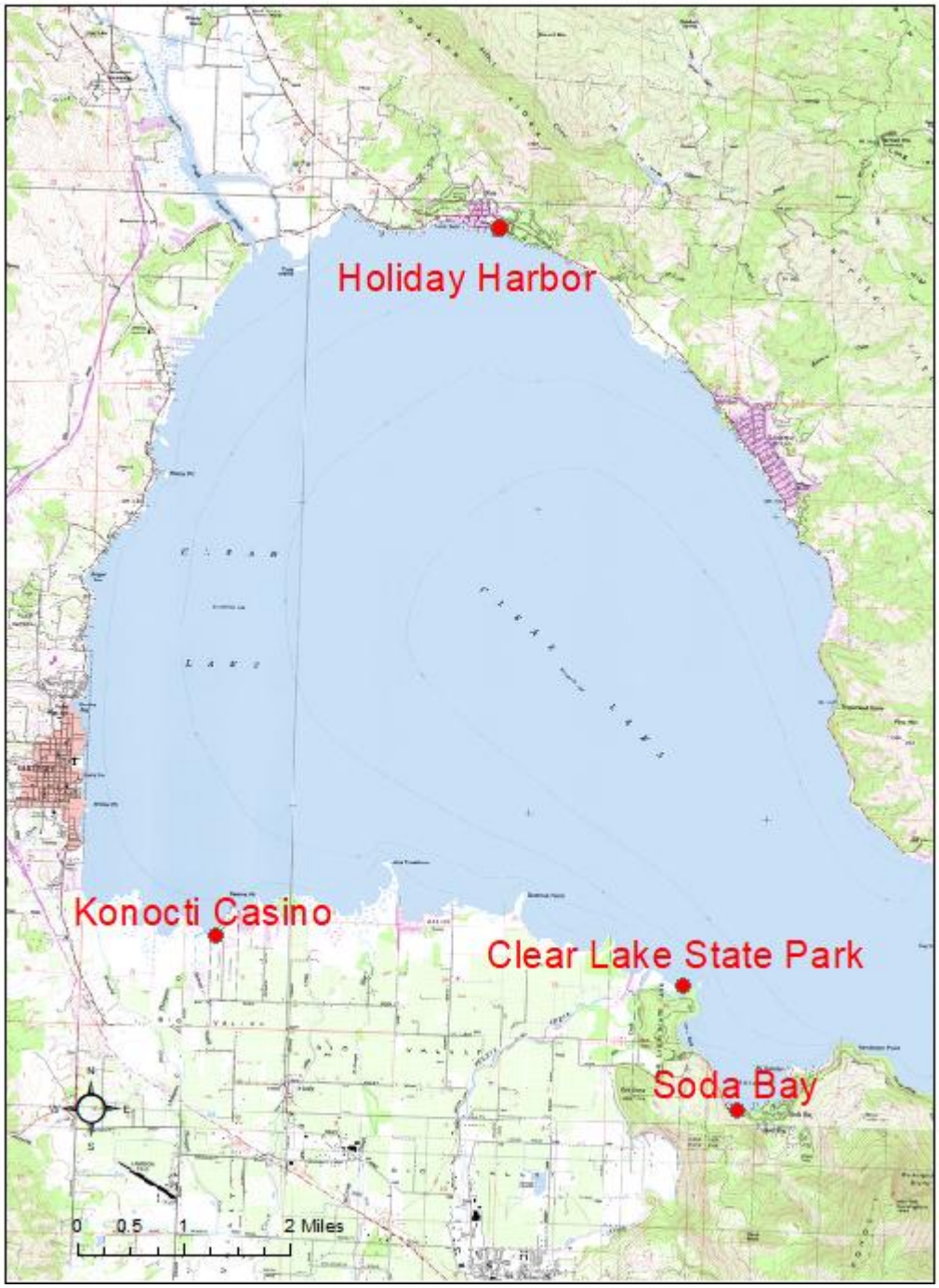

Figure 1. Locations of Holiday Harbor, Konocti Casino, Clear Lake State Park, and Soda Bay boat electrofishing transects, all of which were sampled in Spring, 2026.

Methods and Materials

In estimating the relative 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 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**). We also 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. HCH-C being measured (T. Woodruff).

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

Results

Holiday Harbor

In 2026, we collected 1,189 HCH-C in Holiday Harbor, compared to 391 in 2025 (Ewing 2025), 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 1,184 HCH-C and collected five recaptures. Two juveniles HCH-C (< 5 in.) were collected. Of the 10 sampling efforts, we documented zero initial mortalities associated with processing HCH-C. In 2026, 55 HCH-C were measured. The average total length for HCH-C we collected in Holiday Harbor was 12.1 in. compared to 9.4 in. in 2025, 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 2026, CPUE was 8.31 fish per minute compared to 3.03 fish per minute in 2025, 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 2026, we collected 1,477 HCH-C in Konocti Casino Harbor, compared to 1,107 in 2025 (Ewing 2025), 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 1,471 HCH-C and collected six recaptures. Nine juvenile HCH-C were collected. Of the 10 sampling efforts, we did not document any initial mortalities associated with processing HCH-C. In 2026, 42 HCH-C were measured. The average total length for HCH-C we collected in Konocti Casino Harbor was 11.6 in., compared to 8.8 in 2025, 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 2026, CPUE was 2.66 fish per minute, compared to 1.86 fish per minute in 2025, 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 2026, we collected 291 HCH-C in Clear Lake State Park, compared to 1,278 in 2025 (Ewing 2025), 726 in 2024 (Ewing 2024), 570 in 2023 (Ewing 2023b), 115 in 2022 (Ewing 2023a), 112 in 2021 (Ewing 2021), 34 in 2020 (Ewing 2020), and 155 in 2019 (Ewing 2019) (**Figure 4**). We marked 291 HCH-C and collected zero recaptures. Two juvenile HCH-C were collected. Of the 10 sampling efforts, we did not document any initial mortalities with processing HCH-C. In 2026, three HCH-C were measured. The average total length for HCH-C we collected in Clear Lake State Park was 11.7 in., compared to 11.1 in 2025, 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 2026, CPUE was 0.24, compared to 1.15 in 2025, 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 2026, we collected zero HCH-C in Soda Bay compared to zero in 2025 (Ewing 2025),

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 2,957 HCH-C in 2026 compared to 2,776 in 2025, 969 HCH-C in 2024, 1000 in 2023, 357 in 2022, 348 in 2021, 431 in 2020, and 184 in 2019 (**Figure 4**). In 2026, the average total length was 11.9 in., compared to 9.5 in. in 2025, 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**).

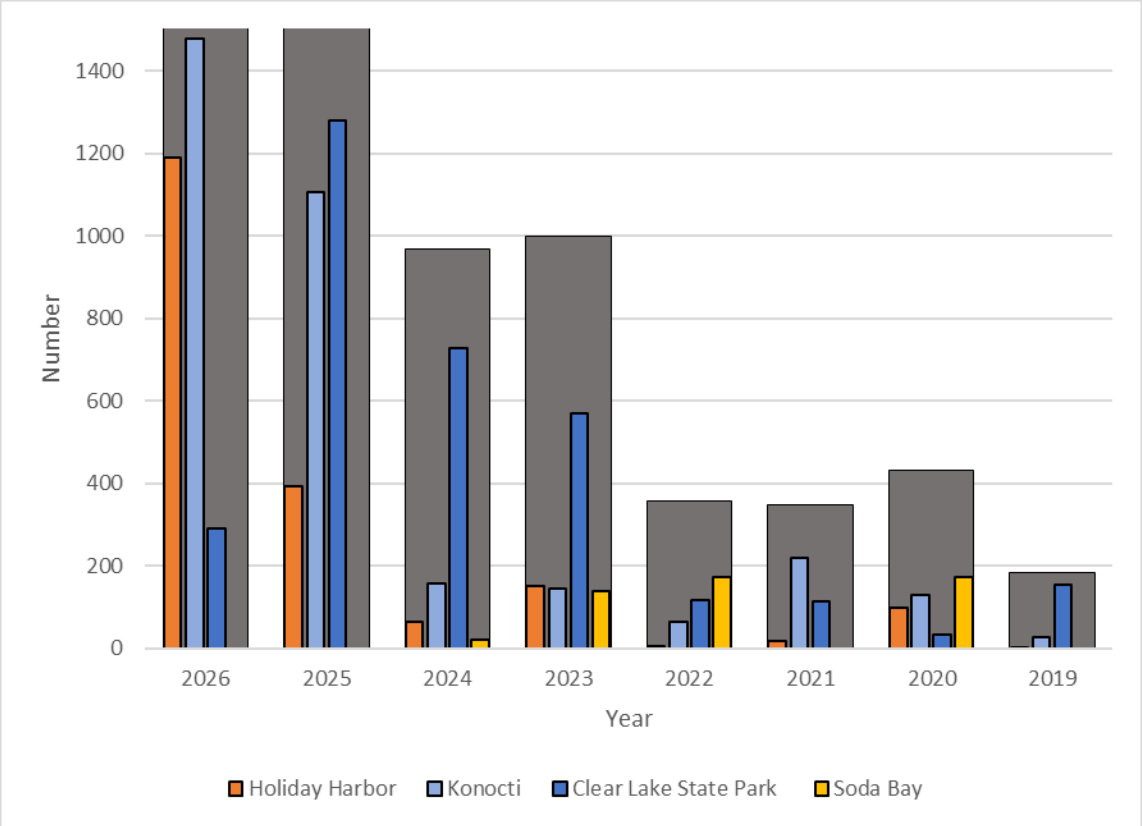

Figure 4. Total number of Clear Lake Hitch collected by location and year.

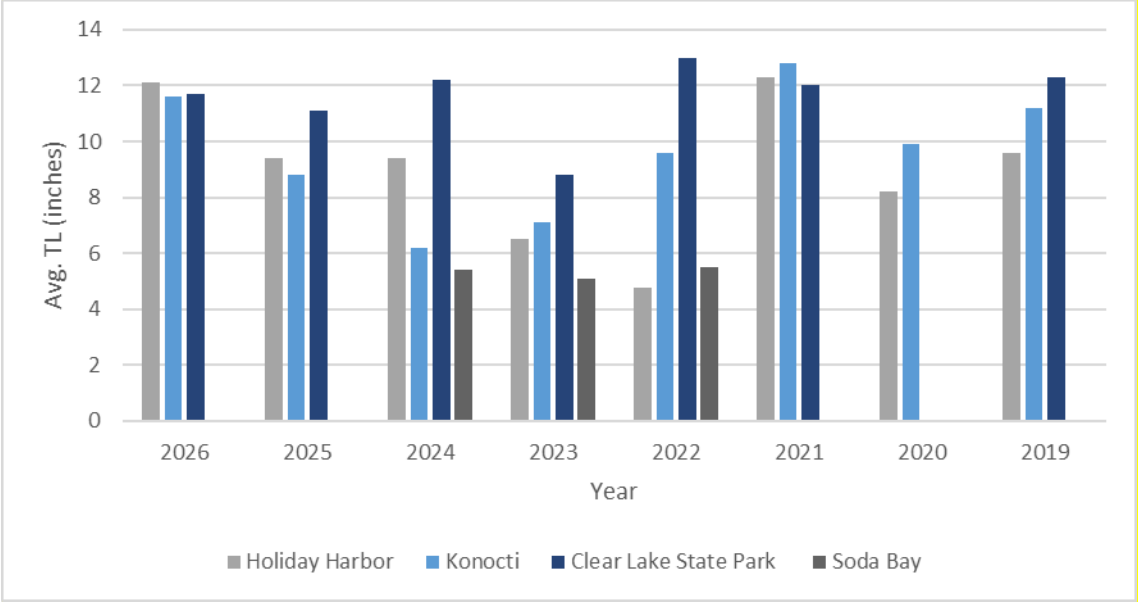

Figure 5. The average total length of Clear Lake Hitch measured in inches. No HCH-C were captured at Soda Bay in 2019, 2021, 2025, and 2026. Due to the first 100 HCH-C being collected in Konocti Casino and Holiday Harbor, the HCH-C collected in 2020 at Clear Lake State Park and Soda Bay were not measured.

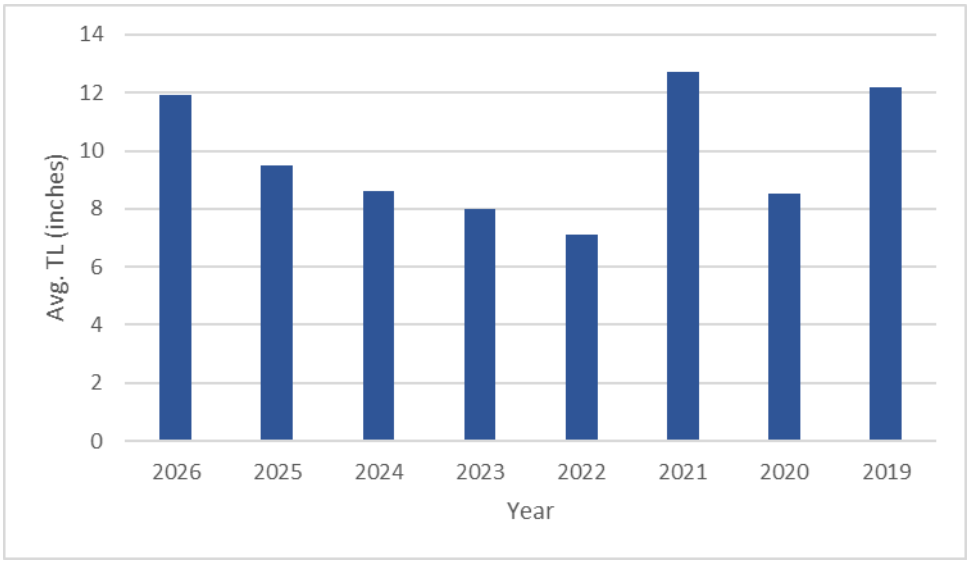

Figure 6. The average total length of Clear Lake Hitch measured in inches at all sampling locations.

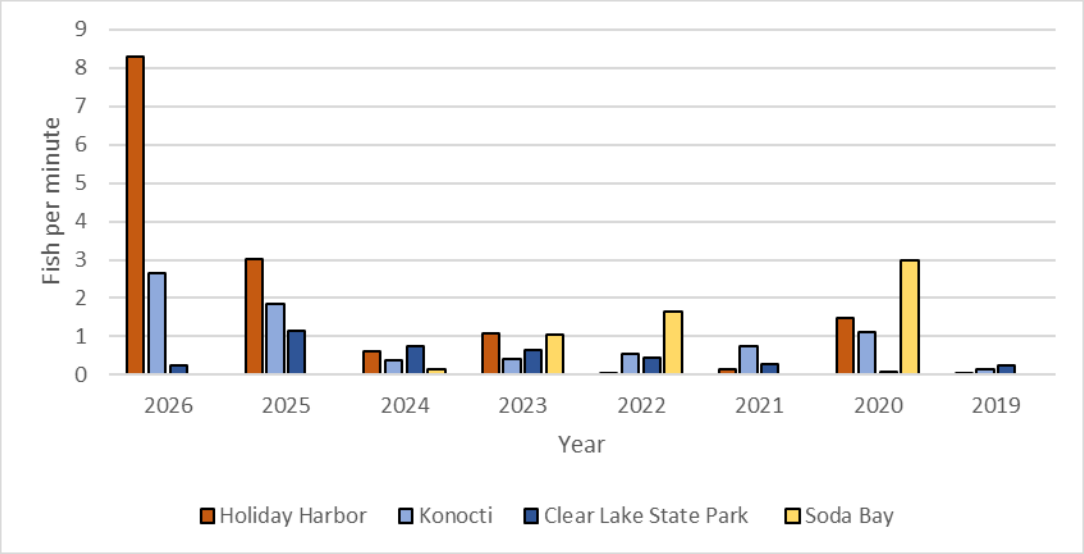

Figure 7. Catch per Unit Effort by location from 2019-2026.

The SM resulted in a relative HCH-C population estimate for the four sampled sites of 331,953 (95% C.I. 191,679 – 685,981). In 2025, the SM estimate was 454,764 (95% C.I. 231,264 – 969,056), compared to 393,750 in 2023, 25,983 in 2022, 24,784 in 2021, and 12,770 in 2020. The 2026 SEM resulted in a lower estimate of 305,331 (95% C.I. 139,361 and NA) compared to 604,274 (95% C.I. 319,544 and 5,546,328) in 2025, 1,289,481 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 2026. 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
3/9 and 3/10/2026	65		65	
3/18 and 3/19/2026	735	1	734	65
3/25 and 3/26/2026	357	1	356	799
4/1 and 4/2/2026	160	0	160	1155
4/8 and 4/9/2026	751	0	751	1315
4/22 and 4/23/2026	151	1	150	2066
4/29 and 4/30/2026	229	0	229	2216
5/6 and 5/7/2026	189	6	183	2445
5/13 and 5/14/2026	120	2	118	2628
5/20 and 5/21/2026	200	0	200	2746
Total	**2957**	**11**	**2946**	

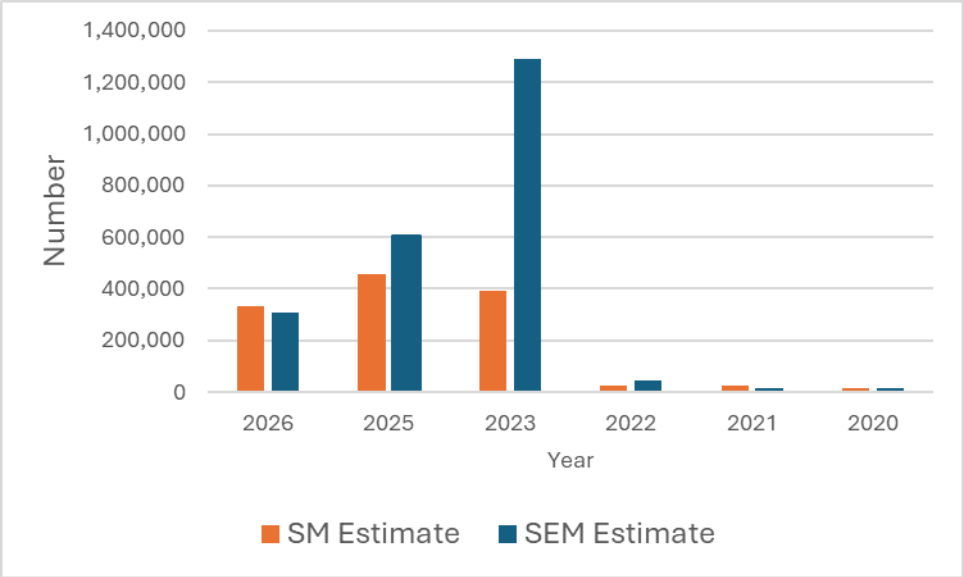

Figure 8. SM and SEM estimates from 2020-2026.

Discussion

CDFW was able to calculate a relative population estimate for HCH-C from 2020−2023, and 2025−2026; however, given the low recapture rates the confidence intervals had a large margin of error and indicate uncertainty in the estimates. Therefore, 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 2026 and in previous years have been low with the highest number of recaptures being 11 in 2026. Low captures rates can lead to bias and low confidence in population estimates and 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 2026 was the greatest number collected in the eight years of surveys. This provides a positive sign for the HCH-C population and much needed optimism.

The 2026 rainfall totals for Clear Lake brought the lake to full lake capacity for a fourth consecutive year, 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 2023-2026, where they were not in 2021 and 2022. This may have been a contributing factor to the fourth 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 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 2023-2026 suggests that in-lake spawning in Clear Lake and Tule Lake has contributed to positive recruitment.

The number of juveniles collected in 2026 (n=13) increased from 2025 (n=1), but a decrease from 2024 (n=43) and 2023 (n=126), and was below the eight-year average of 43. During the entire survey period in the 2026 and 2025 seasons, 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 in the last two years.

The greatest number of HCH-C seen in 2026 was at the Konocti Casino, and may have been due to HCH-C utilizing an area that includes a large area of suitable habitat and lower proportion of Common Carp (*Cyprinus carpio*) relative to the other three sampling sites. Additionally, continued Common Carp and Goldfish (*Carassius auratus*) removal by Rojas Fisheries adjacent to Konocti Casino likely contributed to less Common Carp in the area, making it more hospitable for HCH-C. This was the third consecutive year that Common Carp and Goldfish were removed from the four sample sites. In 2024, the HCH-C to Common Carp ratio was 2.78, increased to 11.35 in 2025, but decreased to 5.77 in 2026. In 2024, the HCH-C to Goldfish ratio was 5.07, decreased very slightly to 4.76 in 2025, and decreased to 3.23 in 2026. Further years of monitoring will be needed to indicate how the ongoing Common Carp/Goldfish removal by Rojas Fisheries, Robinson Rancheria, Carp bowfishing tournaments, and CDFW can assist with HCH-C recruitment. With the majority of Common Carp/Goldfish that were harvested being adults, could mean reduced recruitment in their near future. Continued removal efforts are planned in 2027 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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