

Memorandum

Date: December 29, 2022

To: Erin Chappell
Regional Manager
Bay Delta Region

From: James White
Environmental Scientist
Bay Delta Region

Subject: 2022 Fall Midwater Trawl annual fish abundance and distribution summary

The California Department of Fish and Wildlife (CDFW) has conducted the Fall Midwater Trawl Survey (FMWT) to index the fall abundance of pelagic fishes annually since 1967 (except 1974 and 1979). FMWT equipment and methods have remained consistent since the survey's inception, allowing the indices to be compared across time. These relative abundance indices are not intended to approximate population sizes; however, indices reflect general patterns in population change (Polansky et al. 2019).

Presently, the FMWT conducts 4 monthly surveys from September through December and calculates a monthly abundance index for each survey. The annual abundance index, for each pelagic species, is the sum of the monthly survey indices. Monthly abundance indices are calculated by averaging catch per tow for index stations in each region, multiplying each regional average by its respective weighting factor (i.e., a scalar based on water volume) for each region, and summing those products for all 14 regions (White and Baxter 2022). Sampling regions range from San Pablo Bay upstream to Stockton on the San Joaquin River, to near Hood on the Sacramento River, and into Cache Slough and through the Sacramento River Deep Water Ship Channel (SRDWSC). During each monthly survey, one 12-minute oblique midwater trawl tow is conducted at each of 100 index stations used for index calculation and at an additional 22 non-index stations that provide enhanced distribution information (Fig. 1). All fish are identified and counted at each station.

The 2022 sampling season began September 6 and was completed on December 16. During all four months, all 122 fish tows were conducted. Here we report catch from index and non-index stations, species distributions by region, and annual abundance indices for seven pelagic fish species; Delta Smelt (native), Striped Bass (introduced), Longfin Smelt (native), American Shad (introduced), Threadfin Shad (introduced), Splittail (native), and Wakasagi (introduced). A map of species distribution by station is also publicly available online: ([FMWT Species Distribution Map](#)).

FMWT Station Map

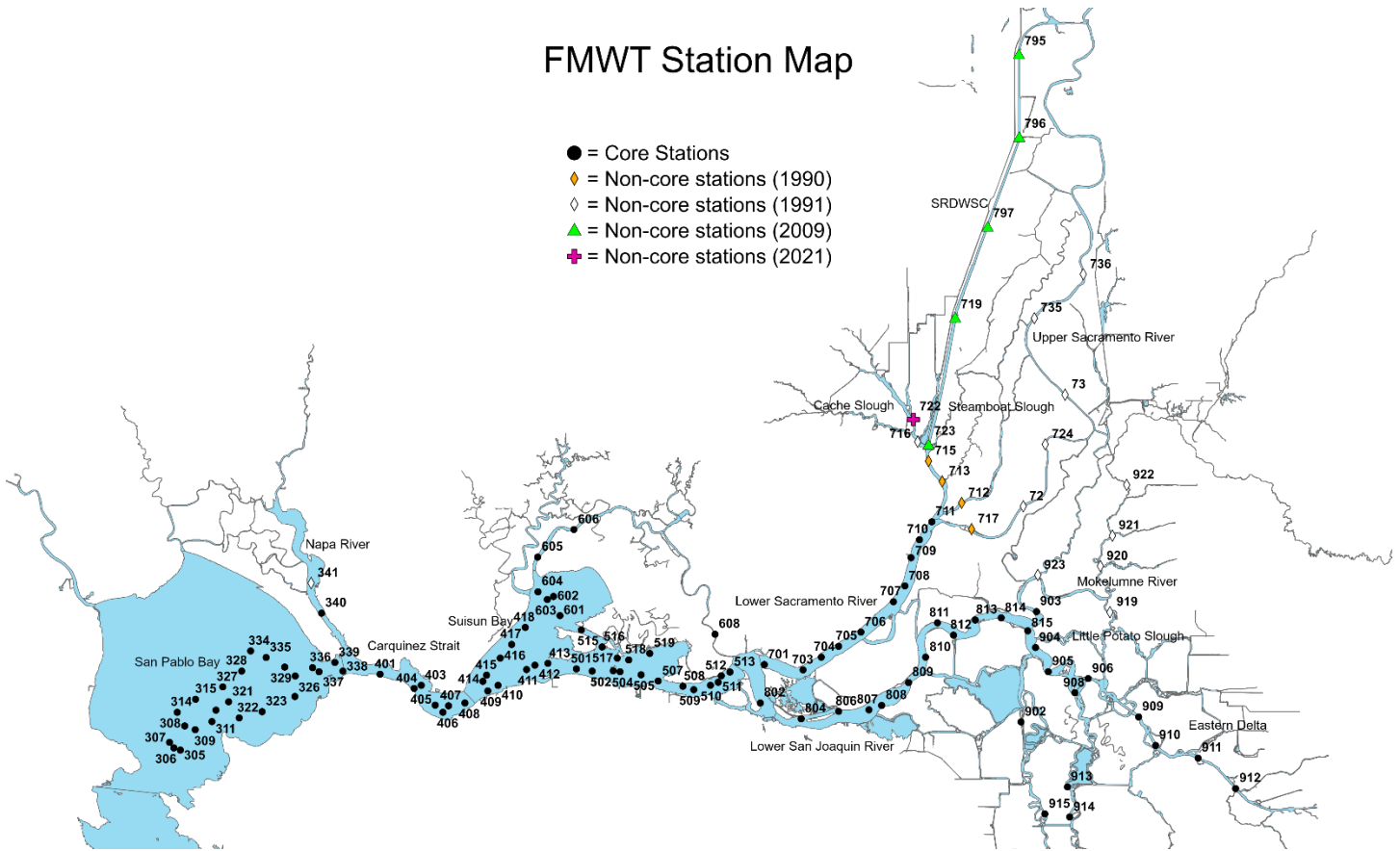


Figure 1. Map of CDFW Fall Midwater Trawl Survey monthly sampling sites among index and non-index stations in the upper San Francisco Estuary, California, USA.

Delta Smelt (*Hypomesus transpacificus*)

The 2022 abundance index was zero and continues the trend of no catch in the FMWT since 2017 (Fig. 2). No Delta Smelt were collected from any stations during our survey months of September-December. An absence of Delta Smelt catch in the FMWT is consistent among other surveys in the estuary. The Enhanced Delta Smelt Monitoring (EDSM) survey of the U.S. Fish and Wildlife Service (USFWS) caught 3 Delta Smelt among 61 sampling days (between 9/6 and 12/15) comprised of 1,997 tows (U.S. Fish and Wildlife Service 2022). On November 29-30, 2022, the Experimental Release Technical Team released 12,942 marked adult Delta Smelt from culture into the Sacramento River near Rio Vista (U.S. Fish and Wildlife Service 2022b). Neither FMWT nor EDSM caught these released Delta Smelt during December sampling. While FMWT did not catch any Delta Smelt, it does not mean there were no smelt present, but the numbers are very low and below the effective detection threshold by most sampling methods.

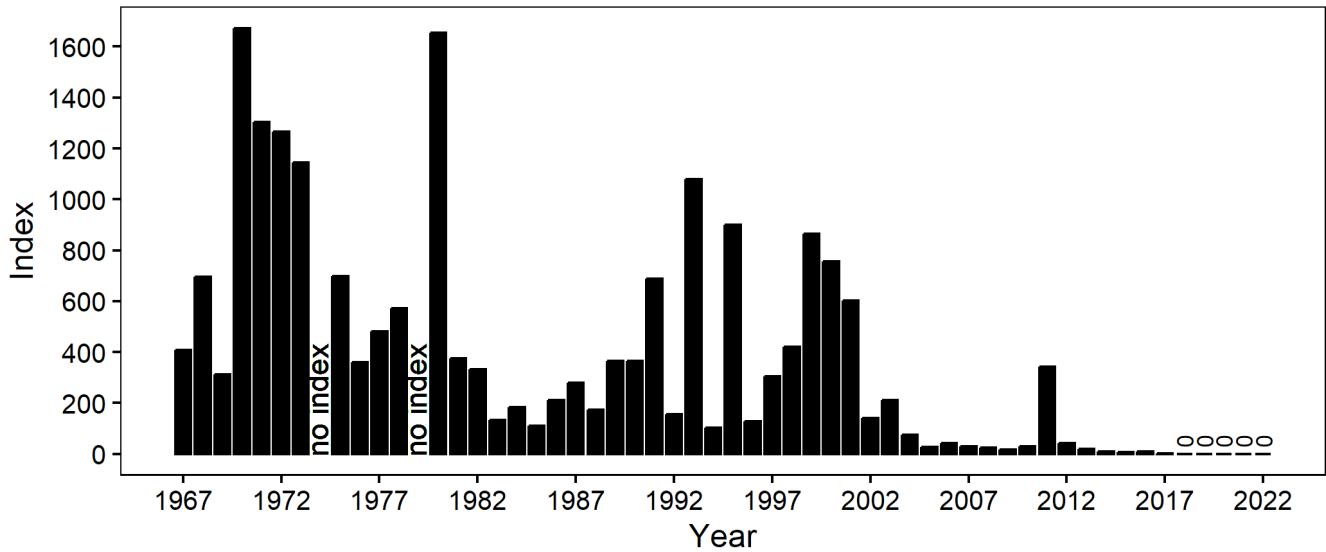


Figure 2. FMWT Delta Smelt annual abundance indices (all ages), 1967-2022. Index values for the past 5 years are shown in detail.

Age-0 Striped Bass (*Morone saxatilis*)

The 2022 abundance index was 66, representing a 15% increase from last year's index (Fig. 3).

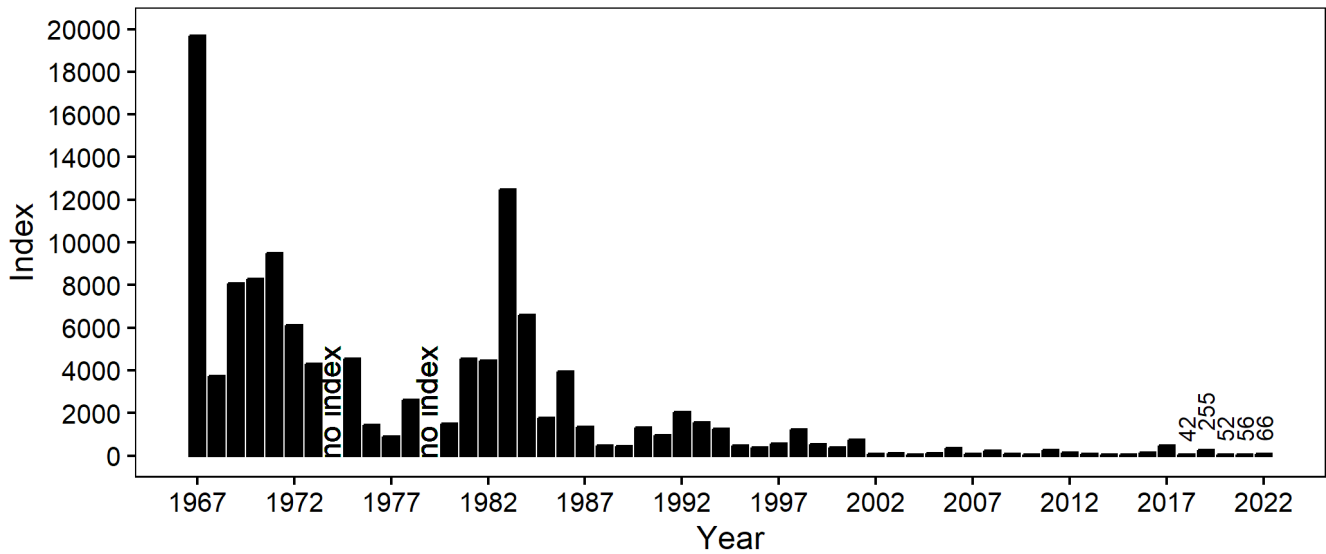


Figure 3. FMWT age-0 Striped Bass annual abundance indices, 1967-2022. Index values for the past 5 years are shown in detail.

Striped Bass were collected every month during September-December. A total of 53 age-0 Striped Bass were collected at index stations and 7 from non-index stations. Monthly catch was highest in October, with catch being highest in Suisun Bay among months (Table 1).

Table 1. Age-0 Striped Bass catch among regions during the 2022 Fall Midwater Trawl survey sampling at index and non-index stations. SRDWSC = Sacramento River Deepwater Shipping Channel.

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
September	Index	Lower Sacramento River	2
September	Index	Suisun Bay	7
September	Non-Index	Mokelumne River	4
October	Index	Carquinez Strait	1
October	Index	Eastern Delta	8
October	Index	Lower Sacramento River	3
October	Index	Lower San Joaquin River	1
October	Index	Suisun Bay	13
November	Index	Lower Sacramento River	4
November	Index	Lower San Joaquin River	1
November	Index	Suisun Bay	5
November	Non-Index	SRDWSC	1
December	Index	Carquinez Strait	1
December	Index	Eastern Delta	4
December	Index	Suisun Bay	3
December	Non-Index	Mokelumne River	1
December	Non-Index	SRDWSC	1
Total			60

Longfin Smelt (*Spirinchus thaleichthys*)

The 2022 abundance index was 403, representing a 20% increase from last year's index (Fig. 4).

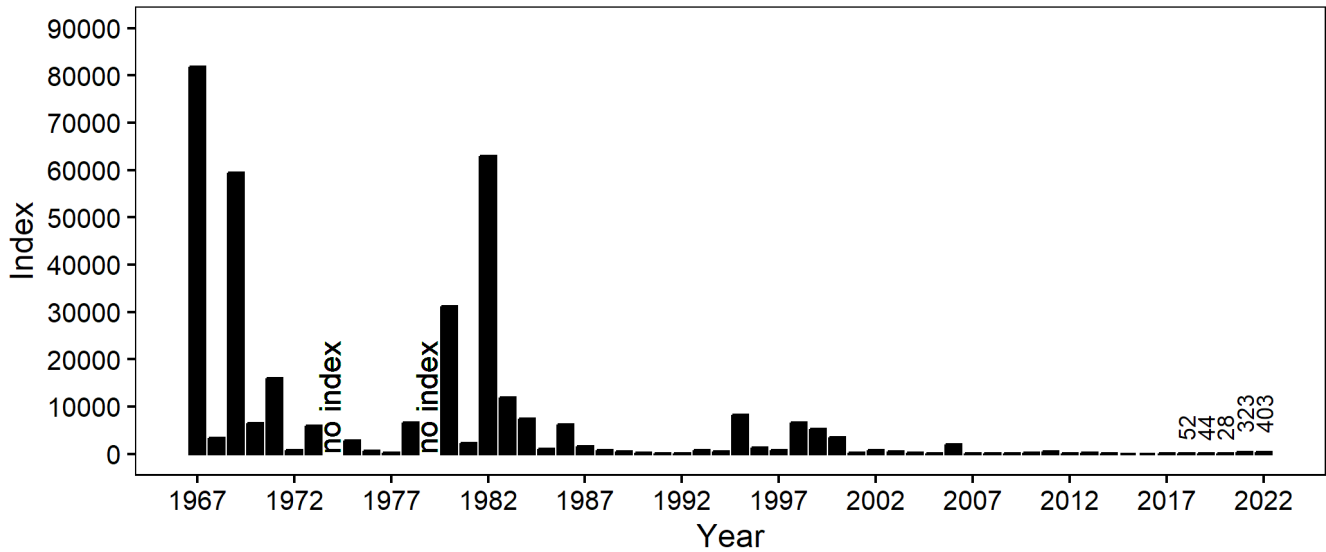


Figure 4. FMWT Longfin Smelt annual abundance indices, 1967-2022. Index values for the past 5 years are shown in detail.

A total of 187 Longfin Smelt were collected at index stations and none from non-index stations. Monthly catch was highest in October, with catch being highest in San Pablo Bay among months (Table 2). Higher catch is usually expected in December as Longfin Smelt adults return to the estuary from the ocean to spawn as water temperatures drop in the late fall or winter. The majority (>88%) of Longfin Smelt caught have been age-0 (Table 3). The FMWT only measures the first 50 individuals of any fish species caught during a tow. The adjusted length frequency adjusts for the fish not measured by calculating the ratio of total catch to the number of fish measured multiplied by the length frequency.

Table 2. Longfin Smelt catch among regions during the 2022 Fall Midwater Trawl survey sampling at index and non-index stations.

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
September	Index	Carquinez Strait	1
September	Index	Lower Sacramento River	2
September	Index	Suisun Bay	2
October	Index	San Pablo Bay	95
October	Index	Suisun Bay	4
November	Index	Lower Sacramento River	2
November	Index	Lower San Joaquin River	1
November	Index	San Pablo Bay	8
November	Index	Suisun Bay	18
December	Index	Carquinez Strait	1
December	Index	Lower San Joaquin River	1

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
December	Index	San Pablo Bay	12
December	Index	Suisun Bay	40
Total			187

Table 3. Longfin Smelt catch per station, fork length (mm), frequency, and age class data during the 2022 Fall Midwater Trawl survey sampling at all stations.

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
September	408	1	54	1.00	Age 0
September	418	1	61	1.00	Age 0
September	503	1	101	1.00	Age 1+
September	704	1	50	1.00	Age 0
September	705	1	57	1.00	Age 0
October	307	86	44	1.72	Age 0
October	307	86	49	3.44	Age 0
October	307	86	50	1.72	Age 0
October	307	86	52	6.88	Age 0
October	307	86	53	15.48	Age 0
October	307	86	54	12.04	Age 0
October	307	86	55	3.44	Age 0
October	307	86	56	3.44	Age 0
October	307	86	57	10.32	Age 0
October	307	86	58	3.44	Age 0
October	307	86	59	1.72	Age 0
October	307	86	60	5.16	Age 0
October	307	86	61	1.72	Age 0
October	307	86	62	10.32	Age 0
October	307	86	66	1.72	Age 0
October	307	86	91	1.72	Age 1+
October	307	86	95	1.72	Age 1+
October	309	2	55	1.00	Age 0
October	309	2	56	1.00	Age 0
October	311	3	56	1.00	Age 0
October	311	3	57	1.00	Age 0
October	311	3	65	1.00	Age 0

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
October	314	3	55	1.00	Age 0
October	314	3	57	1.00	Age 0
October	314	3	64	1.00	Age 0
October	325	1	53	1.00	Age 0
October	515	1	80	1.00	Age 1+
October	601	1	68	1.00	Age 0
October	603	1	83	1.00	Age 1+
October	606	1	61	1.00	Age 0
November	315	4	59	1.00	Age 0
November	315	4	67	1.00	Age 0
November	315	4	68	1.00	Age 0
November	315	4	72	1.00	Age 0
November	323	1	60	1.00	Age 0
November	328	1	60	1.00	Age 0
November	329	1	56	1.00	Age 0
November	336	1	62	1.00	Age 0
November	411	1	64	1.00	Age 0
November	415	1	55	1.00	Age 0
November	417	1	65	1.00	Age 0
November	418	1	100	1.00	Age 1+
November	503	1	66	1.00	Age 0
November	509	5	56	1.00	Age 0
November	509	5	59	2.00	Age 0
November	509	5	63	1.00	Age 0
November	509	5	67	1.00	Age 0
November	510	2	63	1.00	Age 0
November	510	2	64	1.00	Age 0
November	511	1	72	1.00	Age 0
November	512	1	95	1.00	Age 1+

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
November	513	1	70	1.00	Age 0
November	515	2	57	1.00	Age 0
November	515	2	63	1.00	Age 0
November	603	1	63	1.00	Age 0
November	704	1	74	1.00	Age 0
November	706	1	63	1.00	Age 0
November	802	1	66	1.00	Age 0
December	314	2	60	1.00	Age 0
December	314	2	64	1.00	Age 0
December	315	1	60	1.00	Age 0
December	321	1	80	1.00	Age 0
December	327	1	67	1.00	Age 0
December	329	4	57	1.00	Age 0
December	329	4	63	2.00	Age 0
December	329	4	67	1.00	Age 0
December	336	2	62	1.00	Age 0
December	336	2	70	1.00	Age 0
December	337	1	94	1.00	Age 1+
December	404	1	99	1.00	Age 1+
December	416	3	67	1.00	Age 0
December	416	3	71	1.00	Age 0
December	416	3	73	1.00	Age 0
December	417	6	60	1.00	Age 0
December	417	6	63	1.00	Age 0
December	417	6	69	1.00	Age 0
December	417	6	87	1.00	Age 1+
December	417	6	97	1.00	Age 1+
December	417	6	101	1.00	Age 1+
December	418	6	61	1.00	Age 0

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
December	418	6	63	2.00	Age 0
December	418	6	69	1.00	Age 0
December	418	6	71	1.00	Age 0
December	418	6	84	1.00	Age 0
December	502	1	71	1.00	Age 0
December	504	1	74	1.00	Age 0
December	508	3	65	1.00	Age 0
December	508	3	77	1.00	Age 0
December	508	3	94	1.00	Age 1+
December	510	5	63	1.00	Age 0
December	510	5	97	1.00	Age 1+
December	510	5	104	1.00	Age 1+
December	510	5	110	1.00	Age 1+
December	510	5	125	1.00	Age 1+
December	511	2	98	1.00	Age 1+
December	511	2	107	1.00	Age 1+
December	515	1	70	1.00	Age 0
December	517	2	72	1.00	Age 0
December	517	2	74	1.00	Age 0
December	604	4	65	2.00	Age 0
December	604	4	78	1.00	Age 0
December	604	4	95	1.00	Age 1+
December	605	1	70	1.00	Age 0
December	606	5	59	1.00	Age 0
December	606	5	65	1.00	Age 0
December	606	5	67	1.00	Age 0
December	606	5	73	1.00	Age 0
December	606	5	80	1.00	Age 0
December	811	1	108	1.00	Age 1+

Threadfin Shad (*Dorosoma petenense*)

The 2022 abundance index was 257, representing a 14% increase from last year's index (Fig. 5).

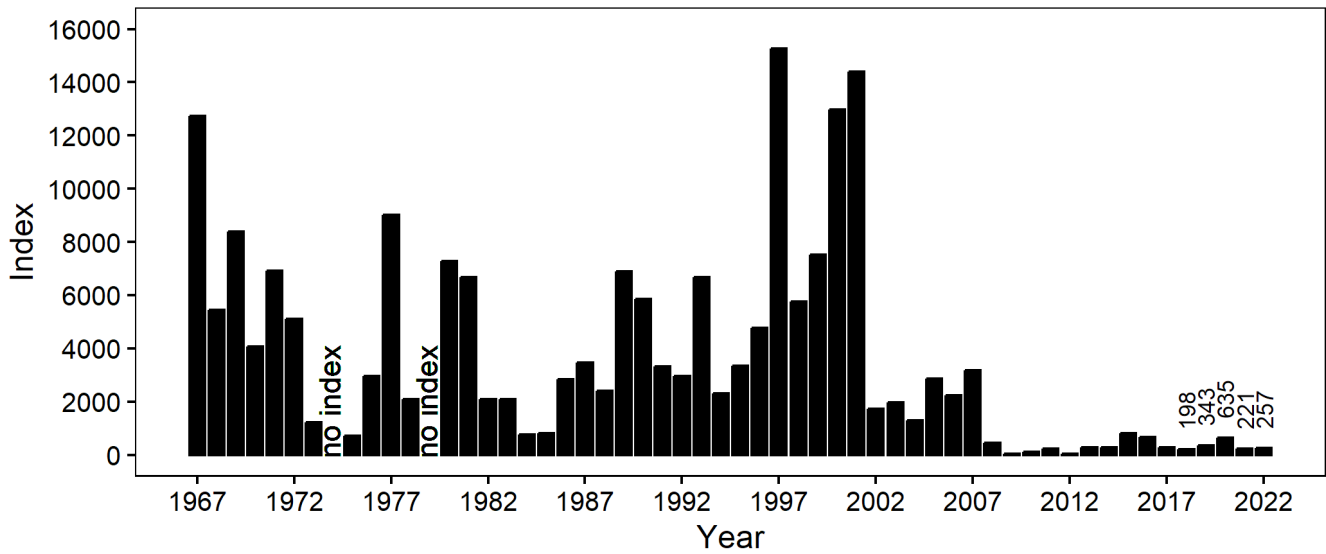


Figure 5. FMWT Threadfin Shad annual abundance indices, 1967-2022. Index values for the past 5 years are shown in detail.

A total of 211 Threadfin Shad were collected at index stations and 1,340 from non-index stations. The greatest monthly catch was in December, with catch being highest in SRDWSC among months (Table 4).

Table 4. Threadfin Shad catch among regions during the 2022 Fall Midwater Trawl survey sampling at index and non-index stations. SRDWSC = Sacramento River Deepwater Shipping Channel.

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
September	Index	Lower Sacramento River	2
September	Index	Lower San Joaquin River	4
September	Non-Index	SRDWSC	495
October	Index	Lower Sacramento River	24
October	Index	Lower San Joaquin River	4
October	Index	Suisun Bay	5
October	Non-Index	SRDWSC	336
November	Index	Lower Sacramento River	20
November	Index	Lower San Joaquin River	36
November	Index	San Pablo Bay	1
November	Index	Suisun Bay	7
November	Non-Index	SRDWSC	36

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
December	Index	Carquinez Strait	6
December	Index	Eastern Delta	12
December	Index	Lower Sacramento River	23
December	Index	Lower San Joaquin River	57
December	Index	San Pablo Bay	2
December	Index	Suisun Bay	8
December	Non-Index	Cache Slough	3
December	Non-Index	Mokelumne River	1
December	Non-Index	SRDWSC	467
December	Non-Index	Upper Sacramento River	2
Total			1,551

American Shad (*Alosa sapidissima*)

The 2022 abundance index was 698, representing a 43% increase from last year's index (Fig. 6). Abundance indices have fluctuated substantially during the period 2018-2022, ranging from a low of 398 to a high of 1,955.

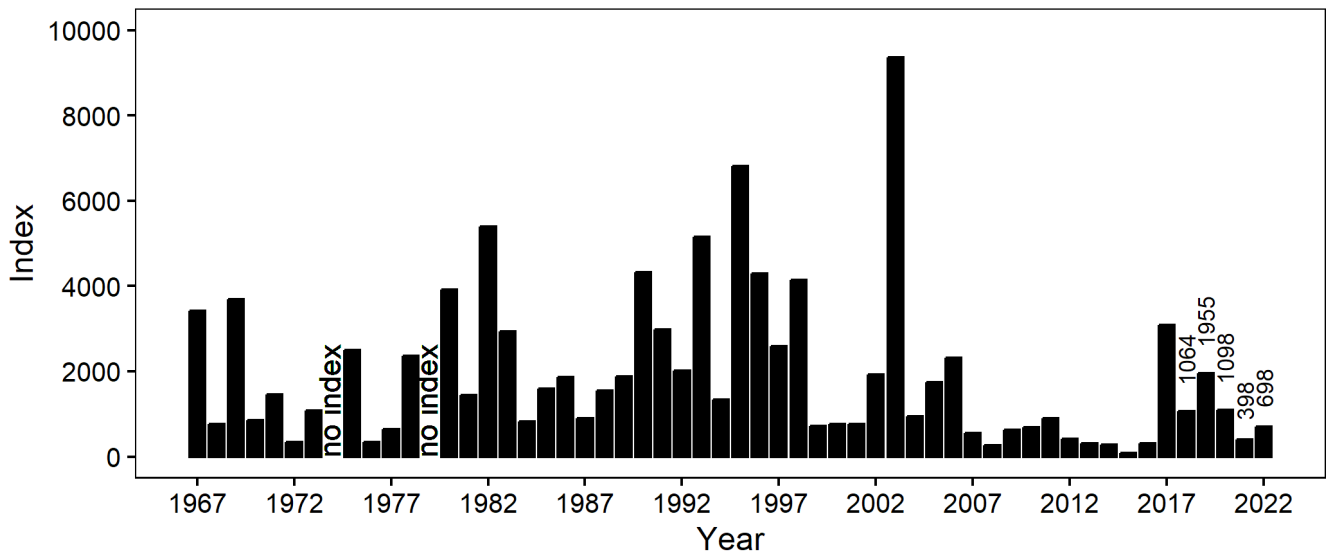


Figure 6. FMWT American Shad annual abundance indices, 1967-2022. Index values for the past 5 years are shown in detail.

A total of 432 American Shad were collected at index stations and 150 from non-index stations. American Shad were collected mostly from Suisun Bay with the greatest monthly catch in December (Table 5).

Table 5. American Shad catch among regions during the 2022 Fall Midwater Trawl survey sampling at index and non-index stations. SRDWSC = Sacramento River Deepwater Shipping Channel.

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
September	Index	Carquinez Strait	35
September	Index	Lower Sacramento River	9
September	Index	Lower San Joaquin River	1
September	Index	San Pablo Bay	4
September	Index	Suisun Bay	7
September	Non-Index	Mokelumne River	1
September	Non-Index	SRDWSC	45
September	Non-Index	Steamboat Slough	9
October	Index	Carquinez Strait	20
October	Index	Lower Sacramento River	25
October	Index	Lower San Joaquin River	4
October	Index	San Pablo Bay	2
October	Index	Suisun Bay	69
October	Non-Index	SRDWSC	33
November	Index	Carquinez Strait	17
November	Index	Lower Sacramento River	10
November	Index	Lower San Joaquin River	3
November	Index	San Pablo Bay	32
November	Index	Suisun Bay	51
November	Non-Index	SRDWSC	35
December	Index	Carquinez Strait	28
December	Index	Eastern Delta	4
December	Index	Lower Sacramento River	1
December	Index	Lower San Joaquin River	12
December	Index	San Pablo Bay	22
December	Index	Suisun Bay	76
December	Non-Index	Cache Slough	7

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
December	Non-Index	Mokelumne River	3
December	Non-Index	Napa River	1
December	Non-Index	SRDWSC	16
Total			582

Splittail (*Pogonichthys macrolepidotus*)

The 2022 Splittail abundance index was zero which shows a continuing trend of very little to no catch of Splittail in FMWT (Fig. 7). During most years, FMWT data does not accurately reflect trends in age-0 Splittail abundance, as the index is low or zero except in relatively wet years, such as 2011, when age-0 fish tend to be abundant. FMWT operates in water >2 m deep, whereas Splittail, particularly age-0 fish, appear to primarily inhabit water <2 m deep (Sommer et al. 1997; Moyle et al. 2004). However, FMWT does effectively detect strong year classes, such as the one in 1998 and the most recent one in 2011.

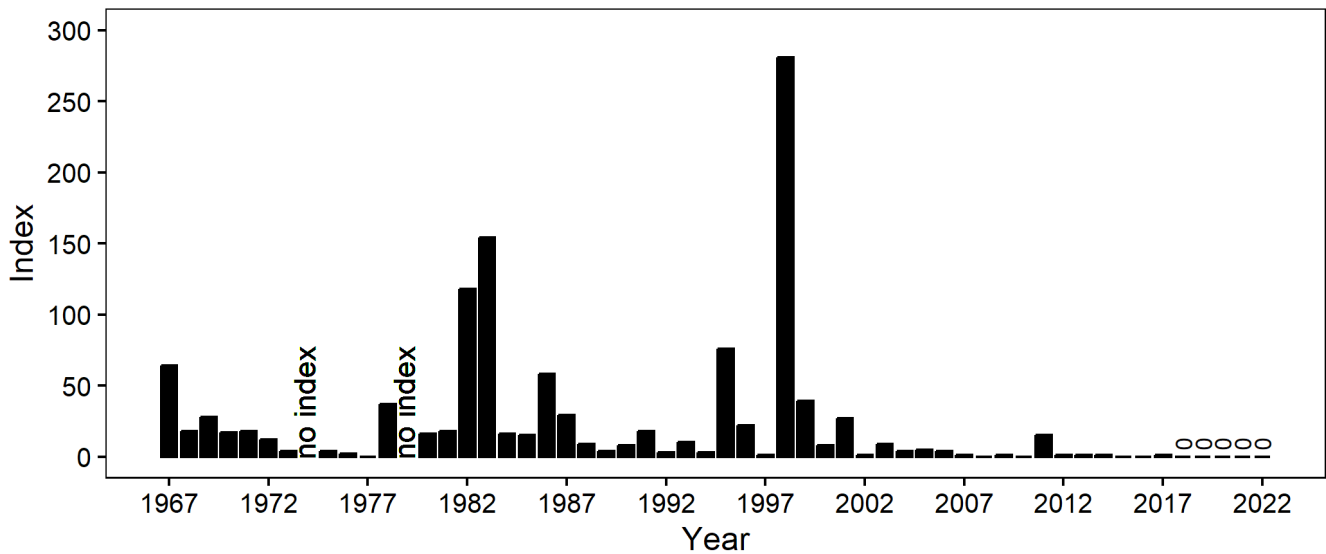


Figure 7. FMWT Splittail annual abundance indices, 1967-2022. Index values for the past 5 years are shown in detail.

Wakasagi (*Hypomesus nipponensis*)

Wakasagi were first introduced to northern California reservoirs by California Fish & Game in 1959 to provide forage for rainbow trout and other salmonids. It is believed they were present in the SF Estuary as early as 1974, but they were not detected in the Estuary until 1990 by other surveys (Moyle 2002; Davis et al. 2022). The first detection of Wakasagi by the FMWT survey was in 1995. The 2022 abundance index was zero because Wakasagi were only caught at non-index stations (Fig. 8).

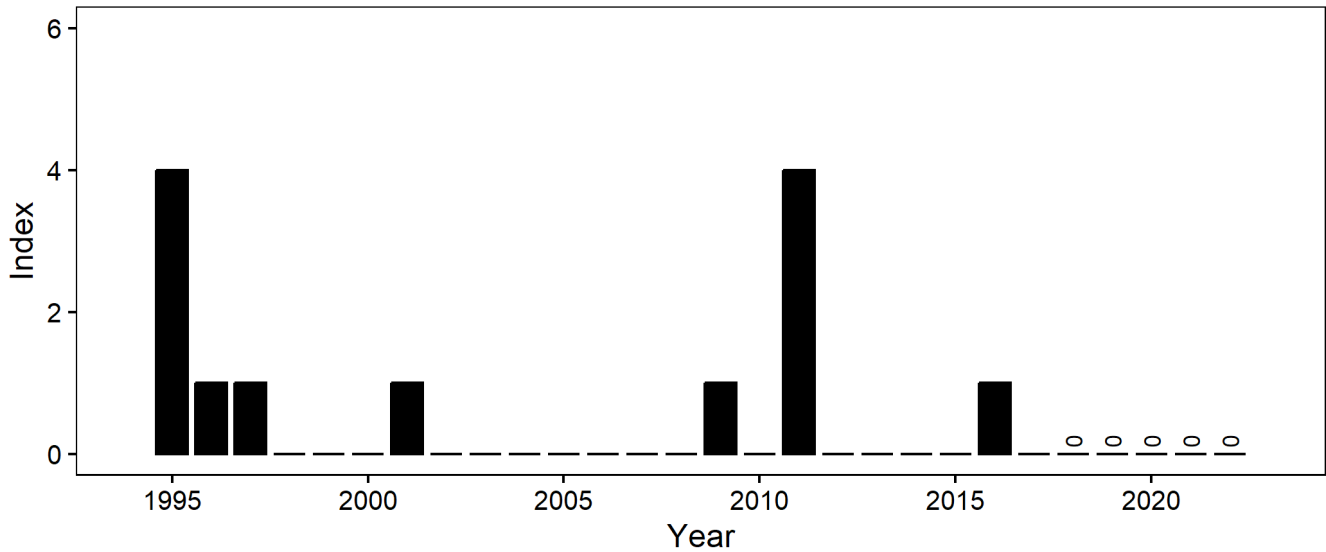


Figure 8. FMWT Wakasagi annual abundance indices, 1995-2022. Index values for the past 5 years are shown in detail.

A total of zero Wakasagi were collected at index stations and 25 from non-index stations. Monthly catch was highest in October and December, with catch being highest in SRDWSC among months (Table 6). Little is known about the life history of the California population of Wakasagi compared to the Japanese populations. Wakasagi in the SF Estuary have yet to become abundant, despite broad temperature (2-29°C) and salinity (0-29 ppt) tolerances (Moyle 2002). FMWT tends to catch this species in the freshwater areas of the north Delta, catch is infrequent and in higher numbers during wet water years.

Table 6. Wakasagi catch among regions during the 2022 Fall Midwater Trawl survey sampling at index and non-index stations. SRDWSC = Sacramento River Deepwater Shipping Channel.

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
September	Non-Index	SRDWSC	15
October	Non-Index	SRDWSC	1
November	Non-Index	SRDWSC	7
December	Non-Index	SRDWSC	2
Total			25

cc: Jim Hobbs, Steve Slater, Lauren Damon, Kathy Hieb

References

- Davis, BE, Adams, JB, Lewis, LS, Hobbs, JA, Ikemiyagi, N, Johnston, C, Mitchell, L, Shakya, A, Schreier, B and Mahardja, B. 2022. Wakasagi in the San Francisco Bay–Delta Watershed: Comparative Trends in Distribution and Life-History Traits with Native Delta Smelt. *San Francisco Estuary and Watershed Science*. 20(3). doi:[10.15447/sfews.2022v20iss3art2](https://doi.org/10.15447/sfews.2022v20iss3art2)
- Moyle PB. 2002. *Inland Fishes of California: revised and expanded*. Univ of California Press.
- Moyle PB, Baxter RD, Sommer T, Foin TC, Matern SA. 2004. Biology and Population Dynamics of Sacramento Splittail (*Pogonichthys macrolepidotus*) in the San Francisco Estuary: A Review. *San Francisco Estuary and Watershed Science*. 2(2):1–47. doi:[10.15447/sfews.2004v2iss2art3](https://doi.org/10.15447/sfews.2004v2iss2art3).
- Polansky L, Mitchell L, Newman KB. 2019. Using Multistage Design-Based Methods to Construct Abundance Indices and Uncertainty Measures for Delta Smelt. *Transactions of the American Fisheries Society*. 148(4):710–724. doi:[gf6d7j](https://doi.org/gf6d7j).
- Sommer TR, Baxter RD, Herbold B. 1997. Resilience of Splittail in the Sacramento–San Joaquin Estuary. *Transactions of the American Fisheries Society*. 126(6):961–976. doi:[cm4253](https://doi.org/cm4253).
- U.S. Fish and Wildlife Service. 2022a. Enhanced Delta Smelt Monitoring Daily Report. Accessed on 12/23/2022. <https://www.fws.gov/media/edsm-daily-report-0>.
- US. Fish and Wildlife Service. 2022b. Notification: Release of brood year 2022 delta smelt at Rio Vista in the Sacramento River. U.S. Fish and Wildlife Service San Francisco Bay-Delta Fish & Wildlife Office Sacramento, CA. http://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html
- White JR, Baxter RD. 2022. Incorporating expanded sampling into an alternative abundance index for the Fall Midwater Trawl survey. *California Fish and Wildlife Journal*. 108(4):1–16. doi:[10.51492/cfwj.108.21](https://doi.org/10.51492/cfwj.108.21).