

Memorandum

Date: January 25, 2024

To: Erin Chappell
Regional Manager
Bay Delta Region

From: Taylor Rohlin
Environmental Scientist
Bay Delta Region

Subject: 2023 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 the 100 index stations used for index calculation, and at an additional 30 non-index stations that provide enhanced distribution information (Figure 1). All fish are identified and counted at each station.

The 2023 sampling season began September 5th and was completed on December 20th. During each of the four months, all 130 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: (*Fish Distribution Map*). Additional information on prior year indices, methods, and catch data can be found on our webpage: [Fall Midwater Trawl](#).

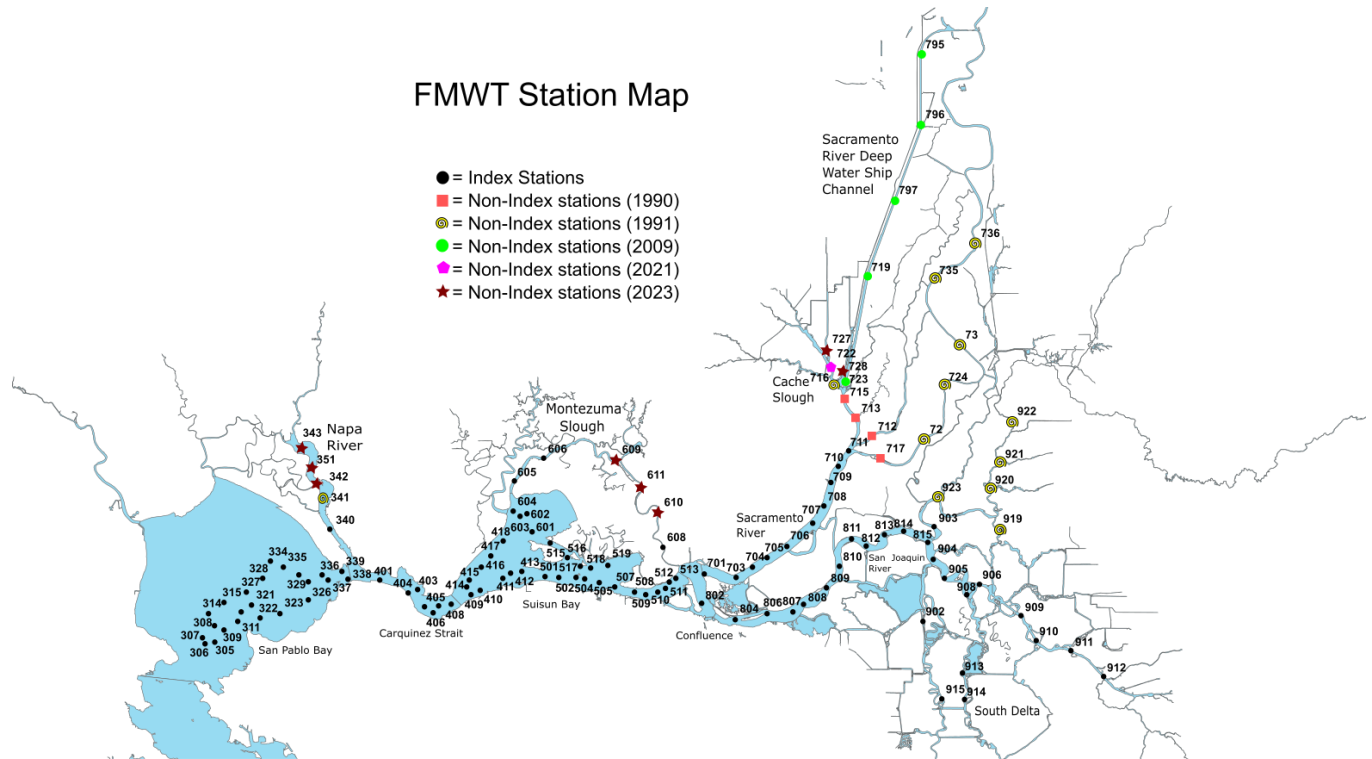


Figure 1. Map of CDFW Fall Midwater Trawl Survey monthly sampling sites (n=130) among index and non-index stations in the upper San Francisco Estuary, California, USA.

Delta Smelt (*Hypomesus transpacificus*)

No Delta Smelt were collected at any stations from September through December. The 2023 September-December index (0) is tied with 2018-2022 as the lowest index in FMWT history. An absence of Delta Smelt catch in the FMWT is consistent among other surveys in the estuary during this period. For example, the Enhanced Delta Smelt Monitoring (EDSM) survey of the U.S. Fish and Wildlife Service (USFWS) caught only 6 Delta Smelt among 16 sampling weeks (between 9/4 & 12/19) comprised of 2054 tows (U.S. Fish and Wildlife Service 2023).

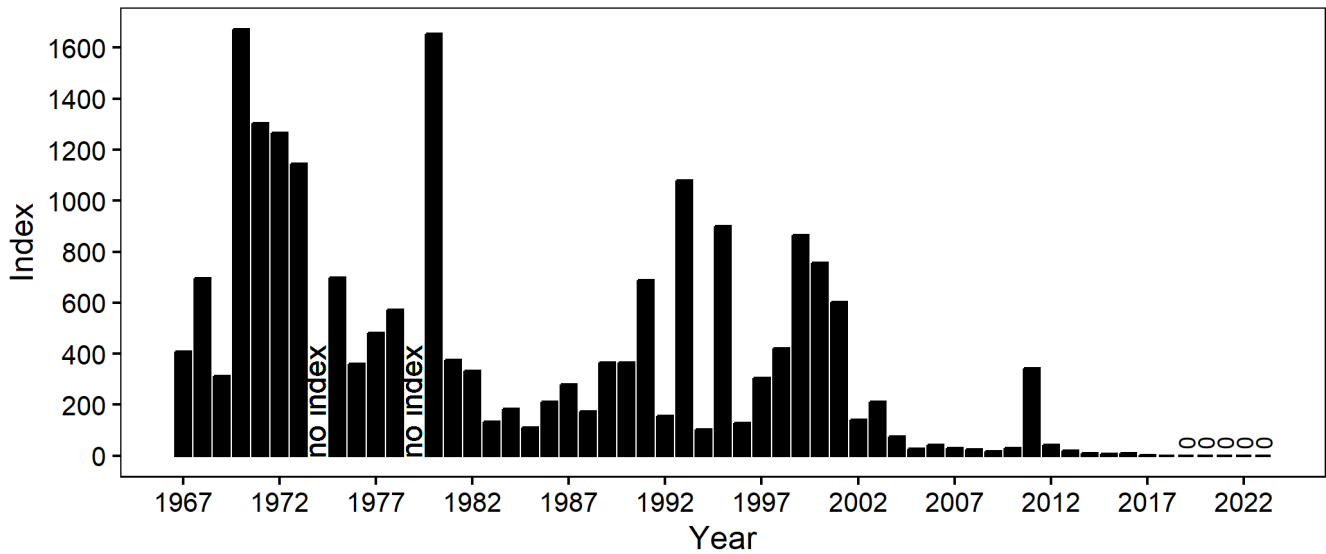


Figure 2. FMWT Delta Smelt annual abundance indices (all ages), 1967-2023. Index values for the past 5 years are shown in detail.

Age-0 Striped Bass (*Morone saxatilis*)

The 2023 abundance index was 266, representing a 75% increase from last year's index (Figure 3).

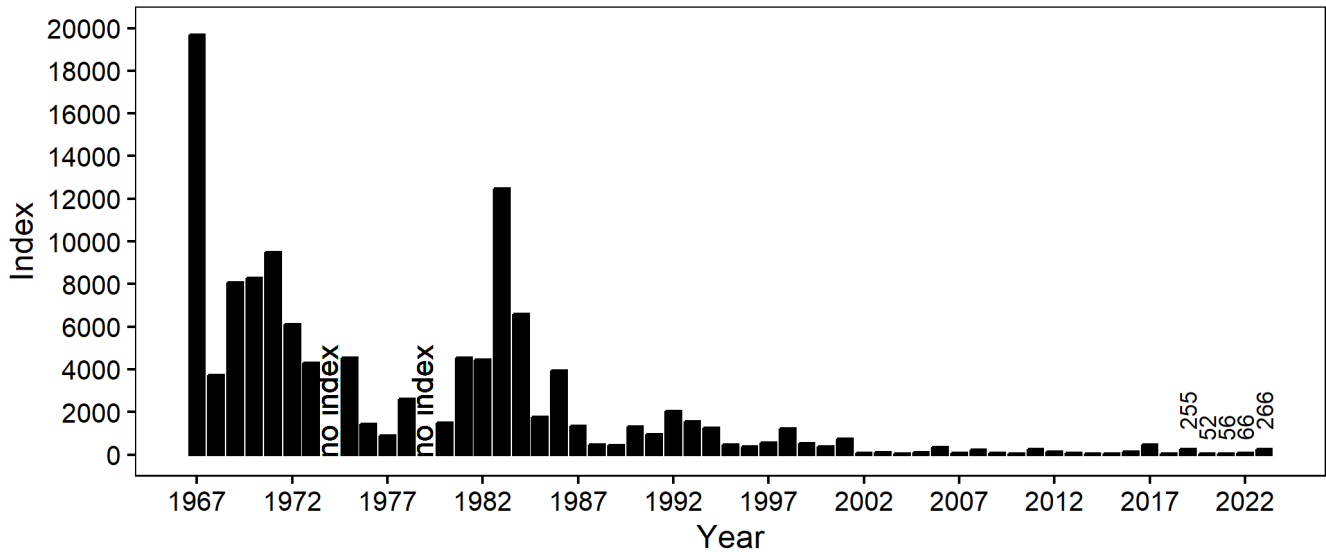


Figure 3. FMWT age-0 Striped Bass annual abundance indices, 1967-2023. Index values for the past 5 years are shown in detail.

Striped Bass were collected every month during September-December. A total of 203 age-0 Striped Bass were collected at index stations and 10 from non-index stations. Monthly catch was highest in September, with catch being highest in Suisun Bay among months (Table 1).

Table 1. Age-0 Striped Bass catch among regions during the 2023 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	Eastern Delta	3
September	Index	Lower Sacramento River	1
September	Index	Lower San Joaquin River	17
September	Index	Suisun Bay	76
September	Non-Index	Montezuma Slough	4
October	Index	Lower San Joaquin River	2
October	Index	San Pablo Bay	6
October	Index	Suisun Bay	29
October	Non-Index	Napa River	1
October	Non-Index	SRDWSC	1
October	Non-Index	Montezuma Slough	2
November	Index	Carquinez Strait	1
November	Index	Lower Sacramento River	12
November	Index	San Pablo Bay	4
November	Index	Suisun Bay	20
November	Non-Index	Montezuma Slough	2
December	Index	Carquinez Strait	5
December	Index	Eastern Delta	1
December	Index	Lower Sacramento River	1
December	Index	San Pablo Bay	5
December	Index	Suisun Bay	20
Total			213

Longfin Smelt (*Spirinchus thaleichthys*)

The 2023 abundance index was 464, representing a 15% increase from last year's index (Figure 4).

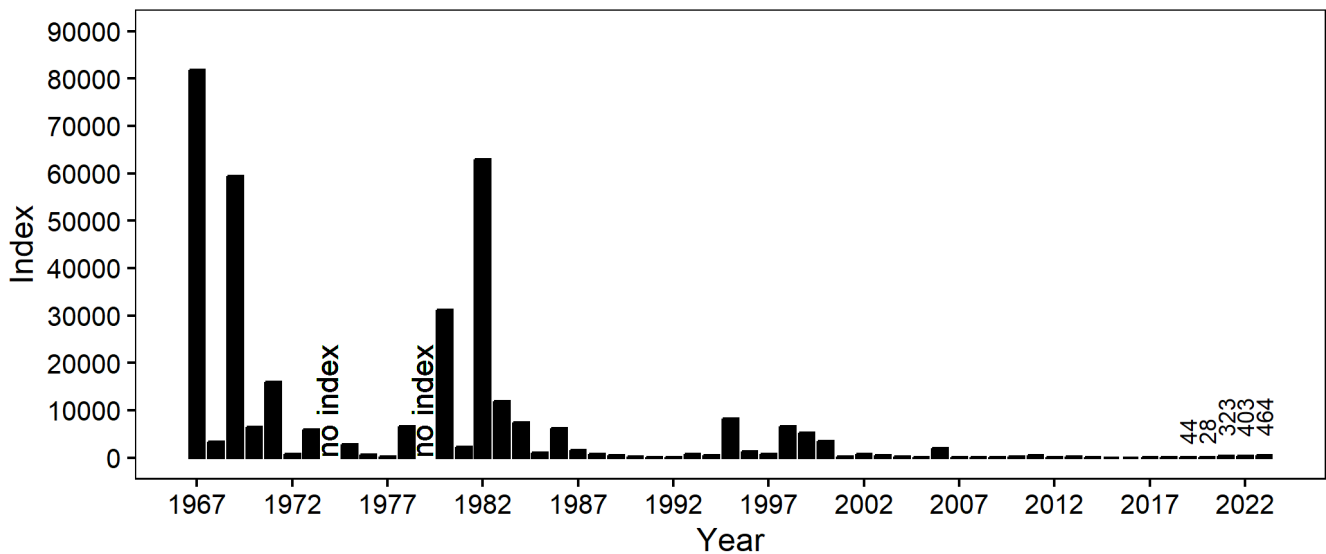


Figure 4. FMWT Longfin Smelt annual abundance indices, 1967-2023. Index values for the past 5 years are shown in detail.

A total of 219 Longfin Smelt were collected at index stations and 6 from non-index stations. Monthly catch was highest in December, 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 (92%) of Longfin Smelt caught have been age-0 (Table 3). The adjusted length frequency is calculated for fish not measured when a large catch at a station is subsampled or if a fish length cannot be determined for a damaged specimen 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 2023 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	Suisun Bay	4
October	Index	Carquinez Strait	1
October	Index	San Pablo Bay	10
October	Index	Suisun Bay	41
November	Index	Carquinez Strait	2
November	Index	Lower Sacramento River	5
November	Index	San Pablo Bay	58
November	Index	Suisun Bay	12
November	Non-Index	Montezuma Slough	4
December	Index	Carquinez Strait	11
December	Index	Lower Sacramento River	2

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
December	Index	San Pablo Bay	52
December	Index	Suisun Bay	21
December	Non-Index	Montezuma Slough	2
Total			225

Table 3. Longfin Smelt catch per station, fork length (mm), frequency, and age class data during the 2023 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	413	1	54	1.000000	age-0
September	415	2	54	1.000000	age-0
September	415	2	58	1.000000	age-0
September	416	1	50	1.000000	age-0
October	309	1	66	1.000000	age-0
October	329	8	45	1.000000	age-0
October	329	8	50	1.000000	age-0
October	329	8	52	1.000000	age-0
October	329	8	57	1.000000	age-0
October	329	8	64	1.000000	age-0
October	329	8	66	1.000000	age-0
October	329	8	67	1.000000	age-0
October	329	8	78	1.000000	age-0
October	334	1	57	1.000000	age-0
October	401	1	70	1.000000	age-0
October	409	1	77	1.000000	age-0
October	410	4	57	2.000000	age-0
October	410	4	58	1.000000	age-0
October	410	4	103	1.000000	age-1+
October	411	1	57	1.000000	age-0
October	412	3	55	1.000000	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	412	3	60	1.000000	age-0
October	412	3	65	1.000000	age-0
October	413	1	58	1.000000	age-0
October	414	1	53	1.000000	age-0
October	415	1	68	1.000000	age-0
October	416	2	43	1.000000	age-0
October	416	2	48	1.000000	age-0
October	417	2	54	1.000000	age-0
October	417	2	68	1.000000	age-0
October	418	8	54	1.000000	age-0
October	418	8	56	1.000000	age-0
October	418	8	61	1.000000	age-0
October	418	8	65	1.000000	age-0
October	418	8	66	2.000000	age-0
October	418	8	68	1.000000	age-0
October	418	8	97	1.000000	age-1+
October	503	2	63	1.000000	age-0
October	503	2	71	1.000000	age-0
October	507	1	67	1.000000	age-0
October	509	3	56	1.000000	age-0
October	509	3	63	1.000000	age-0
October	509	3	65	1.000000	age-0
October	510	1	61	1.000000	age-0
October	511	4	55	1.000000	age-0
October	511	4	65	1.000000	age-0
October	511	4	72	1.000000	age-0
October	511	4	81	1.000000	age-0
October	515	1	68	1.000000	age-0
October	516	1	80	1.000000	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	517	1	70	1.000000	age-0
October	603	1	63	1.000000	age-0
October	606	2	69	2.000000	age-0
November	308	3	56	1.000000	age-0
November	308	3	57	1.000000	age-0
November	308	3	65	1.000000	age-0
November	309	24	48	1.000000	age-0
November	309	24	49	1.000000	age-0
November	309	24	50	5.000000	age-0
November	309	24	51	2.000000	age-0
November	309	24	53	3.000000	age-0
November	309	24	54	4.000000	age-0
November	309	24	55	2.000000	age-0
November	309	24	56	1.000000	age-0
November	309	24	57	1.000000	age-0
November	309	24	58	1.000000	age-0
November	309	24	59	1.000000	age-0
November	309	24	60	2.000000	age-0
November	310	1	73	1.000000	age-0
November	315	4	51	2.000000	age-0
November	315	4	53	1.000000	age-0
November	315	4	55	1.000000	age-0
November	327	10	50	1.000000	age-0
November	327	10	52	1.000000	age-0
November	327	10	54	1.000000	age-0
November	327	10	57	4.000000	age-0
November	327	10	58	1.000000	age-0
November	327	10	70	1.000000	age-0
November	327	10	75	1.000000	age-0

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
November	328	5	53	1.000000	age-0
November	328	5	55	1.000000	age-0
November	328	5	61	1.000000	age-0
November	328	5	64	1.000000	age-0
November	328	5	68	1.000000	age-0
November	329	1	57	1.000000	age-0
November	334	5	55	1.000000	age-0
November	334	5	57	1.000000	age-0
November	334	5	65	1.000000	age-0
November	334	5	68	1.000000	age-0
November	334	5	100	1.000000	age-1+
November	335	2	51	1.000000	age-0
November	335	2	57	1.000000	age-0
November	336	3	68	2.000000	age-0
November	336	3	69	1.000000	age-0
November	406	2	70	1.000000	age-0
November	406	2	92	1.000000	age-1+
November	416	2	57	1.000000	age-0
November	416	2	66	1.000000	age-0
November	418	4	51	1.000000	age-0
November	418	4	53	1.000000	age-0
November	418	4	56	1.000000	age-0
November	418	4	58	1.000000	age-0
November	507	5	54	1.000000	age-0
November	507	5	59	1.000000	age-0
November	507	5	60	1.000000	age-0
November	507	5	63	1.000000	age-0
November	507	5	68	1.000000	age-0
November	606	1	54	1.000000	age-0

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
November	609	4	63	1.000000	age-0
November	609	4	69	1.000000	age-0
November	609	4	74	1.000000	age-0
November	609	4	75	1.000000	age-0
November	703	3	60	1.000000	age-0
November	703	3	66	1.000000	age-0
November	703	3	68	1.000000	age-0
November	704	2	56	1.000000	age-0
November	704	2	73	1.000000	age-0
December	321	8	60	2.000000	age-0
December	321	8	63	2.000000	age-0
December	321	8	68	1.000000	age-0
December	321	8	73	1.000000	age-0
December	321	8	88	1.000000	age-1+
December	321	8	103	1.000000	age-1+
December	325	3	56	2.000000	age-0
December	325	3	59	1.000000	age-0
December	336	35	48	2.058824	age-0
December	336	35	53	1.029412	age-0
December	336	35	54	3.088235	age-0
December	336	35	55	4.117647	age-0
December	336	35	56	2.058824	age-0
December	336	35	57	3.088235	age-0
December	336	35	58	4.117647	age-0
December	336	35	59	1.029412	age-0
December	336	35	61	2.058824	age-0
December	336	35	62	2.058824	age-0
December	336	35	63	1.029412	age-0
December	336	35	65	3.088235	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	336	35	66	1.029412	age-0
December	336	35	67	1.029412	age-0
December	336	35	68	1.029412	age-0
December	336	35	71	1.029412	age-0
December	336	35	111	2.058824	age-1+
December	337	6	55	1.000000	age-0
December	337	6	56	2.000000	age-0
December	337	6	57	2.000000	age-0
December	337	6	68	1.000000	age-0
December	340	9	57	1.000000	age-0
December	340	9	61	1.000000	age-0
December	340	9	63	2.000000	age-0
December	340	9	70	1.000000	age-0
December	340	9	74	1.000000	age-0
December	340	9	75	1.000000	age-0
December	340	9	109	1.000000	age-1+
December	340	9	117	1.000000	age-1+
December	405	1	103	1.000000	age-1+
December	406	1	69	1.000000	age-0
December	501	1	97	1.000000	age-1+
December	502	1	107	1.000000	age-1+
December	503	1	95	1.000000	age-1+
December	505	3	60	1.000000	age-0
December	505	3	69	1.000000	age-0
December	505	3	96	1.000000	age-1+
December	507	1	65	1.000000	age-0
December	509	1	61	1.000000	age-0
December	510	1	73	1.000000	age-0
December	605	1	102	1.000000	age-1+

<i>Month</i>	<i>Station</i>	<i>Catch</i>	<i>Fork Length</i>	<i>Adjusted Length Frequency</i>	<i>Age Class</i>
December	606	11	57	1.000000	age-0
December	606	11	68	1.000000	age-0
December	606	11	72	1.000000	age-0
December	606	11	76	4.000000	age-0
December	606	11	78	1.000000	age-0
December	606	11	80	2.000000	age-0
December	606	11	97	1.000000	age-1+
December	609	1	67	1.000000	age-0
December	610	1	61	1.000000	age-0
December	705	2	61	1.000000	age-0
December	705	2	81	1.000000	age-0

Threadfin Shad (*Dorosoma petenense*)

The 2023 abundance index was 515, representing a 50% increase from last year's index (Figure 5).

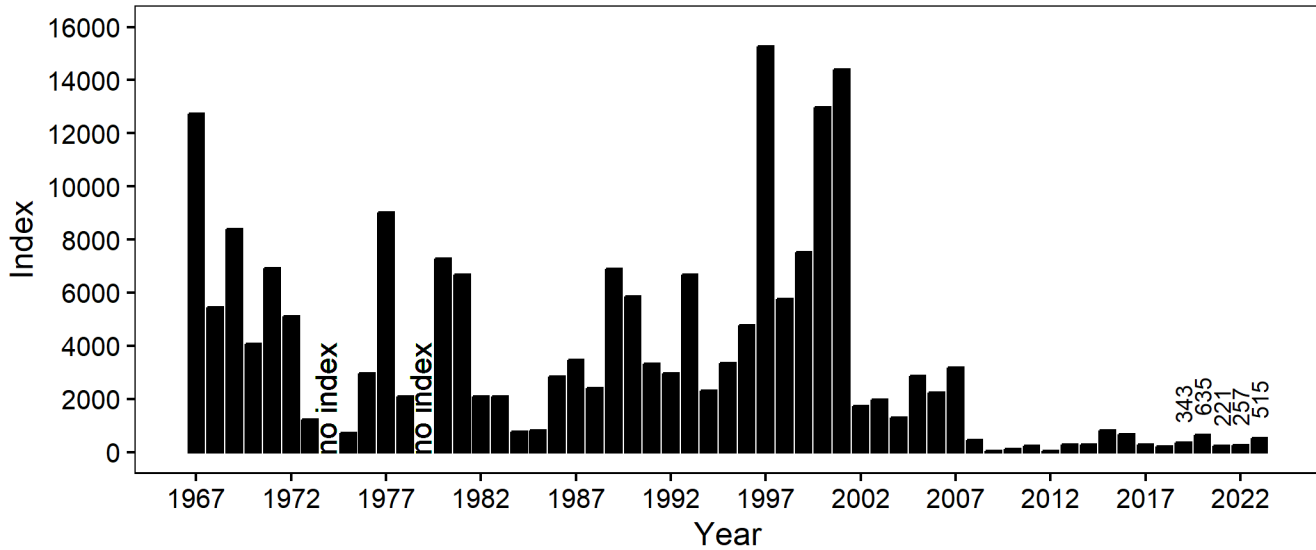


Figure 5. FMWT Threadfin Shad annual abundance indices, 1967-2023. Index values for the past 5 years are shown in detail.

A total of 424 Threadfin Shad were collected at index stations and 1498 from non-index stations. The greatest monthly catch was in September, with catch being highest in SRDWSC among months (Table 4).

Table 4. Threadfin Shad catch among regions during the 2023 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	Eastern Delta	74
September	Index	Lower Sacramento River	15
September	Index	Lower San Joaquin River	9
September	Index	Suisun Bay	15
September	Non-Index	Cache Slough	4
September	Non-Index	Montezuma Slough	13
September	Non-Index	SRDWSC	466
October	Index	Eastern Delta	9
October	Index	Lower Sacramento River	2
October	Index	Lower San Joaquin River	2

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
October	Index	San Pablo Bay	1
October	Index	Suisun Bay	70
October	Non-Index	Montezuma Slough	71
October	Non-Index	SRDWSC	227
November	Index	Eastern Delta	75
November	Index	Lower Sacramento River	75
November	Index	Lower San Joaquin River	1
November	Index	San Pablo Bay	2
November	Index	Suisun Bay	27
November	Non-Index	Montezuma Slough	13
November	Non-Index	Napa River	5
November	Non-Index	SRDWSC	306
December	Index	Carquinez Strait	1
December	Index	Lower Sacramento River	7
December	Index	Lower San Joaquin River	2
December	Index	Suisun Bay	37
December	Non-Index	Montezuma Slough	71
December	Non-Index	SRDWSC	322
Total			1,922

American Shad (*Alosa sapidissima*)

The 2023 abundance index was 2421, representing a 71% increase from last year's index (Figure 6). Abundance indices have fluctuated substantially during the period 2019-2023, ranging from a low of 398 to a high of 2421.

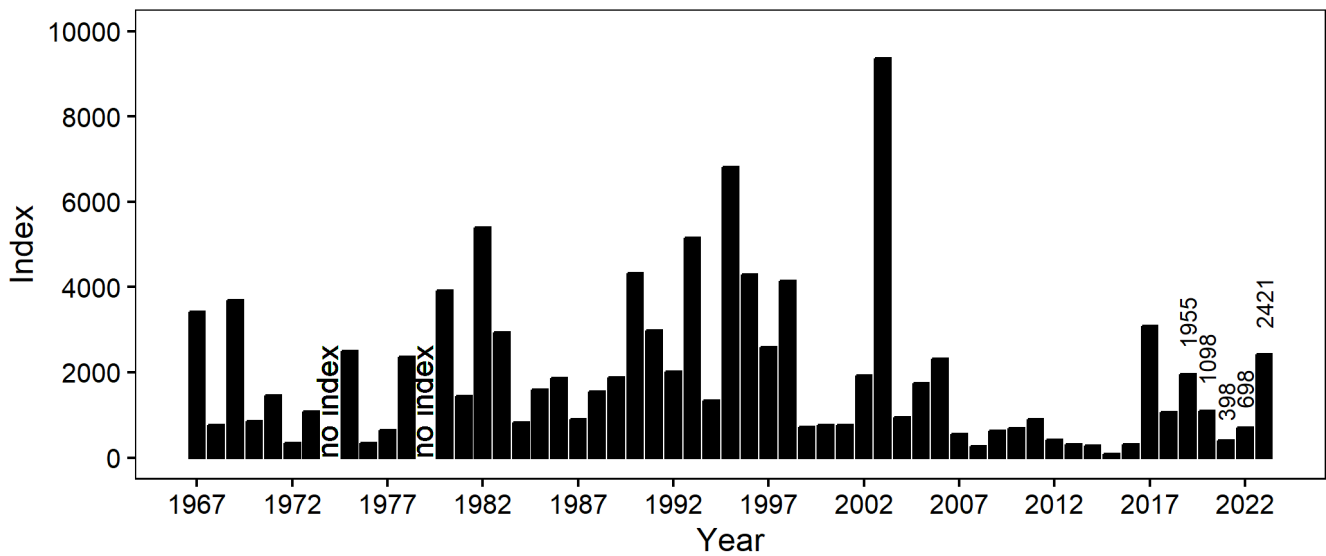


Figure 6. FMWT American Shad annual abundance indices, 1967-2023. Index values for the past 5 years are shown in detail.

A total of 1539 American Shad were collected at index stations and 505 from non-index stations. American Shad were collected mostly from Suisun Bay with the greatest monthly catch in September (Table 5).

Table 5. American Shad catch among regions during the 2023 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	3
September	Index	Eastern Delta	65
September	Index	Lower Sacramento River	106
September	Index	Lower San Joaquin River	10
September	Index	San Pablo Bay	13
September	Index	Suisun Bay	184
September	Non-Index	Cache Slough	21
September	Non-Index	Montezuma Slough	63
September	Non-Index	Napa River	1
September	Non-Index	SRDWSC	96
September	Non-Index	Steamboat Slough	1
September	Non-Index	Upper Sacramento River	4
October	Index	Carquinez Strait	6

<i>Month</i>	<i>Type</i>	<i>Region</i>	<i>Catch</i>
October	Index	Eastern Delta	1
October	Index	Lower Sacramento River	3
October	Index	San Pablo Bay	53
October	Index	Suisun Bay	204
October	Non-Index	Cache Slough	4
October	Non-Index	Montezuma Slough	64
October	Non-Index	Napa River	8
October	Non-Index	SRDWSC	111
October	Non-Index	Upper Sacramento River	1
November	Index	Carquinez Strait	2
November	Index	Eastern Delta	75
November	Index	Lower Sacramento River	107
November	Index	Lower San Joaquin River	1
November	Index	San Pablo Bay	86
November	Index	Suisun Bay	196
November	Non-Index	Montezuma Slough	22
November	Non-Index	Napa River	5
November	Non-Index	SRDWSC	60
December	Index	Carquinez Strait	37
December	Index	Eastern Delta	1
December	Index	Lower Sacramento River	18
December	Index	Lower San Joaquin River	11
December	Index	San Pablo Bay	140
December	Index	Suisun Bay	217
December	Non-Index	Cache Slough	1
December	Non-Index	Montezuma Slough	6
December	Non-Index	Napa River	20
December	Non-Index	SRDWSC	17
Total			2,044

Splittail (*Pogonichthys macrolepidotus*)

The 2023 Splittail abundance index was 0 which shows a continuing trend of very little to no catch of Splittail in FMWT (Figure 7). During most years, FMWT data probably 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 following increased recruitment associated with floodplain inundation. 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).

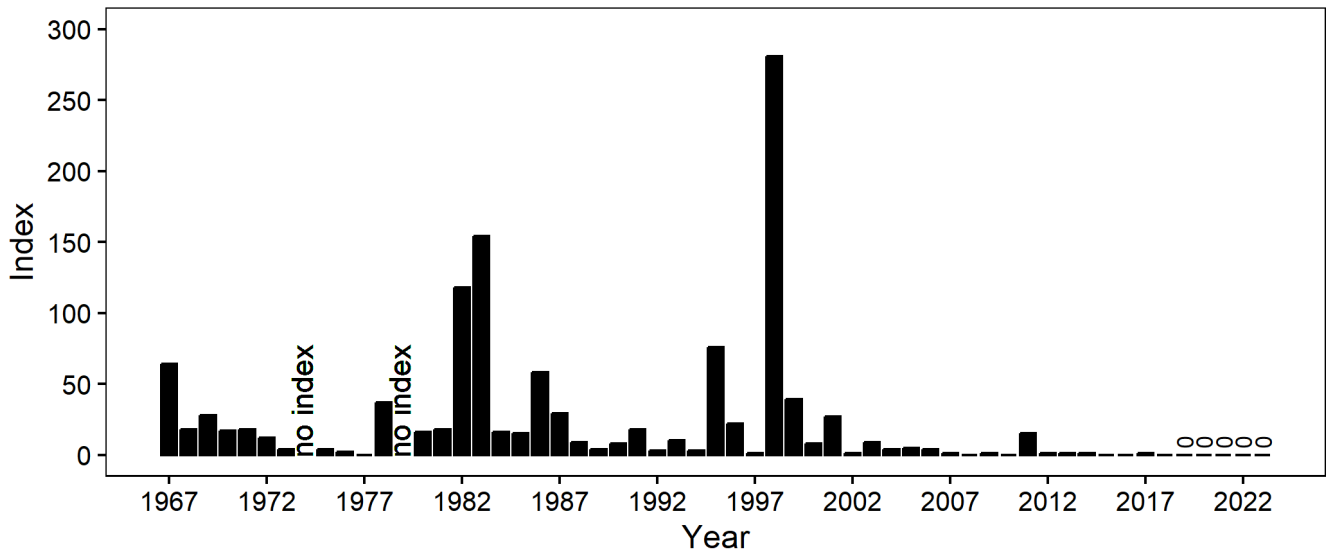


Figure 7. FMWT Splittail annual abundance indices, 1967-2023. Index values for the past 5 years are shown in detail.

A total of 0 Splittail were collected at index stations, and 4 from non-index stations. Monthly catch was highest in September, with catch only occurring in Montezuma Slough among months (Table 6).

Table 6. Splittail catch among regions during the 2023 Fall Midwater Trawl survey sampling at index and non-index stations.

Month	Type	Region	Catch
September	Non-Index	Montezuma Slough	3
December	Non-Index	Montezuma Slough	1
Total			4

Wakasagi (*Hypomesus nipponensis*)

Wakasagi were first introduced to northern California reservoirs by California Fish & Game in 1959 as a forage fish. It is believed they were present in the San Francisco Estuary as early as 1974, but they were not detected in the estuary until 1990 by other surveys (Moyle 2002). The first detection of Wakasagi by the FMWT survey was in 1995. The 2023 abundance index was 0 because Wakasagi were only caught at non-index stations in the SRDWSC (Figure 8).

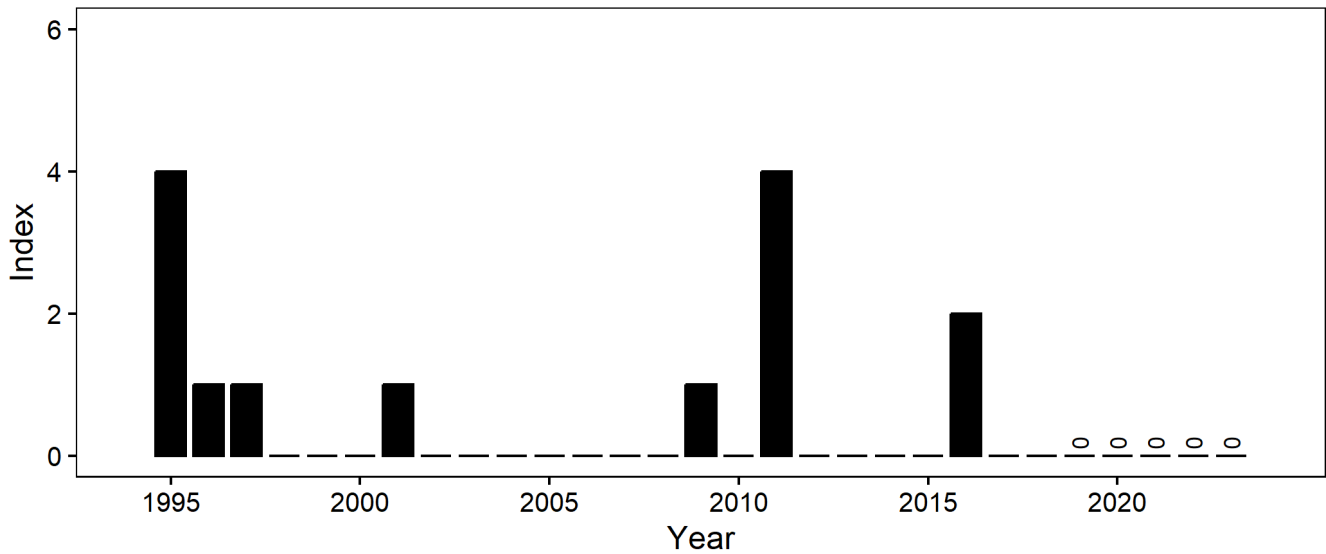


Figure 8. FMWT Wakasagi annual abundance indices, 1995-2023. Index values for the past 5 years are shown in detail.

A total of 0 Wakasagi were collected at index stations and 40 from non-index stations. Monthly catch was highest in November, with catch being highest in SRDWSC among months (Table 7). 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 7. Wakasagi catch among regions during the 2023 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	13
October	Non-Index	SRDWSC	6
November	Non-Index	SRDWSC	15
December	Non-Index	SRDWSC	6
Total			40

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