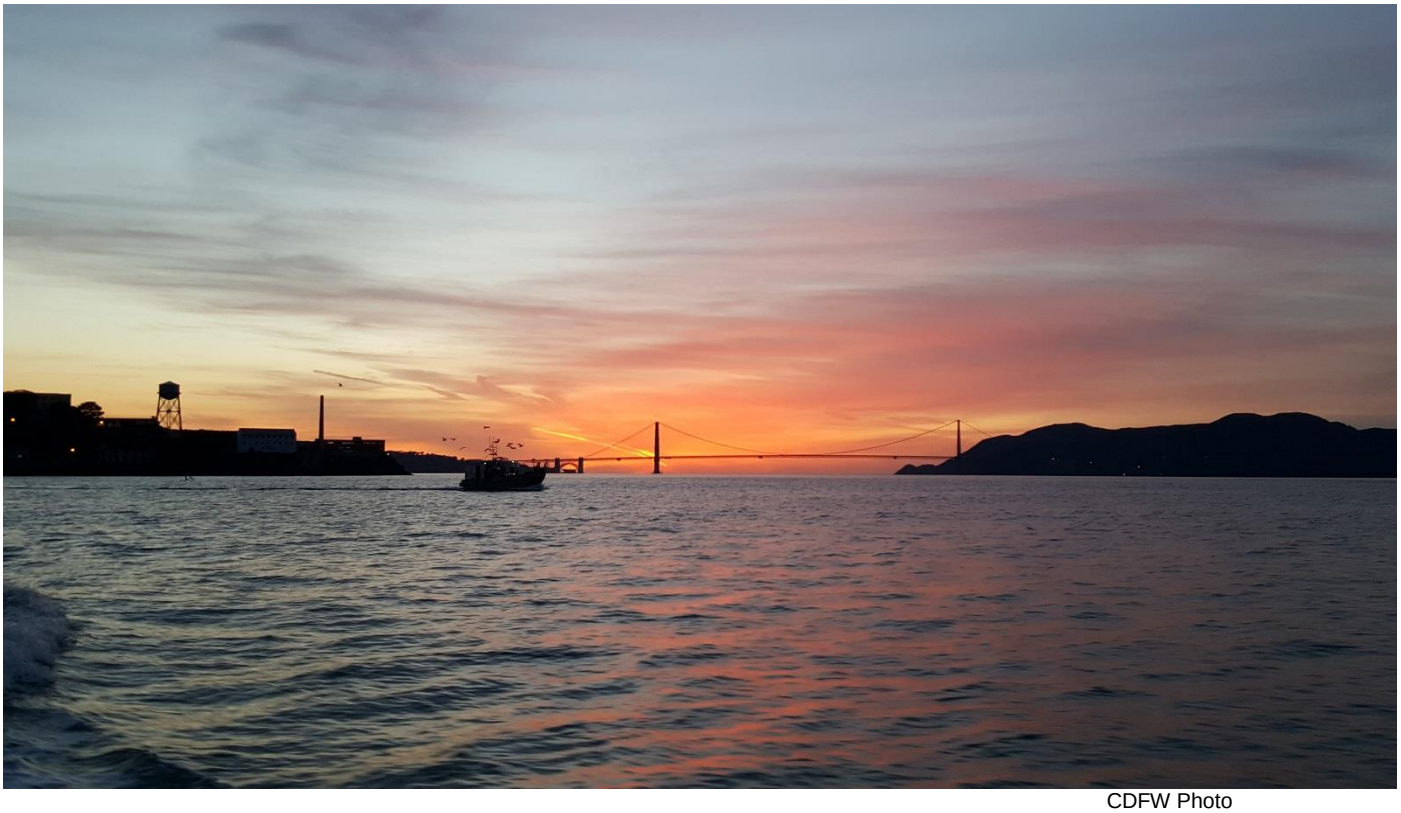
2017-18 Summary of the Pacific Herring Spawning Population and Commercial Fisheries in San Francisco Bay



CDFW Photo

2018
Final Report

California Department of Fish and Wildlife
Aquaculture and Bay Management Project
Herring Management and Research
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INTRODUCTION

The California Department of Fish and Wildlife (Department) has conducted Pacific Herring (*Clupea pallasii*) research in San Francisco Bay as part of its ongoing monitoring and management of the commercial fishery since 1972. The Department uses annual dive surveys and individual spawn deposition surveys to calculate a spawning biomass estimate each year. It also uses mid-water trawl survey data to estimate the age class structure, sex composition, and general condition of the San Francisco Bay spawning population each season. The Department collaborates with the industry to collect commercial fishery data to determine age class structure of the population. The annual biomass estimate, age class structure, condition indices, commercial catch analysis, along with various environmental indicators all serve as the basis for establishing fishing quotas for the next season and are used by the Department to make recommendations to the Fish and Game Commission (Commission) who has regulatory authority over the fishery. Specific information on commercial herring fishing regulations are contained in Title 14, California Code of Regulations, Sections 163 and 164. When required, the Department prepares an Environmental Document using the Commission's certified regulatory program to outline observed trends in the California Pacific Herring population and to analyze potential environmental impacts associated with the fishery and proposed annual regulation changes.

More information on the life history of Pacific Herring, the Department's management objectives, and the review and analysis of proposed commercial herring harvest regulations can be found in the 1998 Final Environmental Document and the most recent Final Supplemental Environmental Document (FSED) **https://www.wildlife.ca.gov/Fishing/Commercial/Herring/CEQA.**

POPULATION SUMMARY

Spawning Biomass Estimate

The 2017-18 Pacific Herring season in San Francisco Bay ended with a below average spawning biomass estimate of 15,300 tons. The historical average equals 48,500 tons (1979-present), and this was the fourth year in a row of below average herring returns (Figure 1).

There were 14 spawn events through the season starting in mid-December and ending in mid-March (Table 1). The first recorded spawn of the season occurred December 17, 2017, and the last recorded spawn occurred March 11, 2018. The largest spawn event occurred along the San Francisco Waterfront from the 7-9 of January, with 5,783 tons of herring estimated. There were small spawning events in Richardson Bay and isolated spawns in the South and East Bay areas of San Francisco Bay. Several small and moderate sized spawn events occurred in the vicinity of Point Richmond this season, a shift from a more recent trend of Marin County as the primary spawn area (see Figure 2 for spatial distribution of all spawn events).

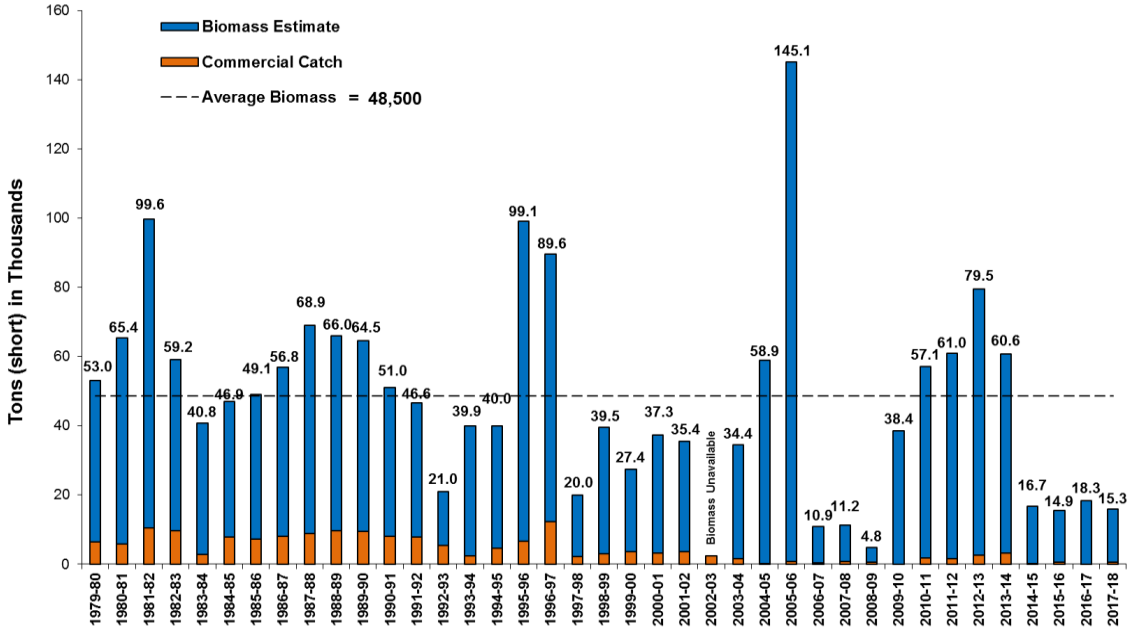

Figure 1. San Francisco Bay Pacific Herring biomass estimates and commercial catch, 1979-2018.

Table 1. San Francisco Bay Pacific Herring spawning biomass estimate by event with commercial catch totals, 2017-18.

San Francisco Bay Pacific Herring spawning biomass estimate by event with commercial catch totals 2017-18

#	Approximate Spawn/Catch Date	Location	Submerged Areas	Shore Areas	Spawn Total	Gill-Net * Catch	HEOK	Biomass Total
1	December 17, 2017	Alameda Rock Wall - Ballena Bay		65	65			65
2	December 19, 2017	Point Richmond	13		13			13
3	December 29-31, 2017	Point Richmond	779		779			779
4	January 7-9, 2018	San Francisco Waterfront		5,618	5,618	164		5,783
5	January 7-9, 2018	Richardson Bay	401		401			401
6	January 17-18, 2018	Coyote Point		42	42	50		91
7	January 23-25, 2018	Marin Shoreline	2,667	998	3,664	397		4,061
8	January 26-27, 2018	Point Richmond	3,031		3,031			3,031
9	February 1-2, 2018	Point Richmond	236		236			236
10	February 9-11, 2018	Point Molate/Pt Orient	103	7	110			110
11	February 13-15, 2018	Richardson Bay	604		604			604
12	February 25-27, 2018	Richardson Bay	15		15			15
13	March 5-6, 2018	Point Richmond	*trace*		0			*trace*
14	March 10-11, 2018	Richardson Bay	124		124			124
Spawn Events (n) = 14		**Totals in short tons**	7,973	6,730	**14,703**	**611**	**0**	**15,313**

Figure 2. San Francisco Bay herring spawn event map for the 2017-18 season.

Age Structure and Biological Characteristics

Herring from both the San Francisco Bay spawning population and the commercial catch are aged each season using otolith surface readings. The proportion of age-5, -6, -7 and -8 fish was the highest on record. Historically, the commercial fishery is supported by a greater proportion of older fish than exists in the spawning population as a whole, which reduces the burden on younger cohorts to support the fishery. Conversely, the proportion and tonnage (Figures 3 and 4) of age 3 herring in the spawning biomass for the 2017-18 season was the lowest on record (1982-83 to present). The proportion of age 2 herring was also well below average. Reduced numbers of young fish negatively affect recruitment to the commercial fishery (Figure 5). This low recruitment of herring to the spawning biomass may also result in reduced reproductive potential in subsequent seasons and lead to reduced availability of herring as forage in ocean and bay ecosystems.

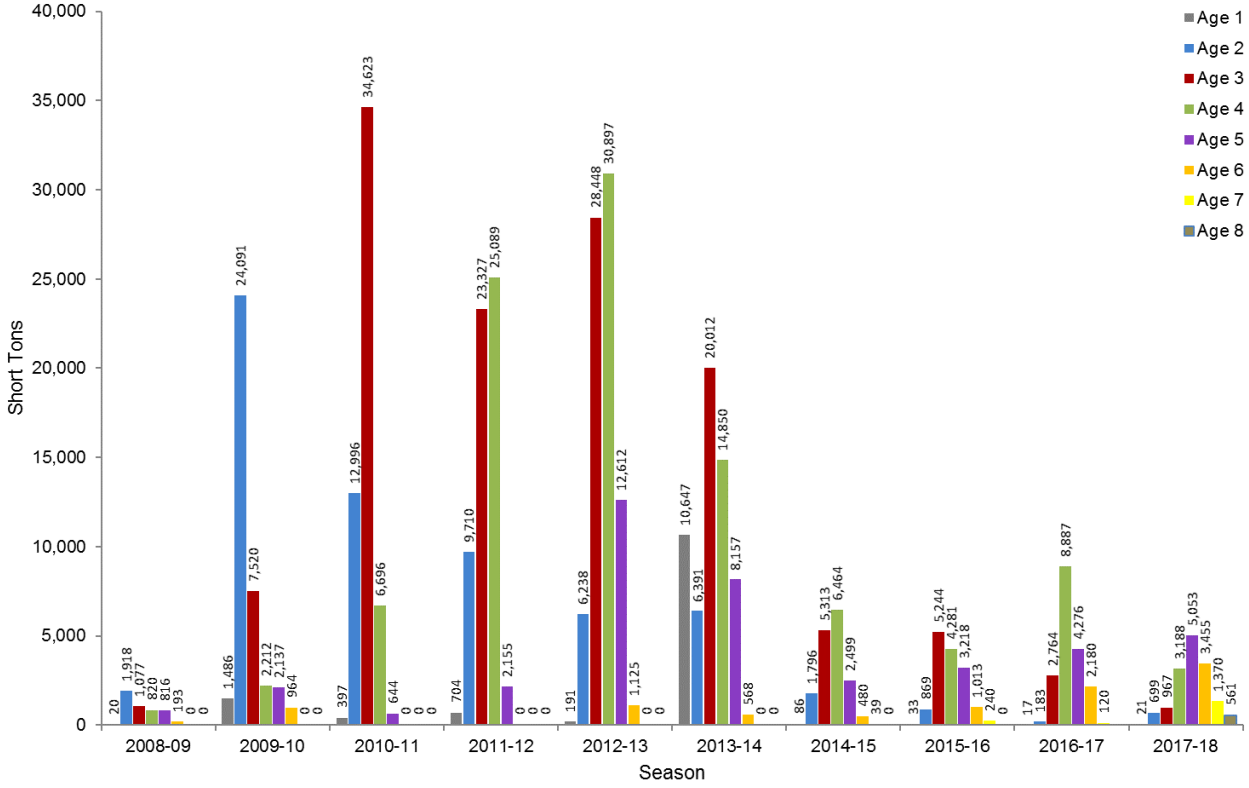

Figure 3. Estimated short tons of San Francisco Bay spawning biomass by age class for the 2008-09 to 2017-18 seasons based on research catch.

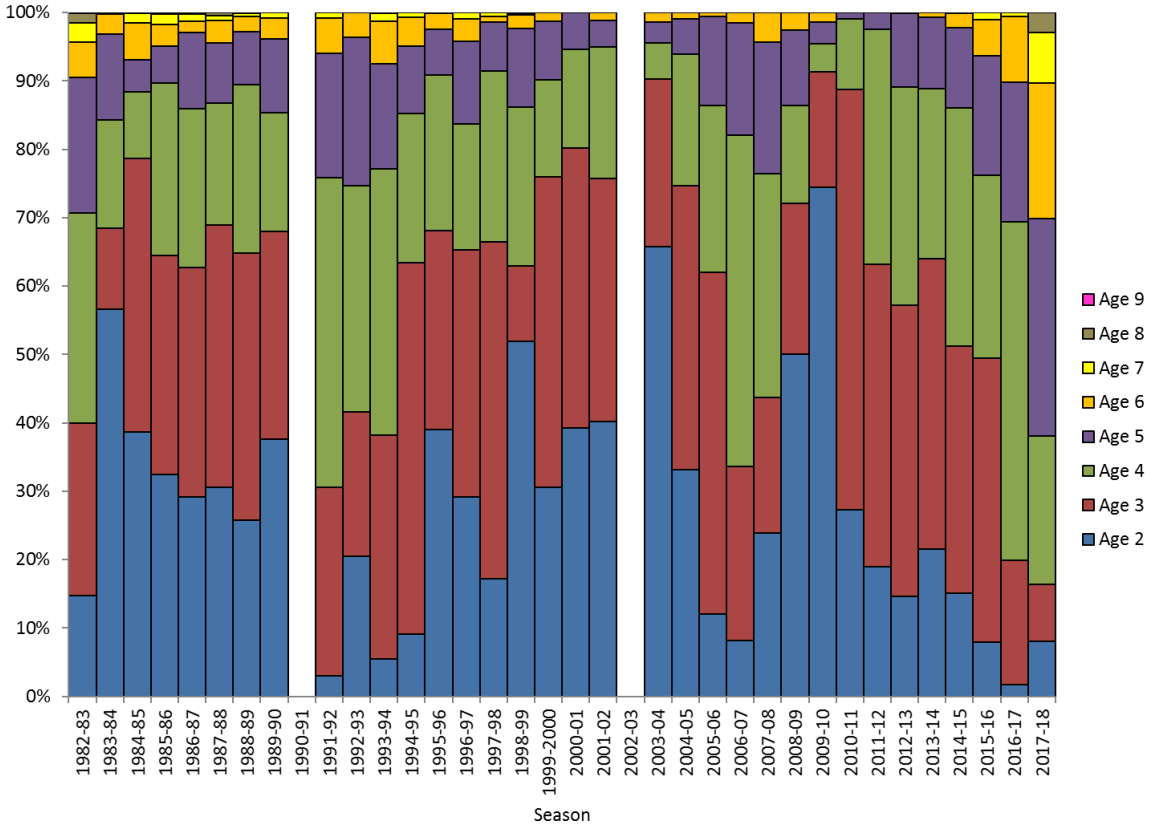

Figure 4. Percent at age, by number, of ripe fish for the San Francisco Bay herring spawning biomass. Based on age composition of the research catch (excluding age-1 fish).

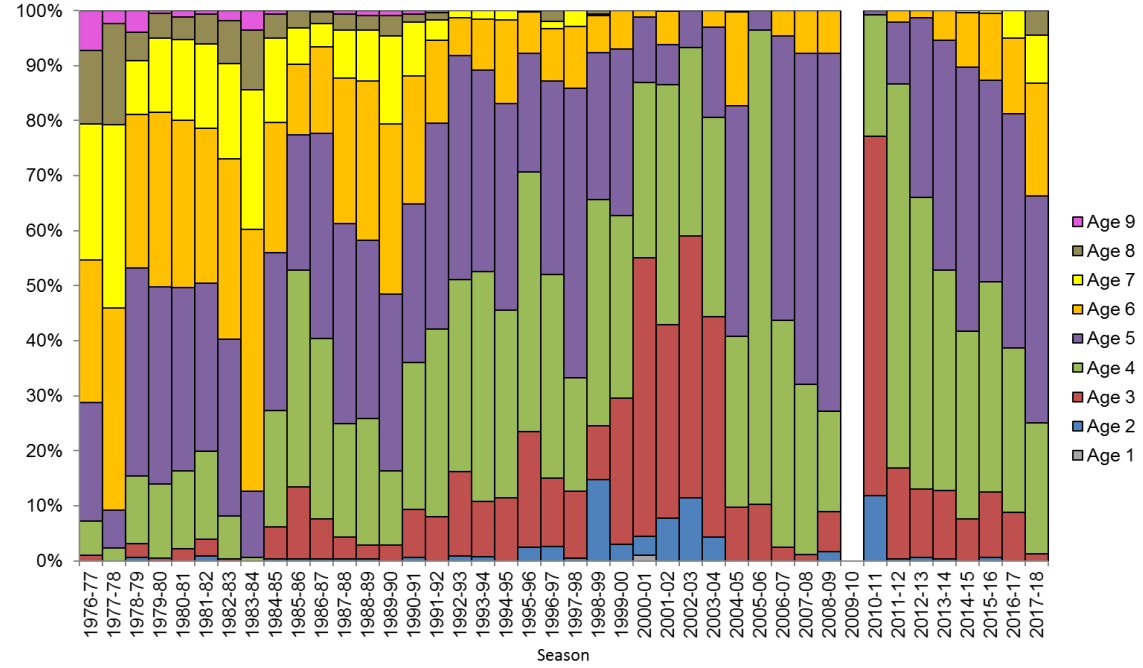

Figure 5. Age composition of the commercial gill net catch. Percent by number of fish for the San Francisco Bay herring fishery. Note: Fishery closed during the 2009-10 season.

The length-weight relationships for herring in spawning condition are used to develop a condition factor index (CI), which is derived from a fish's weight divided by the cube of its length, and used to describe the health of a population. Condition indices may be effected by sampling method such as research gillnets which may bias samples towards deeper bodied, higher condition fish. High condition indices have been associated with increased reproductive capacity and fish survival (Schloesser and Fabrizio 2017). The average San Francisco Bay herring CI for mature 2017-18 fish was 1.59, the highest on record (Figure 6), and continues the upward trend in CI since the low values of 2003-04 and 2004-05.

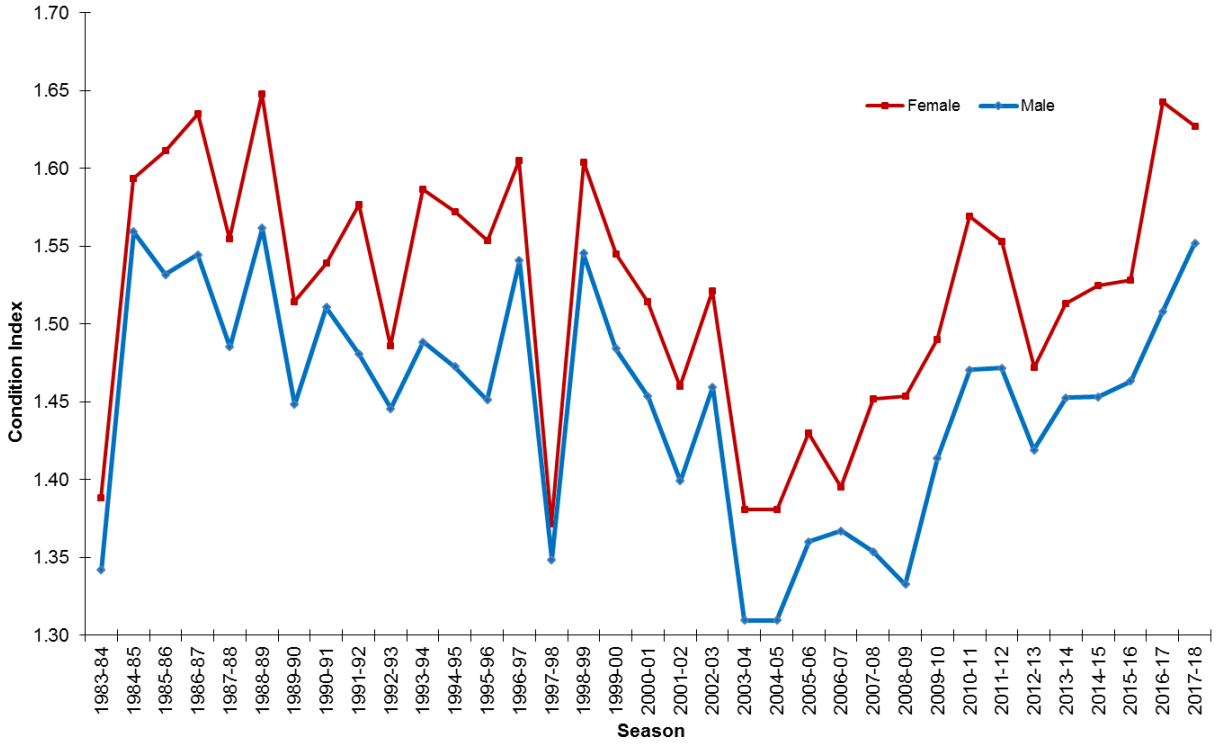

Figure 6. Average Condition Index (CI) and CI for ripe male and female fish based on research catch from the San Francisco Bay herring spawning population.

Ecological Context

The Department evaluates the SSB estimate and biological condition of the stock within the context of the greater California Current Ecosystem (CCE). This evaluation is aided by the NOAA California Current Integrated Ecosystem Assessment team's State of the California Current Ecosystem Annual Report. According to the most recent report, conditions in the CCE during the 2017-18 season were closer to what is considered average for the system (NOAA 2018). Following the major El Niño event of 2015-16, the Oceanic Niño Index (ONI), which describes the El Niño Southern Oscillation (ENSO),

was neutral for most of 2017 before shifting to slight La Niña conditions. La Niña conditions typically indicate cooler water and higher productivity in the CCE. Additionally, Pacific Decadal Oscillation (PDO) values declined in 2017, approaching the long-term mean for the first time since winter 2013-14. The shift to relatively productive conditions in the CCE is not complete, however, as some slightly-anomalously warm sea surface temperatures (SST) persisted in the Gulf of Alaska and west coast of North America in 2017. These anomalous conditions were carried over from the marine heat wave ("warm blob"), which dissipated in 2016. Despite these lingering, positive SST anomalies, the northern copepod biomass anomaly has recovered to neutral values in summer 2017 after a downward trend that started in 2014. At the same time, the southern copepod biomass anomaly has decreased to neutral values. This shift is significant, as copepods form an important energy source for forage species like Pacific Herring in the CCE, and northern copepods, which are associated with a more productive system, are the energetically more valuable of the two due to their higher lipid content. Finally, the hydrologic picture in the CCE, according to Snow Water Equivalent (SWE – a measure of the water content of snowpack) was near the long-term average in 2017 for all sub regions of the CCE. This means that freshwater outflow levels were normal (similar to 2016) after years of decline and a 2015 historic low. See NOAA 2018 for more details and additional information on the CCE during the 2017-18 season.

Despite the general trend of a return to normal in the CCE, the low SSB observed in San Francisco Bay during the 2017-18 season reflects the lingering effects of four years of sub-optimal ecological conditions, including the major El Niño event of 2015-16. The Department has recognized the detrimental impacts of strong El Niño events on the San Francisco Bay herring stock as part of its precautionary management approach (CDFW 1998). In addition to the lower observed SSB, these negative impacts are evident in the shift in age structure observed in the seasons following 2015-16 – especially 2017-18 – with reduced numbers of the three and four year old fish that typically compose the bulk of the SSB. This reduction has resulted in an increase in the relative proportion of the older age classes, which is consistent with the suggestion that major El Niño events negatively affect recruitment and year class strength of San Francisco Bay herring put forth by Sydeman et al. (2018).

COMMERCIAL GILL NET FISHERY SUMMARY

The herring gill net fisheries catch herring as they move into shallow areas to spawn. The traditional product from this fishery, *kazunoko*, is the sac roe (eggs) removed from the females, which is processed and exported for sale in Japan. California's roe fishery began in 1973 and a formal limited-entry permit system was implemented in 1977.

In San Francisco Bay, the fishery is separated into Even and Odd fishing groups (platoons) based on permit numbers. Platoons rotate fishing weeks throughout the season and the calendar year in January determines which platoon begins fishing first. Thus, the Even platoon was designated to fish first for the 2017-18 season. Generally,

the opening date of the fishery is set for January 1 and the closing date is set for March 15 with minor adjustments each year to account for annual changes in the calendar. The DH fishery continued to be integrated into the Even and Odd platoons this season. The 2017-18 season gillnet fishery opened at 5:00 p.m. on Monday, January 1, 2018, and closed at 12:00 p.m. (noon) on Thursday, March 15, 2018. Since 1974, the gill net fisheries have been closed each week from noon on Friday until 5:00 p.m. on Sunday. The weekend closure reduces conflicts with recreational users of the bay and allows additional herring escapement from the commercial fishery.

The total fishery quota for San Francisco Bay was set at 834 short tons (tons) for the 2017-18 season. This was less than five percent of the previous season's (2016-17) spawning biomass estimate of 18,300 tons. This quota carried over from the previous two season's regulatory process because spawning biomass estimates were similar from year to year. The total quota for the gill net fishery was 750.6 tons (Table 2). This quota was split between the Even and Odd platoons based on the number of permits in each platoon, with the Even receiving 384.5 tons and the Odd receiving 366.1 tons. The Odd Platoon reached its quota and was closed on Tuesday, January 23. The Even Platoon ceased fishing prior to the end of the season. Approximately 81 percent (611 tons) of the San Francisco Bay gill net quota was landed by the combined platoons during the 2017-18 commercial herring season (Tables 2 and 3). Commercial fishing effort increased slightly over last season. Nine commercial fishing vessels participated in the gill net fishery during the 2017-18 season.

Fish sampled from the commercial gill net fishery during the 2017-18 season were the same length, on average, as those sampled in the previous season (Figure 7) and included the longest body length recorded since 2007-08. Average and maximum sizes have increased since 2010-11, however, the overall trend of reduced size of herring in the commercial catch continued.

Roe count (percentage) is calculated by herring buyers and is the percentage of landing weight that consists of herring roe. It is used for price calculations for the ex-vessel price paid, which consist of a base price plus "points" based on percentage points above or below ten percent yield by weight. The average "roe count" for the 2017-18 season was 11.9 percent (Table 2 and Figure 8), which was the lowest since the 1993-94 season and below the 1983-84 to 2017-18 average of 13.6 percent. Roe count was unusually low on January 8, at only 8.9 percent, the roe percentage was 12.8 percent for the remainder of the landings.

Even Gill Net Fishery

The Even platoon fishery opened on Monday, January 1, 2018, at 5:00 p.m. Nine fishing vessels participated and landings were made on January 17, 18, 24, 25 and 26 (Table 4). The roe count was 13.1 percent (Table 2). Eighteen of the 84 permits assigned to this platoon fished this season. The Even platoon landed 279.9 tons of herring, which was equal to 72.8 percent of its quota.

Odd Gill Net Fishery

The Odd platoon fishery opened on Sunday, January 7, 2017, at 5:00 p.m. Nine fishing vessels participated and made landings on January 8 and 23 (Table 5). Roe count was 10.5 percent (Table 2). Eighteen of the 80 permits assigned to this platoon made landings this season. The Odd platoon landed 330.7 tons of herring, which was 90.3 percent of its quota and was closed on January 23 to avoid exceeding its quota.

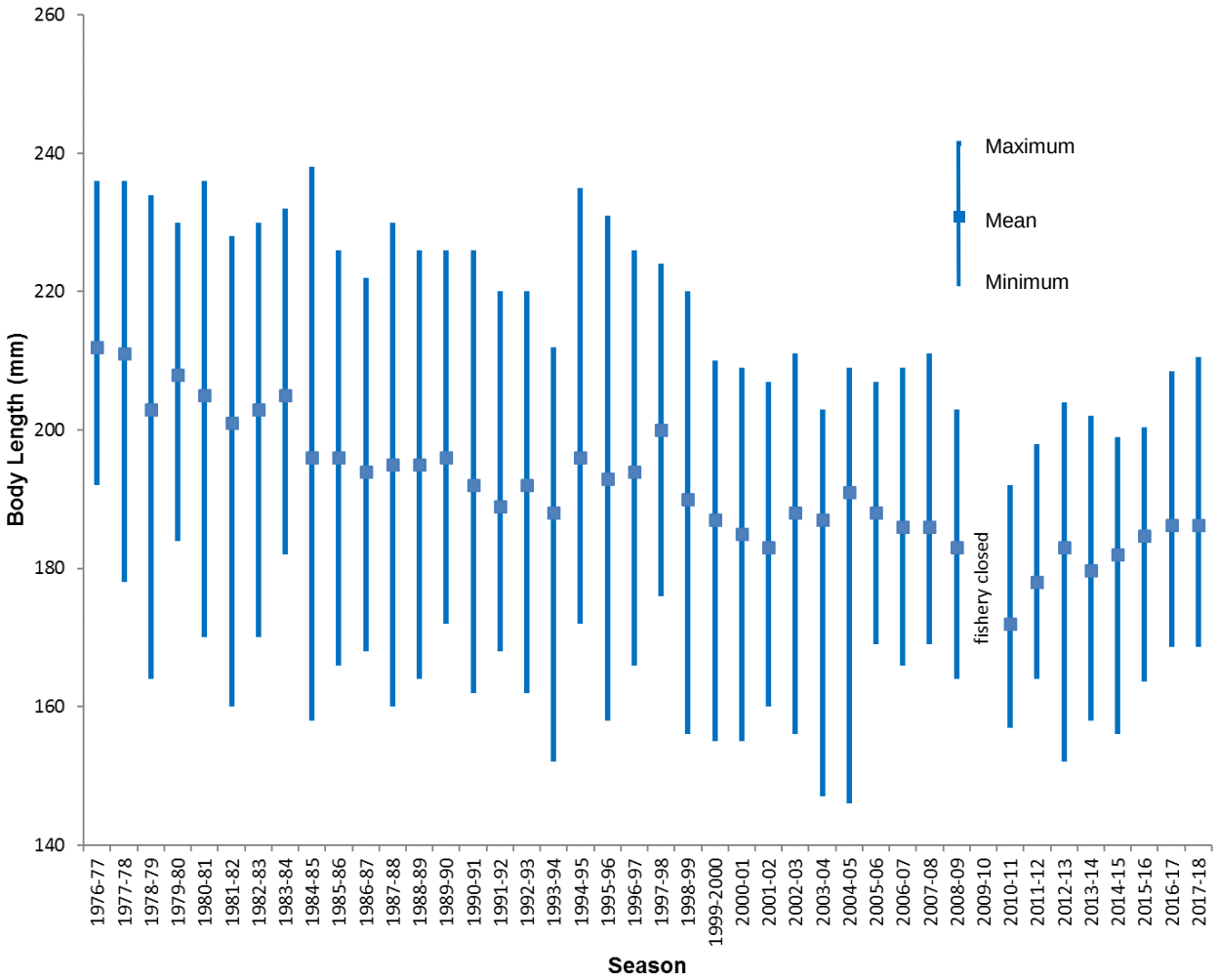

Figure 7. San Francisco Bay herring commercial minimum, mean and maximum body length from 1976-77 through 2017-18 seasons.

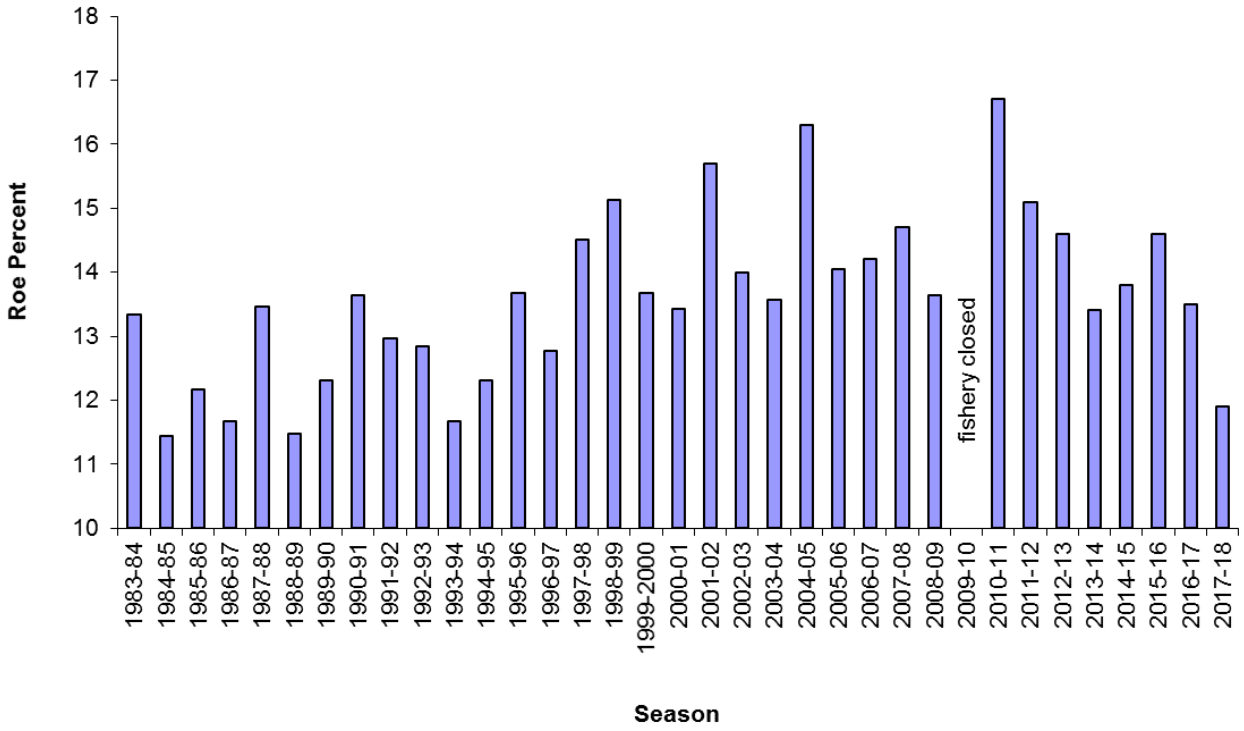

Figure 8. Average roe count in the San Francisco Bay gill net fisheries from 1983-84 through 2017-18 seasons

TABLE 2. Herring quotas, landings, roe count, and fish count, for San Francisco Bay, 2017-18 Season.

FISHERY	QUOTA (tons)	LANDINGS (tons)	HARVEST PERCENTAGE (%)	ROE COUNT	FISH COUNT
Odd gill net	366.1	330.8	90.4%	10.5	98.3
Even gill net	384.5	279.9	72.8%	13.1	96.8
TOTAL GILL NET	750.6	610.7	81.4%	11.9*	97.3*

* Roe count and fish count are averages of information provided on receipts; therefore they may not equal the sum of platoon averages.

TABLE 3. Quotas and landings for the herring sac roe fisheries in San Francisco Bay, 1972-73 season through 2017-18 season.

Season	Quota (tons)	Landings (tons)	Season	Quota (tons)	Landings (tons)
1972-73*	1,500	436			
1973-74*	500	1,938	1996-97	13,543	11,496
1974-75*	600	514	1997-98	9,793	1,981
1975-76*	3,000	1,719	1998-99	2,739	2,817
1976-77*	4,000	4,201	1999-2000	5,460	3,356
1977-78*	5,000	4,987	2000-01	2,499	2,991
1978-79*	5,000	4,115	2001-02	4,128	3,287
1979-80*	6,000	6,430	2002-03	3,262	2,097
1980-81*	7,250	5,811	2003-04	2,020	1,540
1981-82*	10,000	10,415	2004-05	3,169	145
1982-83*	10,399	9,699	2005-06	4,328	744
1983-84*	10,399	2,828	2006-07	4,328	292
1984-85*	6,500	7,740	2007-08	1,057	687
1985-86*	7,530	7,278	2008-09	1,019	507
1986-87	7,470	8,098	2009-10	0	0
1987-88	8,432	8,741	2010-11	1,845	1,727
1988-89	9,238	9,736	2011-12	1,845	1,634
1989-90	9,057	8,962	2012-13	2,655	2,332
1990-91	8,858	7,741	2013-14	3,442	3,198
1991-92	7,134	7,417	2014-15	2,303	46
1992-93	5,175	5,151	2015-16	751	493
1993-94	1,996	2,302	2016-17	751	37
1994-95	4,408	4,574	2017-18	751	611
1995-96	5,524	6,165	Average	4,710	3,892

* Quotas and landings prior to the 1985-86 season include HEOK and fresh fish allocation and landings.

TABLE 4. Daily landings for the Even gill net platoon.

Date	Pounds	Tons	# Receipts	Tons/Receipt*	Roe Count*
1/17/2018	20,928	10.5	2	5.2	12.8
1/18/2018	78,197	39.1	17	2.3	12.5
1/24/2018	209,390	104.7	14	7.5	12.8
1/25/2018	244,646	122.3	18	6.8	13.6
1/26/2018	6,646	3.3	2	1.7	13.7
Totals and averages	559,807	279.9	53	5.3*	13.1*

* Tons per receipt and roe count are averages of all receipts; therefore they may not equal the sum of daily averages

TABLE 5. Daily landings for the Odd gill net platoon.

Date	Pounds	Tons	# Receipts	Tons/Receipt*	Roe Count*
1/08/2018	328,816	164.4	22	7.5	8.9
1/23/2018	332,726	166.4	23	7.2	12.2
Totals and averages	661,542	330.8	45	7.4*	10.5*

* Tons per receipt and roe count are averages of all receipts; therefore they may not equal the sum of daily averages

HERRING EGGS ON KELP (HEOK) FISHERY SUMMARY

The HEOK fishery occurs only in San Francisco Bay. The fishery suspends Giant Kelp, *Macrocystis pyrifera*, from rafts on which herring spawn. The product of this fishery, *komochi* or *kazunoko kombu*, is the egg-coated kelp blades that are processed and exported to Japan where it is consumed as a delicacy. All HEOK permittees must hold a current herring permit and request from the Department that the gill net permit be converted to a HEOK permit for the season. The opening and closing dates for the herring eggs on kelp fishery are not adjusted to take into account annual changes in the calendar. The herring eggs on kelp season began December 1, 2017, and ended March 31, 2018.

The total amount of HEOK that may be harvested is based on the previous season's spawning population estimate in San Francisco Bay and the HEOK fishery is currently allocated a quota equal to approximately one percent of the overall San Francisco Bay quota. In 2017-18, the total quota for the HEOK fishery was 18.7 tons of product (Table 6), which was converted from 83.4 tons of whole fish from the total San Francisco Bay quota. Nine HEOK permits were renewed this season but there was no fishing effort and no HEOK product landed.

Table 6. Quotas and landings of product for the HEOK fishery in San Francisco Bay, 1989-90 season through 2017-18 season.

Season	Quota (tons)	Landings (tons)
1989-90	110.0	107.1
1990-91	144.0	47.0
1991-92	114.0	84.2
1992-93	84.5	47.4
1993-94	35.1	35.0
1994-95	85.0	13.1
1995-96	106.5	106.8
1996-97	286.0	185.7
1997-98	209.0	36.4
1998-99	54.4	31.7
1999-2000	99.2	30.5
2000-01	49.3	27.2
2001-02	73.2	45.3
2002-03	57.6	53.3
2003-04	38.9	6.3
2004-05	55.7	0
2005-06	34.0	0
2006-07	34.0	3.9
2007-08	17.0	15.1
2008-09	17.6	3.3
2009-10	Fishery closed	0
2010-11	14.3	0
2011-12	12.3	0
2012-13	40.5	39.3
2013-14	66.0	0
2014-15	44.2	0
2015-16	18.7	0
2016-17	18.7	0
2017-18	18.7	0
Average	66.8	31.7

CONCLUSION

The San Francisco Bay commercial Pacific Herring fishery continued during the 2017-18 season at a low level of effort relative to historic fishery participation. This coincided with an estimated spawning biomass well below the long-term average and the fourth year of low overall returns for this fishery. The low biomass estimate recorded during the 2017-18 season likely reflects continued population-level impacts sustained during multiple consecutive years of anomalously high sea-surface temperatures, depressed productivity, and low freshwater outflow in the central California Current Ecosystem. Despite the relatively low spawning biomass observed, the Department considers precautionary target harvest rates as the primary means of assuring a sustainable

fishery even in years of unfavorable ecological conditions. The Department's management objectives include maintaining healthy Pacific Herring stocks in California to conserve the living resources that depend on herring as forage, setting conservative harvest targets for the commercial fishery, and providing recreational fishing opportunities. Through the Fish and Game Commission, and with the help of the fishing industry, the conservation community and the Director's Herring Advisory Committee, the Department will continue to manage the Pacific Herring fishery with the primary goal of ensuring fishery sustainability.

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