2016-17 Summary of the Pacific Herring Spawning Population and Commercial Fisheries in San Francisco Bay

CDFW Photo

July 2017
Final Report

California Department of Fish and Wildlife
Aquaculture and Bay Management Project
Herring Management and Research
Marine Region, 5355 Skylane Blvd. Suite B
Santa Rosa, CA 95403

INTRODUCTION

The California Department of Fish and Wildlife (Department) has conducted herring 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 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. In addition, the Department prepares an Environmental Document 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 2016-17 Pacific herring season in San Francisco Bay ended with a below average spawning biomass estimate of 18,300 tons. The historical average equals 49,400 tons (1979-present), and this was the third year in a row of below average herring returns, but an increase from the 2014-15 and 2015-16 seasons (Figure 1).

Oceanographically, this modest increase in biomass accompanies an early 2017 shift to neutral and La Nina conditions in the California Current Ecosystem (CCE) following the strong El Nino event of 2015-16. Additionally, the marine heatwave (i.e. the 'Warm Blob') has dissipated as of fall 2016, although anomalously warm temperatures persisted along the west coast of North America throughout winter 2016-17. Finally, the Central CCE experienced above average upwelling during summer 2016, but the increased productivity typically associated with above-average upwelling was not observed, likely due to a deepened thermocline leftover from the Warm Blob (NOAA 2017). Taken together, these continuing sub-optimal conditions in the northeast Pacific likely contributed to the below-average spawning biomass observed during the 2016-17 season.

Hydrologically, the 2016-17 Pacific herring season followed a multi-year, record drought in California. After a historic low in 2015, the Snow-Water Equivalent (SWE, a metric of the total water content of snowpack) in 2016 returned to average levels in all ecoregions of the CCE. High spring and summer air temperatures in 2016 resulted in early and rapid snow melt and increase in maximum flow rates. Also, above-average precipitation during winter 2016-17 led to high outflow into the San Francisco Bay estuary system, resulting in a SWE outlook for 2017 likely to exceed 2016's. This high outflow during the 2016-17 herring season may have affected herring spawning behavior and larval survival (NOAA 2017). See Chapter 3.3 of the 2015 FSED for more information.

There were 13 spawn events through the season starting in early-December and ending in late-February (Table 1). The first recorded spawn of the season occurred December 14, 2016, and the last recorded spawn occurred February 27, 2017. The largest spawn event occurred inside Richardson Bay from the 13th – 16th of January, with 17,225 tons of herring estimated. There were several smaller spawning events in Richardson Bay and isolated spawns in the South and East Bay areas of San Francisco Bay (see Figure 2 for spatial distribution of all spawn events).

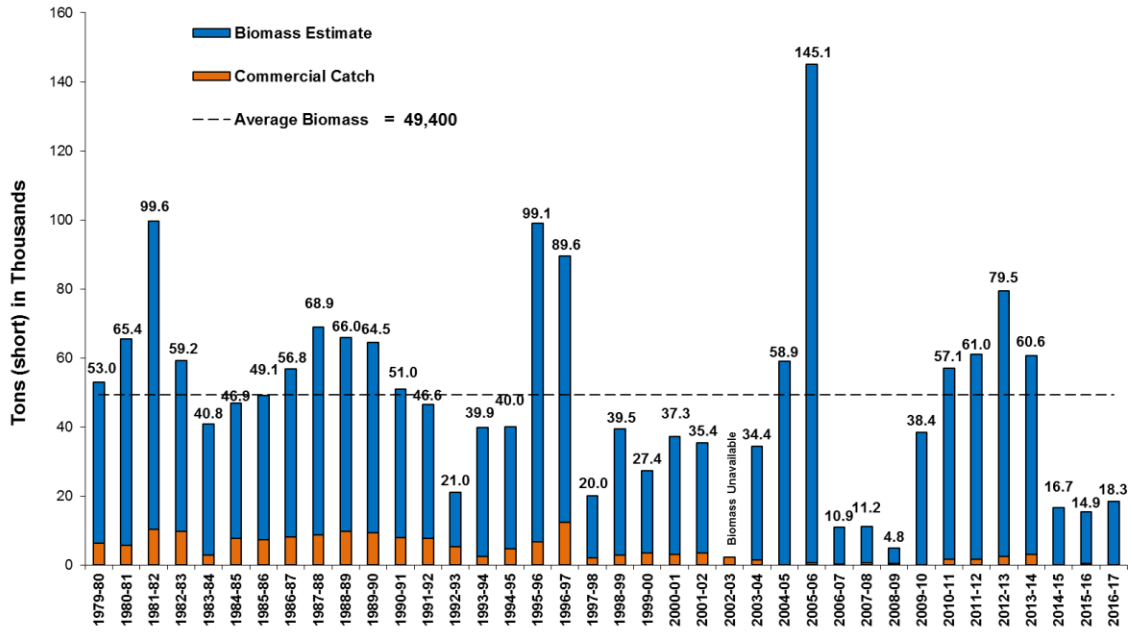

Figure 1. San Francisco Bay Pacific herring biomass estimates and commercial catch, 1979-2017.

Table 1. San Francisco Bay Pacific herring spawning biomass estimate by event with commercial catch totals, 2016-17.

San Francisco Bay Pacific herring spawning biomass estimate by event with commercial catch totals 2016-17								
#	Approximate Spawn/Catch Date	Location	Submerged Areas	Shore Areas	Spawn Total	Gill-Net *	HEOK	Biomass Total
1	December 14, 2016	Richardson Bay	87		87			87
2	December 14, 2016	Millbrae/Burlingame		12	12			12
3	January 6-9, 2017	Point Richmond	132	120	252			252
4	January 6, 2017	Richardson Bay	398		398			398
5	January 13-14, 2017	Alameda Rock Wall		12	12			12
6	January 13-16, 2017	Richardson Bay	17,225		17,225			17,225
7	January 26-29, 2017	Belvedere Cove	3		3	18		20
8	January 28, 2017	Richardson Bay	38		38			38
9	January 28, 2017	Angel Island		10	10			10
10	January 31-February 1, 2017	Coyote Point		8	8			8
11	February 2-4, 2017	Point Richmond	8		8	19		27
12	February 11-12, 2017	Richardson Bay	84		84			84
13	February 25-27, 2017	Richardson Bay	176		176			176
Spawn Events (n) = 13		**Totals in short tons**	**18,149**	**162**	**18,311**	**37**	**0**	**18,348**

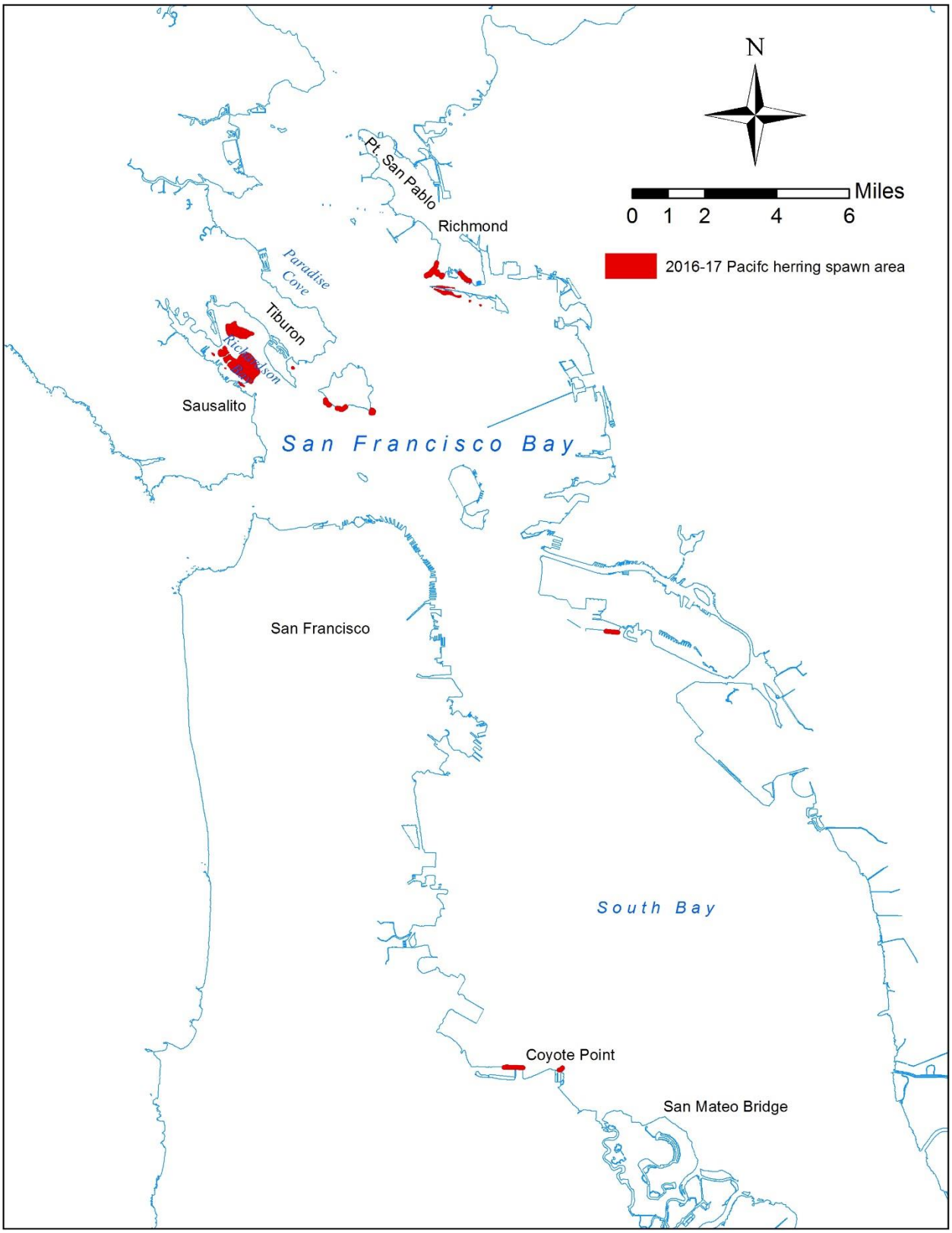

Figure 2. San Francisco Bay herring spawn event map for the 2016-17 season.

Herring from both the San Francisco Bay spawning population and the commercial catch are aged each season using otolith surface readings. The proportion and tonnage (Figures 3 and 4) of age 2 herring in the spawning biomass for the 2016-17 season was the lowest on record (1982-83 to present). The proportion of age 3 herring was also well below average. Reduced numbers of young fish negatively affect recruitment to the commercial fishery, which relies primarily on older fish (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. Age 4 herring were most abundant in the spawning population during the 2016-17 season and the proportion of age 5 and older fish has increased each season since 2010-11 and at over 30 percent is 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.

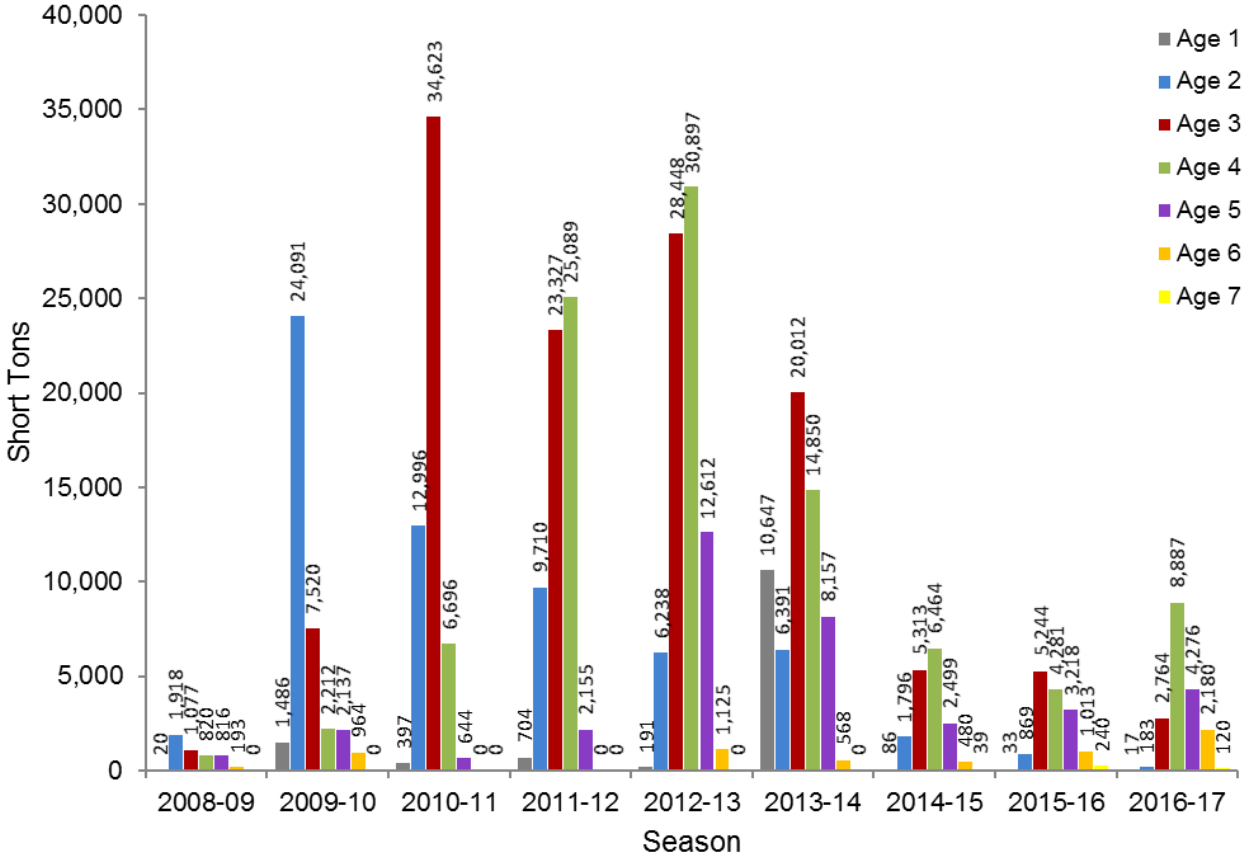

Figure 3. Estimated short tons of San Francisco Bay spawning biomass by age class for the 2008-09 to 2016-17 seasons based on research catch.

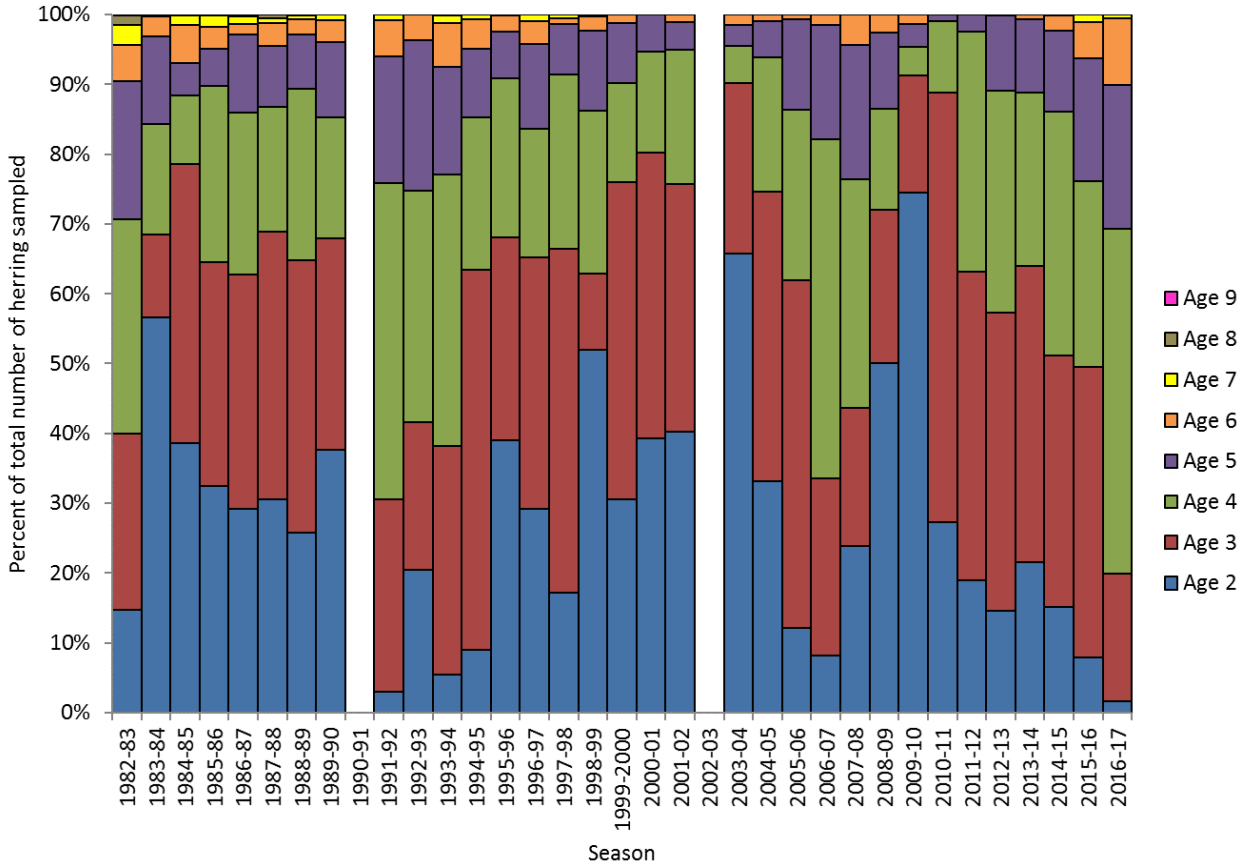

Figure 4. Percent at age, by number, of ripe fish for the San Francisco Bay herring spawning biomass. Based on age composition of the research catch (excluding age-1 fish).

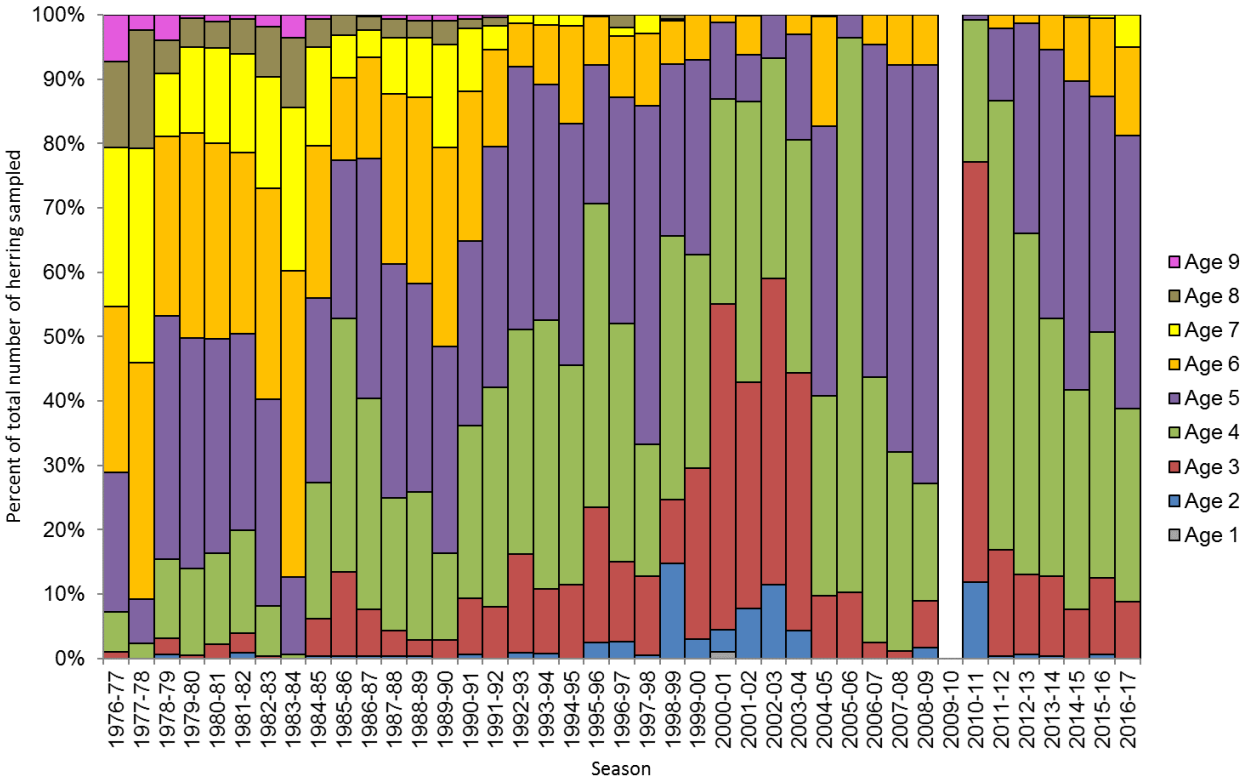

Figure 5. Age composition of the commercial gill net catch. Percent by number of fish for the San Francisco Bay herring fishery. Note: Fishery closed during the 2009-10 season.

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. 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 2016-17 fish was the highest since 1999 (Figure 6) and continues the upward trend in CI since the low values of 2003-04 and 2004-05.

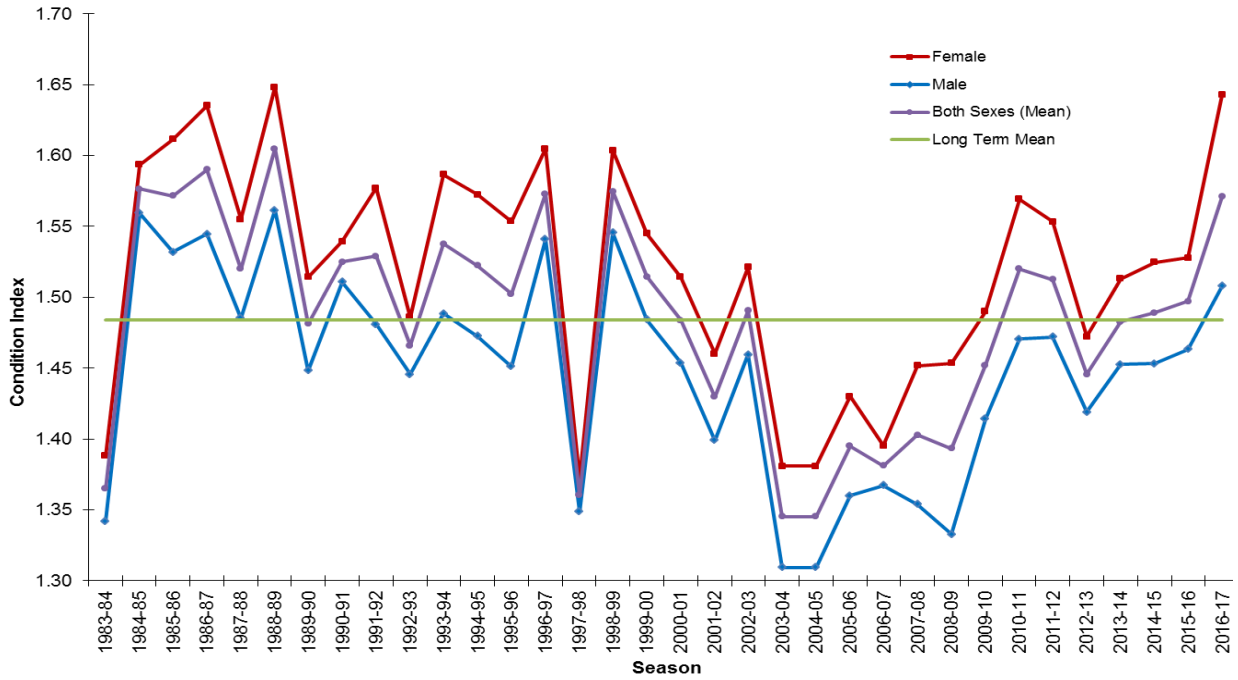

Figure 6. Average Condition Index (CI) and CI for ripe male and female fish based on research catch from the San Francisco Bay herring spawning population.

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 Odd platoon was designated to fish first for the 2016-17 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 2016-17 season opened at 5:00 p.m. on Sunday, January 1, 2017, and closed at 12:00 p.m. (noon) on Wednesday, March 15, 2017. 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 2016-17 season. This was approximately six percent of the previous season's (2015-16) spawning biomass estimate of 14,898 tons. This quota carried over from the previous 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 390.5 tons and the Odd receiving 360.1 tons. Neither platoon reached its quota, as both platoons ceased fishing prior to the end of the season. Approximately five percent (37 tons) of the San Francisco Bay gill net quota was landed by the combined platoons during the 2016-17 commercial herring season (Tables 2 and 3). Commercial fishing effort decreased over last season, with only eight commercial fishing vessels participated in the gill net fishery during the 2016-17 season.

Fish sampled from the commercial gill net fishery during the 2016-17 season were slightly longer, on average, than 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.

The average “roe count” for the 2016-17 season was 13.5 percent (Table 2 and Figure 8), which is near the 1983-84 to 2016-17 average of 13.6 percent. 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.

Odd Gill Net Fishery

The Odd platoon fishery opened on Sunday, January 1, 2017, at 5:00 p.m. Seven fishing vessels participated and made landings on February 1 and 2 (Table 4). Two of the seven fishing vessels had landings only in the Odd fishery. Roe count was 13.8 percent (Table 2). Thirteen of the 86 permits assigned to this platoon made landings this season. The Odd platoon landed 19 tons of herring, which was five percent of its quota.

Even Gill Net Fishery

The Even platoon fishery opened on Sunday, January 8, 2017, at 5:00 p.m. Six fishing vessels participated and all landings were made on January 26 (Table 5) and one of the six fishing vessels had landings only in the Even fishery. The roe count was 13.2 percent (Table 2). Nine of the 90 permits assigned to this platoon fished this season. The Even platoon landed 17.9 tons of herring, which was equal to five percent of its quota.

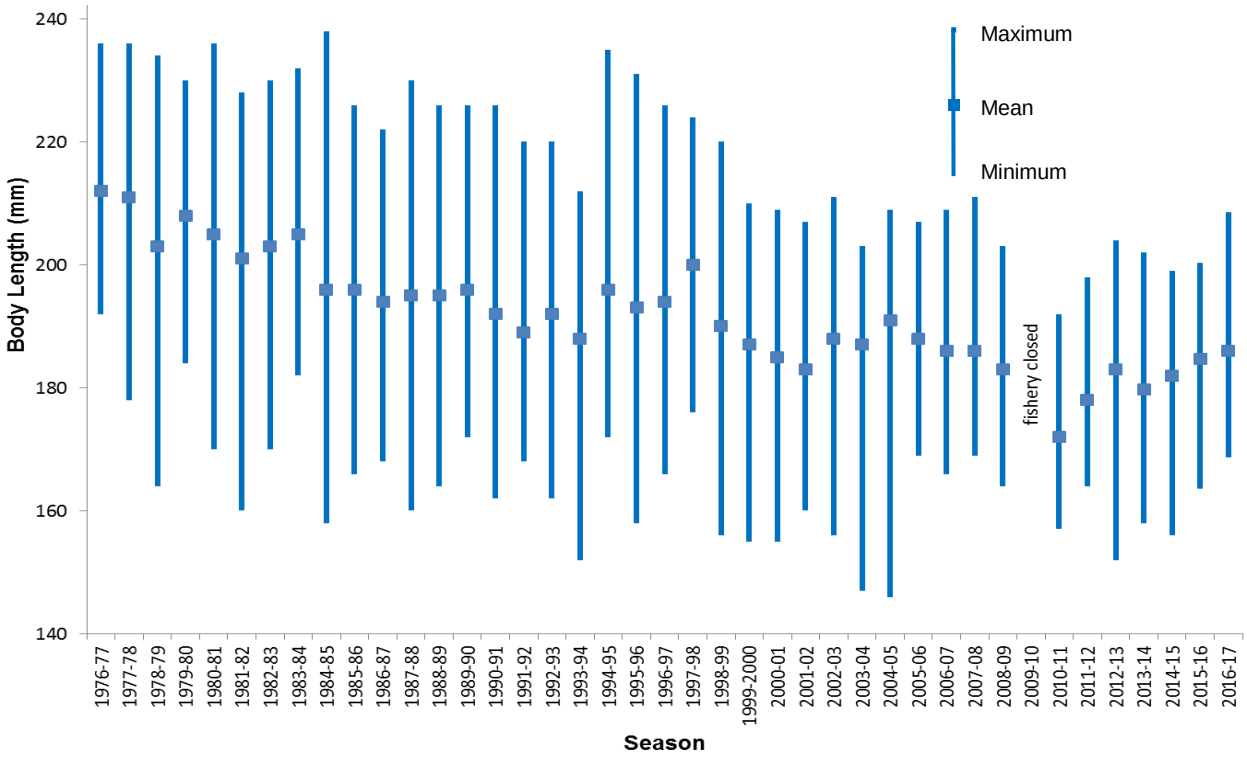

Figure 7. San Francisco Bay herring commercial minimum, mean and maximum body length from 1976-77 through 2016-17 seasons.

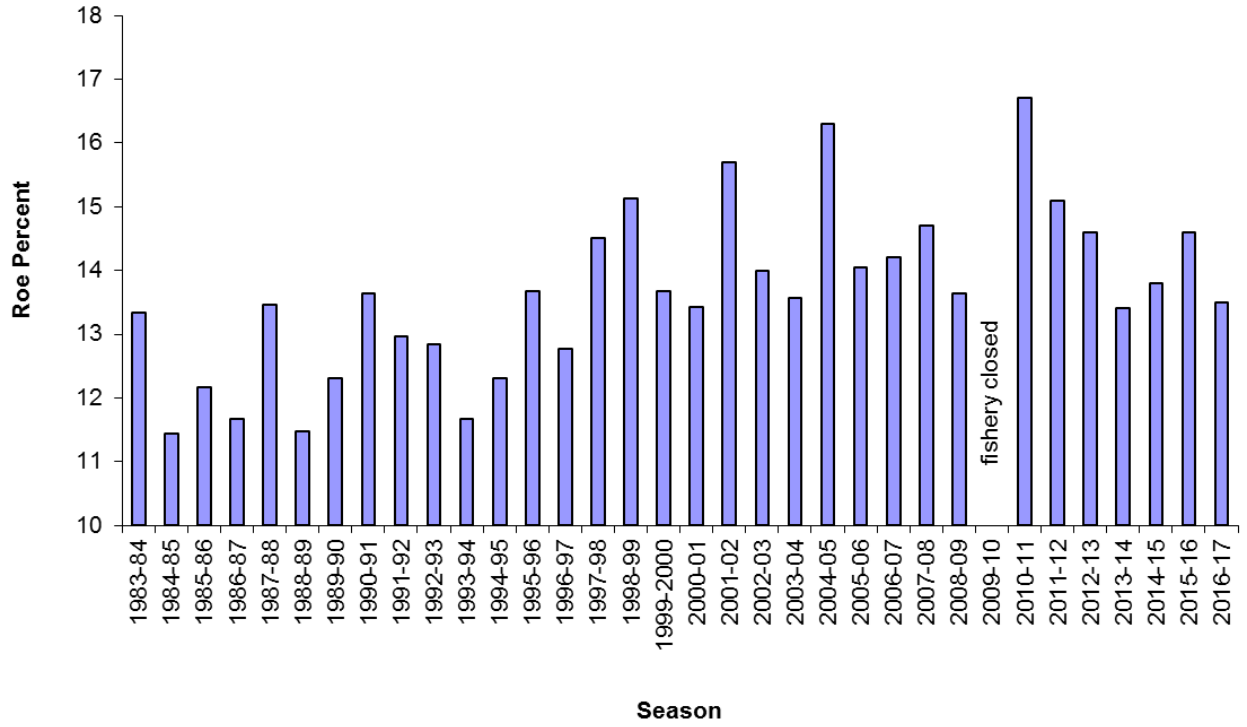

Figure 8. Average roe count in the San Francisco Bay gill net fisheries from 1983-84 through 2016-17 seasons

TABLE 2. Herring quotas, landings, roe count, and fish count, for San Francisco Bay, 2016-2017 Season.

FISHERY	QUOTA (tons)	LANDINGS (tons)	HARVEST PERCENTAGE (%)	ROE COUNT	FISH COUNT
Odd gill net	360.1	19.3	5.3%	13.8	100.8
Even gill net	390.5	17.9	4.6%	13.2	NA
TOTAL GILL NET	750.6	37.2	5.0%	13.5*	100.8*

* 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 2016-17 season.

Season	Quota (tons)	Landings (tons)	Season	Quota (tons)	Landings (tons)
1972-73*	1,500	436	1995-96	5,524	6,165
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	Average	4,798	3,965

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

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

Date	Pounds	Tons	# Receipts	Tons/Receipt*	Roe Count*
2/1/2017	10,288	5.1	2	2.6	NA
2/2/2017	28,238	14.1	11	1.3	13.8
Totals and averages	38,526	19.2	13	1.5*	13.8*

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

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

Date	Pounds	Tons	# Receipts	Tons/Receipt	Roe Count
1/26/2017	35,892	17.9	8	2.2	13.2
Totals and averages	35,892	17.9	8	2.2	13.2

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, 2016, and ended March 31, 2017.

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 2016-17, 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. Ten 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 2016-17 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
Average	68.6	32.8

CONCLUSION

The San Francisco Bay commercial Pacific herring fishery continued during the 2016-17 season at a reduced level of effort. This coincided with an estimated spawning biomass well below the historical average, though slightly higher than the previous two seasons. The low biomass estimate recorded during the 2016-17 season is likely attributable to continuing low levels of productivity in the northeast Pacific Ocean, which adversely affect herring. Despite the relatively low spawning biomass observed, the Department considers precautionary harvest percentages of the previous season's spawning biomass 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.

REFERENCES

California Department of Fish and Game (1998). Final Environmental Document (FED), Pacific Herring Commercial Fishing Regulations (Sections 163, 163.5, and 164, Title 14, California Code of Regulations). State of California. The Natural Resources Agency.

National Oceanic and Atmospheric Administration (2017). California Current Integrated Ecosystem Assessment (CCIEA) California Current Ecosystem Status Report, California Current Integrated Ecosystem Assessment Team.

Schloesser, R. W. and M. C. Fabrizio, 2017. Condition Indices as Surrogates of Energy Density and Lipid Content in Juveniles of Three Fish Species, Transactions of the American Fisheries Society.