

# Summary of the 2015-16 Pacific Herring Spawning Population and Commercial Fisheries in San Francisco Bay



CDFW Photo

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Aquaculture and Bay Management Project  
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## **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 can be found 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 2015-16 Pacific herring season in San Francisco Bay ended with a below average spawning biomass estimate of 14,898 tons. The historical average equals 50,300 tons (1979-present), and this was the second year in a row of below average herring returns (Figure 1). This decline is likely attributable to poor oceanic and estuarine conditions which adversely affect herring survival. Recent sea surface temperature (SST) data collected in the northeast Pacific indicate record high SST anomalies, which along with the development of a large El Nino have resulted in low productivity at most trophic levels (National Marine Fisheries Service 2015). Additionally, reduced freshwater influence in the San Francisco Estuary associated with the ongoing drought has resulted in atypical estuarine conditions, which may have negative impacts on both spawning herring and young herring in the estuary. See Chapter 3.3 of the 2015 FSED for more information.

There were 13 spawn events through the season starting in late-November and ending in mid-March (Table 1). The first recorded spawn of the season occurred November 23, 2015, and the last recorded spawn occurred March 16, 2016. The largest spawn event



occurred along the San Francisco waterfront from the 28<sup>th</sup> – 30<sup>th</sup> of December, with 5,279 tons of herring estimated. The second largest was from Paradise Cove to Richardson Bay, January 9<sup>th</sup> – 16<sup>th</sup>, with 3,017 tons. The third largest spawning event occurred from Keil Cove to Richardson Bay on the Marin shoreline on December 14<sup>th</sup>-18<sup>th</sup>, estimated at 2,279 tons. There were several smaller spawning events in Richardson Bay and along the Marin county shore, and isolated spawns ranging from Point San Pablo in the north to the San Mateo Bridge in the south (see Figure 2 for spatial distribution of all spawn events).



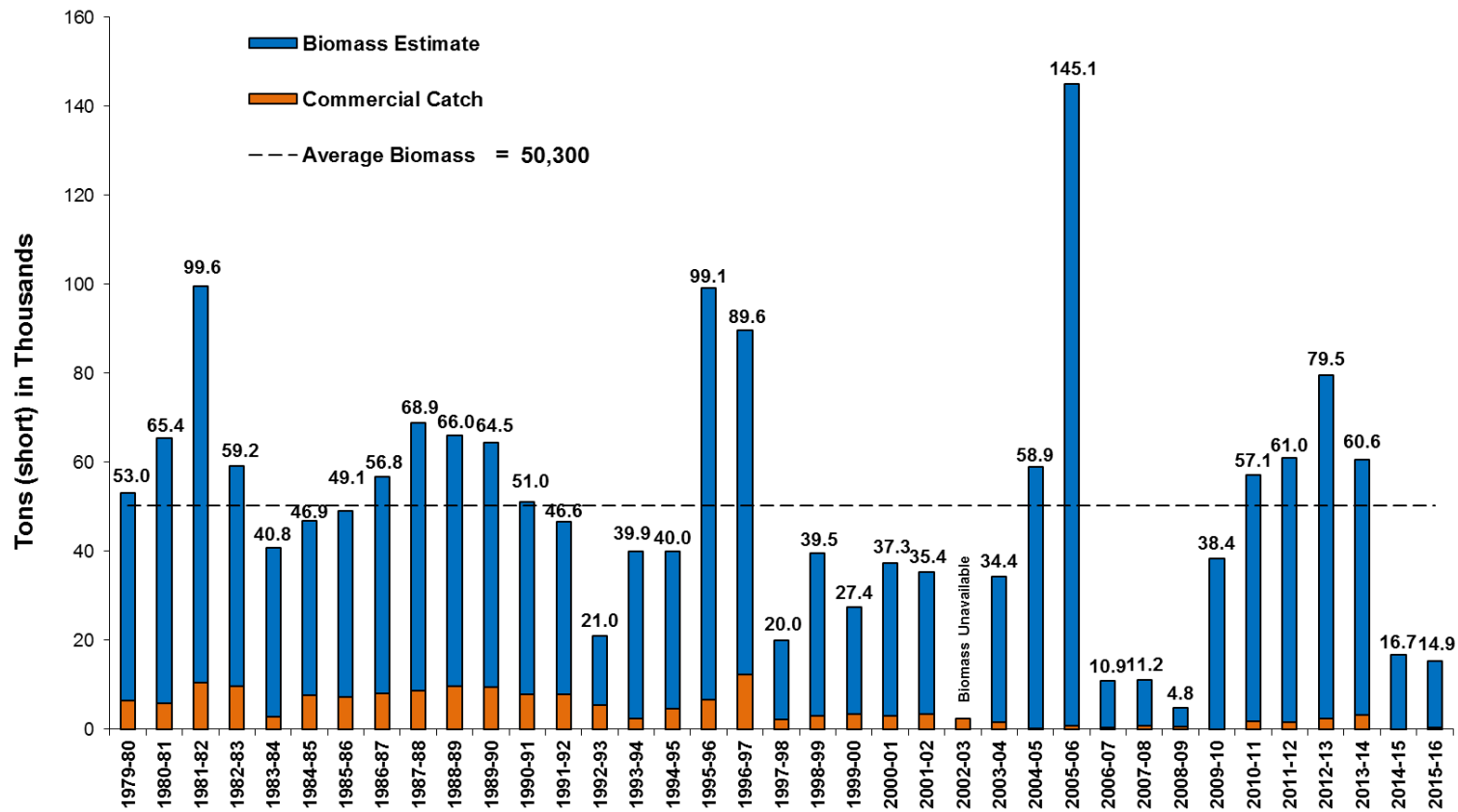


Figure 1. San Francisco Bay Pacific herring biomass estimates and commercial catch, 1979-2016.



Table 1. San Francisco Bay Pacific herring spawning biomass estimate by event with commercial catch totals, 2015-16.

#	Approximate Spawn/Catch Date	Location	Submerged Areas	Shore Areas	Spawn Total	Gill-Net HEOK	Biomass Total			
1	November 23, 2015	Richardson Bay	Trace		Trace		Trace			
2	December 14-18, 2015	Richardson Bay-Belvedere-Keil Cove	2,279		2,279		2,279			
3	December 27-28, 2015	Coyote Point		249	249		249			
4	December 28-30, 2015	San Francisco Waterfront		5,279	5,279		5,279			
5	December 28-31, 2015	Richardson Bay	24		24		24			
6	January 9-16, 2016	Paradise Cove-Richardson Bay	1,513	1,504	3,017	270	3,287			
7	January 16-18, 2016	Point Richmond	24	114	138		138			
8	January 26-28, 2016	San Mateo Bridge		21	21	75	96			
9	January 28-February 1, 2016	Richardson Bay	1,778		1,778	15	1,793			
10	February 3-8, 2016	Point Richmond-Point Molate	476	165	641	41	682			
11	February 6-7, 2016	Keil Cove-Belvedere Cove	381	8	388		388			
12	February 23-25, 2016	Richardson Bay-Belvedere-Keil Cove	507	86	592	92	684			
13	March 16, 2016	Richardson Bay	Trace		Trace		Trace			
<b>Spawn Events (n) = 13</b>			<b>Totals in short tons</b>		<b>6,980</b>	<b>7,425</b>	<b>14,405</b>	<b>493</b>	<b>0</b>	<b>14,898</b>



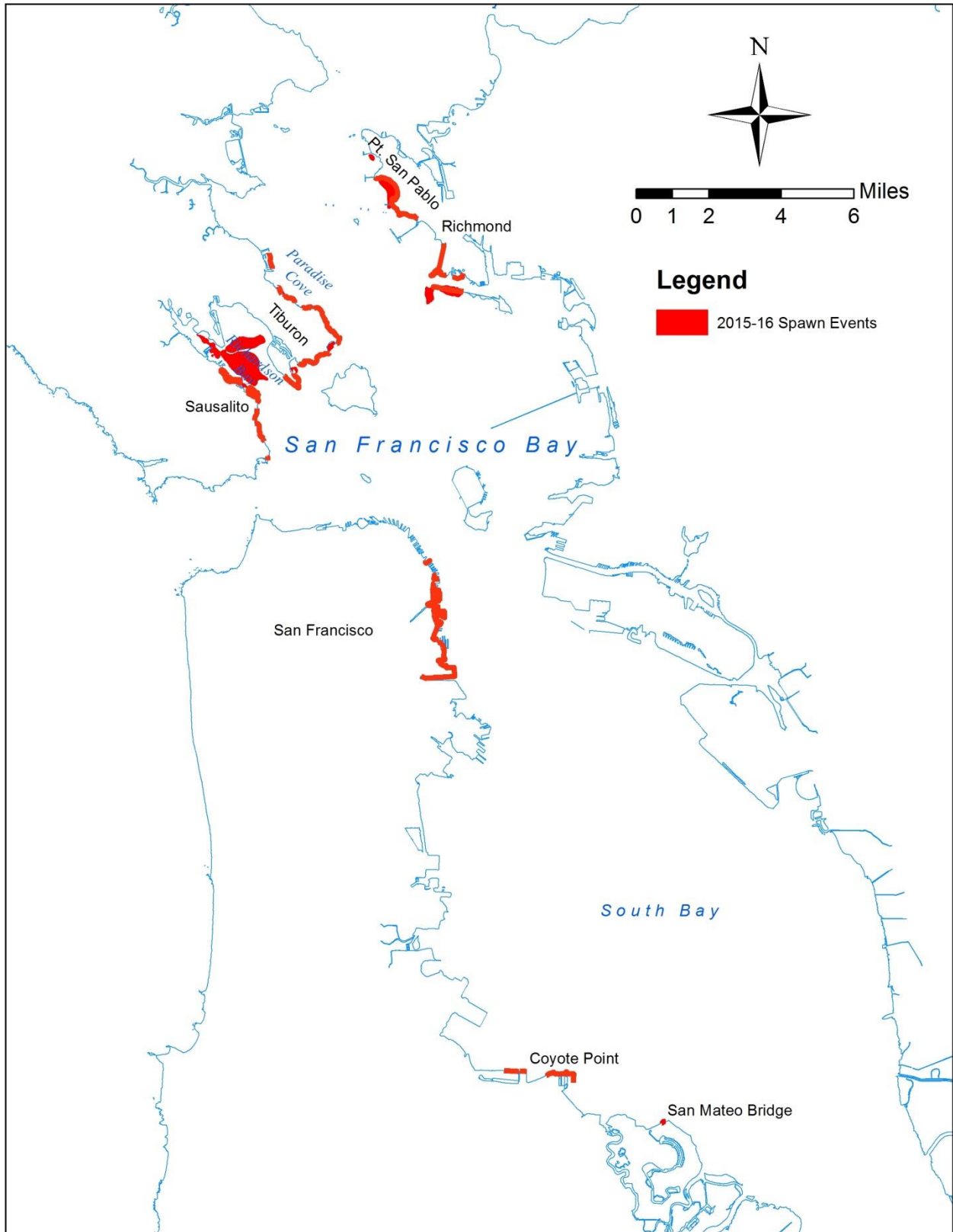


Figure 2. San Francisco Bay herring spawn event map 2015-16 season.



Herring from both the San Francisco Bay spawning population and commercial catch are aged each season using otolith surface readings. Age 3 and 4 herring were most abundant in the spawning population for the 2015-16 season and the proportion of age 5 and older fish has increased since the 2014-15 season (Figure 3). The proportion of spawning age 2 herring was the lowest since the early 1990's and reduced numbers of young fish negatively affect recruitment to the San Francisco Bay fishery. The proportion of age six and older herring increased between the 2014-15 and 2015-16 seasons in both the research and commercial catch (Figures 4 and 5). Historically the commercial fishery has been supported by a greater proportion of older fish from the spawning population, which may reduce the burden on younger cohorts to support the fishery.

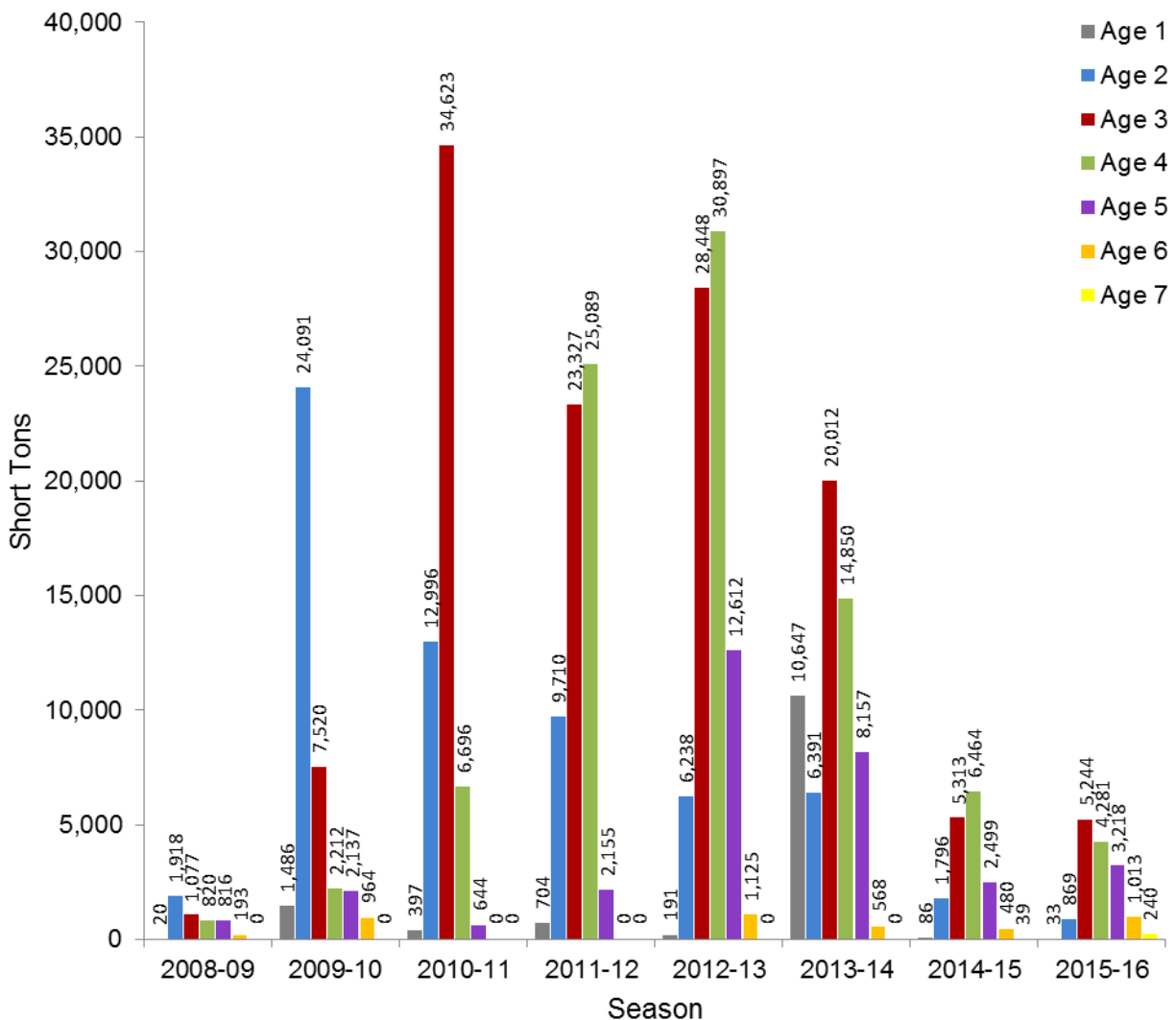


Figure 3. Estimated San Francisco Bay spawning biomass by age class for the 2008-09 to 2015-16 seasons based on research catch.



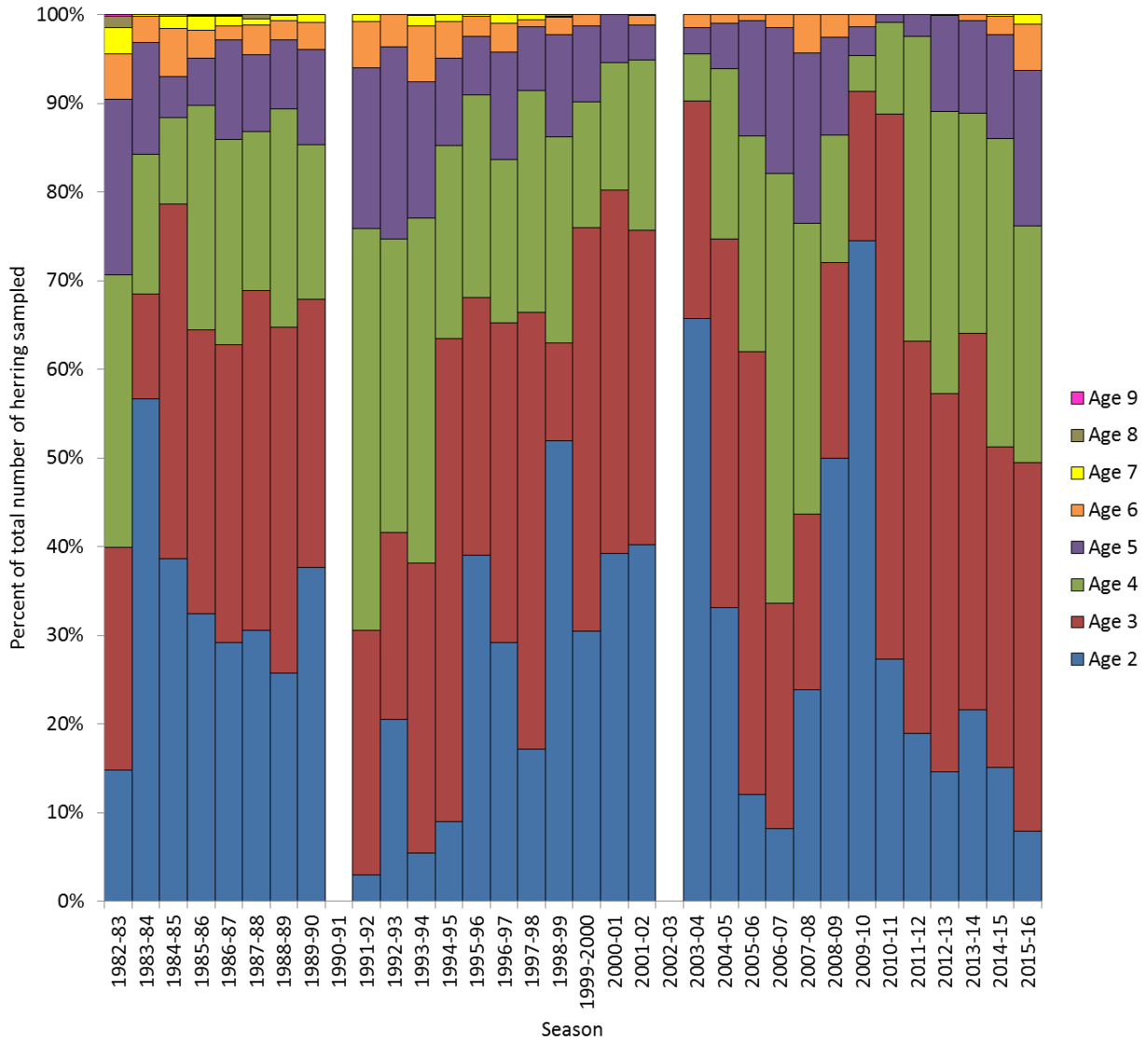


Figure 4. Age composition of the research catch (excluding age-1 fish). Percent by number of ripe fish for the San Francisco Bay herring spawning biomass.





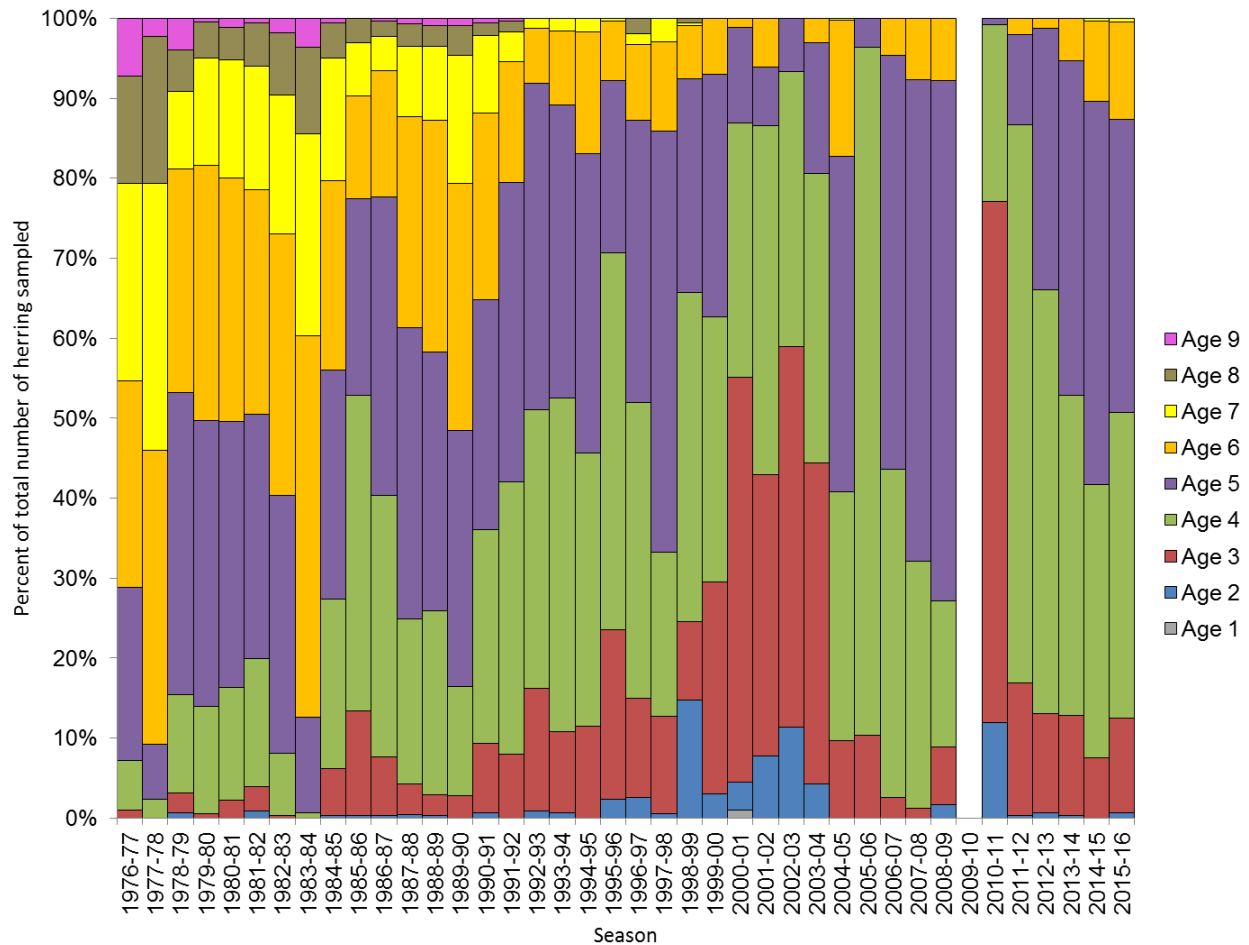


Figure 5. Age composition of the commercial gill net catch. Percent by number of fish for the San Francisco Bay herring fishery. Note: The fishery was closed during the 2009-10 season.

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. The San Francisco Bay herring CI for mature 2015-16 fish was near average and showed a slight increase relative to the 2013-14 season (Figure 6).



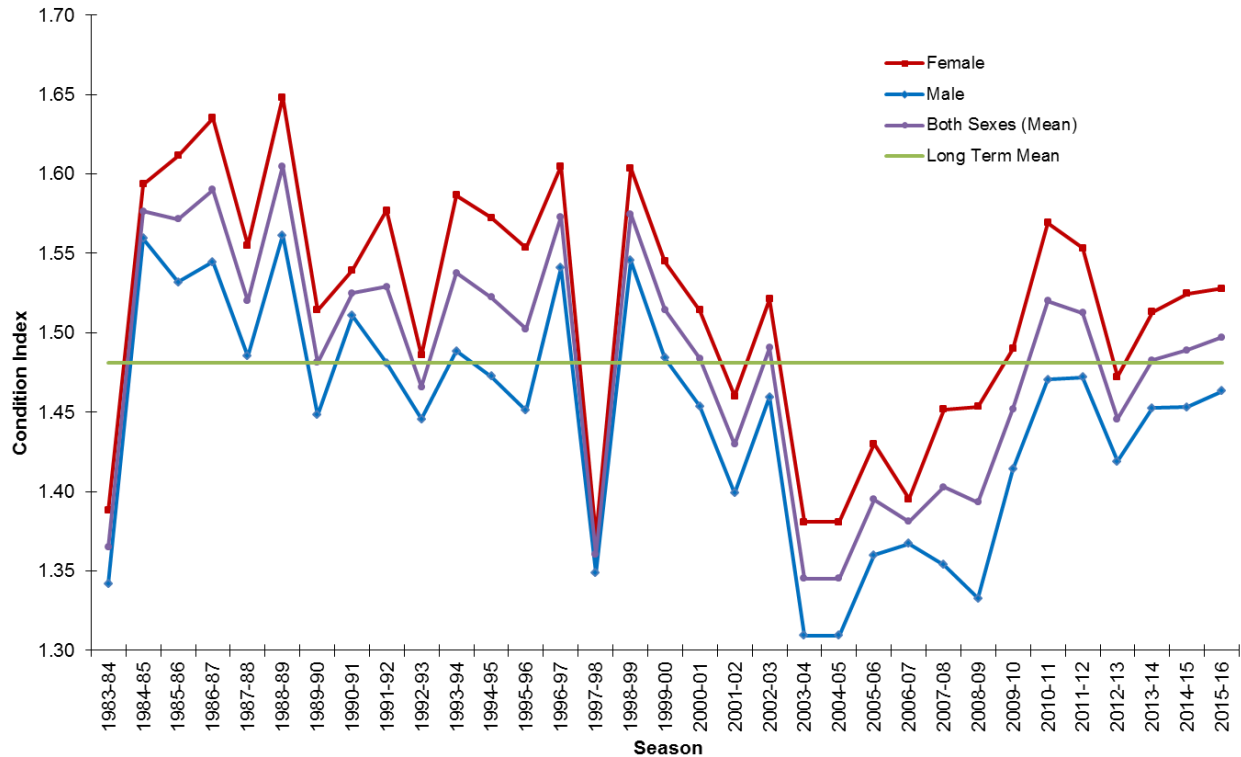


Figure 6. Average Condition Index (CI) and CI for ripe male and female fish based on research catch from the San Francisco Bay herring spawning population.

## **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 season year determines which platoon begins fishing first. Thus, the Even platoon was designated to fish first for the 2015-16 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 2015-16 season opened at 5:00 p.m. on Sunday, January 3, 2016, and closed at 12:00 p.m. (noon) on Friday, March 11, 2016. Since 1974, the gill net fisheries are closed each week from noon on Friday until 5:00 p.m. on Sunday. This weekend closure was instituted to reduce conflicts with recreational users of the bay.

The total fishery quota for San Francisco Bay was set at 834 short tons (tons) for the 2015-16 season. This was 5 percent of the previous season's (2014-15) spawning



biomass estimate of 16,676 tons. 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. The Odd platoon reached its quota on February 8, 2016, and the Even platoon ceased fishing prior to reaching the quota. Approximately 66 percent (492.5 tons) of the San Francisco Bay gill net quota was landed by the combined platoons during the 2015-16 commercial herring season (Tables 2 and 3). Commercial fishing effort increased over last season, however only 11 commercial fishing vessels participated in the gill net fishery during the 2015-16 season.

Fish landed by the gill net fishery during the 2015-16 season were slightly longer, on average, than those landed in the six previous seasons (Figure 7). They still however, continue the trend of reduced size of herring in the commercial catch. The commercial samples had the fourth lowest maximum body length on record.

The average “roe count” for the 2015-16 season was 14.6 percent (Table 2 and Figure 8), which is above the 1983-84 to 2015-16 average of 13.6 percent. Roe percentage 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 10 percent yield by weight.

### **Even Gill Net Fishery**

The Even platoon fishery opened on Sunday, January 3, 2016, at 5:00 p.m. Ten fishing vessels participated and landings were made on January 18 and February 1, 24, and 25 (Table 4). The roe count was 15.3 percent (Table 2). Eleven percent of the permits assigned to this platoon fished this season. The Even platoon landed 136 tons of herring which was equal to 35 percent of its quota.

### **Odd Gill Net Fishery**

The Odd platoon fishery opened on Sunday, January 10, 2016, at 5:00 p.m. Eleven fishing vessels participated and made landings on their first and second weeks before meeting their quota and being closed at the beginning of the third week of operation (Table 5). Roe count was 14.3 percent (Table 2). Thirteen percent of the permits assigned to this platoon made landings this season. The Odd platoon landed 356 tons, which was 99 percent of its quota.

### **Special Education Permits**

No Special Education Permits were issued for the 2015-16 season.



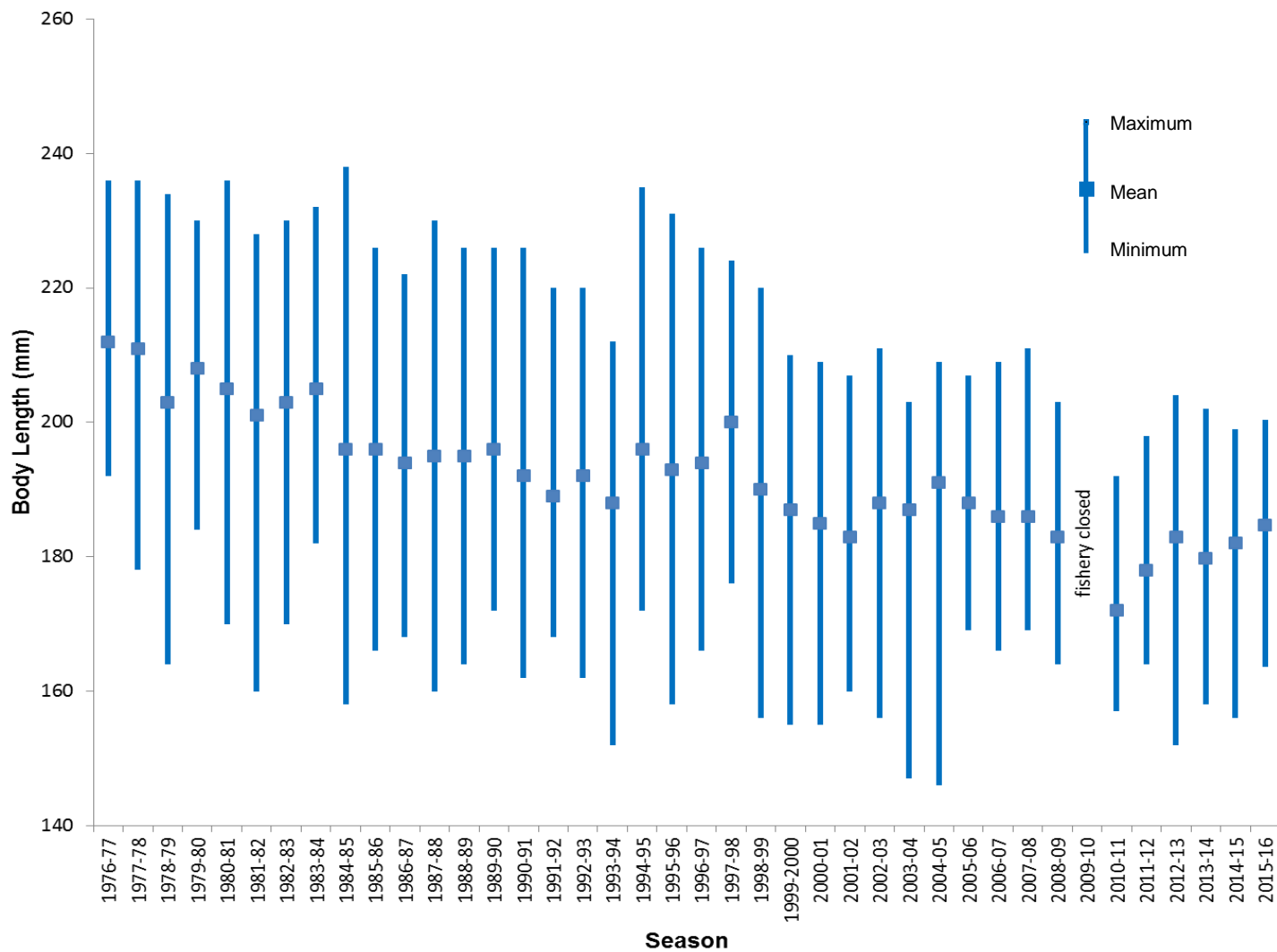


Figure 7. San Francisco Bay herring commercial minimum, mean and maximum body length from 1976-77 through 2015-16 seasons.



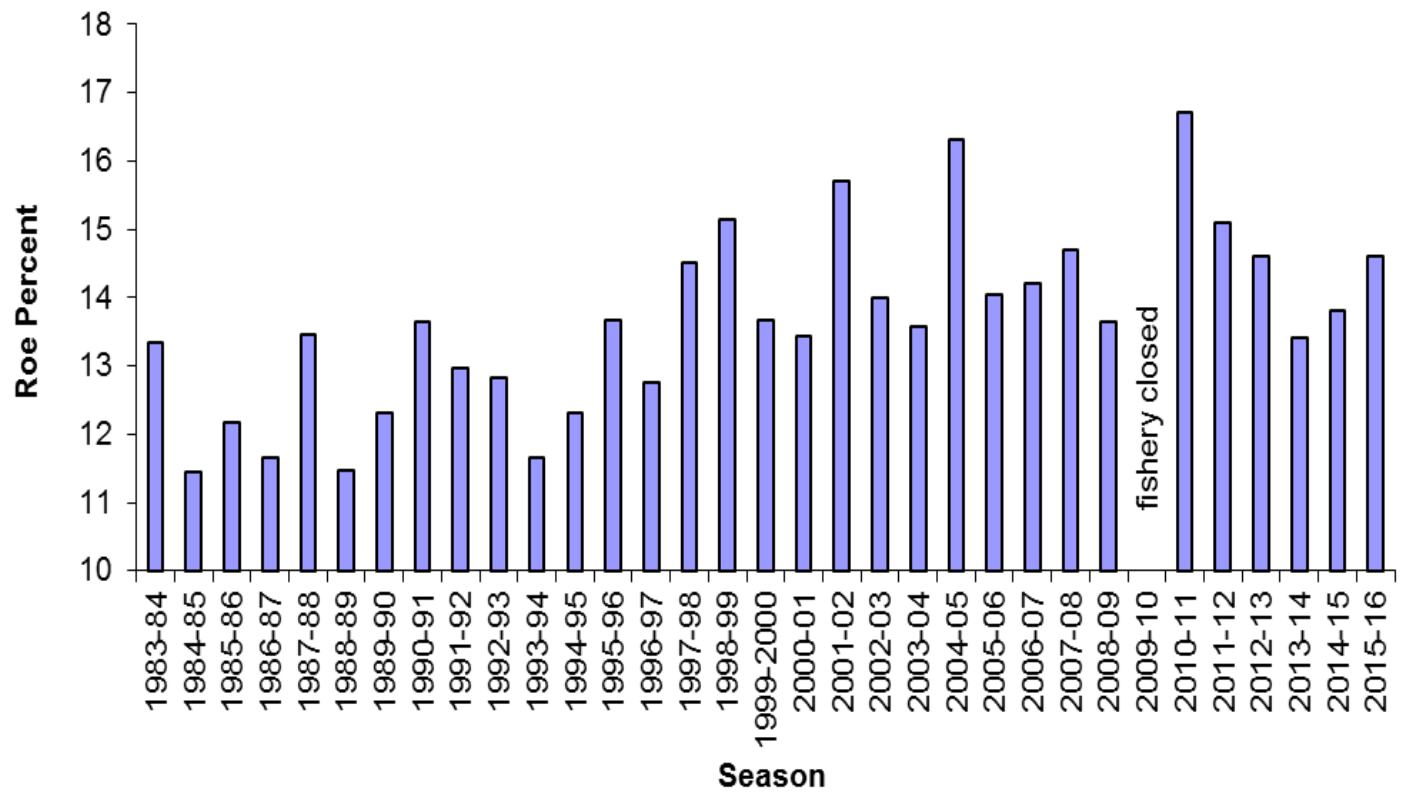


Figure 8. Average roe count in the San Francisco Bay gill net fisheries from 1983-84 through 2015-16 seasons.



## **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 herring eggs on kelp season began December 1, 2015, and ended March 31, 2016. 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 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 2015-16, the total quota for the HEOK fishery was 18.7 tons of product, 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).

TABLE 2. Herring quotas, landings, roe count, and fish count, for San Francisco Bay, 2014-2015 Season.

FISHERY	QUOTA (tons)	LANDINGS (tons)	HARVEST PERCENTAGE (%)	ROE COUNT	FISH COUNT
Odd gill net	360.1	356.457	99.0%	14.3	101.2
Even gill net	390.5	136.087	34.8%	15.3	101.4
<b>TOTAL GILL NET</b>	<b>750.6</b>	<b>492.544</b>	<b>65.6%</b>	<b>14.6*</b>	<b>101.3*</b>
HEOK (0 of 10 active)	83.4 (whole fish) = 18.66 tons product	0.0	0.0%		
<b>SF BAY TOTAL</b>	<b>834</b>	<b>492.544</b>	<b>59.1%</b>		

\* 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 2015-16 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	750.6	493
1993-94	1,996	2,302	Average	4,986	4,137
1994-95	4,408	4,574			

\* 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
1/18/2016	59,535	29.7625	18	1.65	13.3
2/1/2016	29,711	14.8555	13	1.14	16.3
2/24/2016	180,544	90.272	15	6.02	16.7
2/25/2016	2,394	1.197	2	0.60	16.6
Totals and averages	272,184	136.087	48	2.83*	15.3*

\* 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 Odd gill net platoon.**

Date	Pounds	Tons	# Receipts	Tons/Receipt	Roe Count
1/14/2016	343,058	171.529	12	6.56	12.9
1/15/2016	137,381	68.690	20	3.43	13.3
1/27/2016	43,796	21.898	4	5.47	15.7
1/28/2016	105,992	52.996	19	2.79	14.6
2/8/2016	82,687	41.343	19	2.18	17.1
Totals and averages	712,914	356.457	74	4.14*	14.3*

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

**Table 6. Quotas and landings of product for the HEOK fishery in San Francisco Bay, 1989-90 season through 2015-16 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
Average	73.1	34.0





## **CONCLUSION**

The San Francisco Bay commercial Pacific herring fishery continued during the 2015-16 season at a reduced level of effort. This coincided with an estimated spawning biomass well below the historical average. The low biomass estimate recorded during the 2015-16 season is likely attributable to low levels of productivity in the northeast Pacific Ocean and poor estuarine conditions which adversely affect herring. Despite the observed reduction in spawning biomass, 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 Marine Fisheries Service (2016). California Current Integrated Ecosystem Assessment (CCIEA) State of the California Current Report, California Current Integrated Ecosystem Assessment Team.

