

3.6 Age distribution of Pacific halibut in the 2016 IPHC fishery-independent setline survey

Joan E. Forsberg

Abstract

Pacific halibut otoliths are collected annually from the International Pacific Halibut Commission (IPHC) fishery-independent setline survey to provide age data for use in the stock assessment. The annual setline survey provides catch and biological data (including ages) that are independent of the commercial fishery and can be used to monitor changes in the stock over time.

The age distribution of Pacific halibut sampled during the 2016 IPHC fishery-independent setline survey is summarized in this paper. Fish ranging from three to 50 years old were captured, with 11-year-olds comprising the largest age group in the overall catch. Average age was higher and average fork length was lower for males than females in all regulatory areas.

Otolith collections

Samples used for age data

Pacific halibut otoliths are collected annually to provide age data for use in the stock assessment. Otoliths are obtained from three main sources: the International Pacific Halibut Commission (IPHC) fishery-independent setline survey (setline survey), the commercial Pacific halibut fishery, and the National Marine Fisheries Service (NMFS) trawl surveys. Otoliths collected from the commercial catch provide age data that are representative of the directed fishery removals, while otoliths from the NMFS trawl survey provide age data for small Pacific halibut that are not captured on longline gear. Age distributions for the commercial fishery and NMFS trawl survey collections are presented in Forsberg (2017) and Sadorus et al. (2017a, b). The annual setline survey, which uses standardized methods, gear, and bait, provides catch and biological data (including ages) that are independent of the commercial fishery and can be used to monitor changes in the stock over time. The setline survey otolith collection target is 2,000 (± 500) for Areas 2A, 2B, 2C, 3A, 3B, 4A, and 4B, and Areas 4C/4D combined. Targets are achieved by setting otolith sampling rates for each regulatory area based on projected catch rates. Setline survey sampling procedures, including area-specific otolith sampling rates, are described in Henry et al. (2017).

Additional otoliths

Paired otoliths for the IPHC clean otolith archive collection (COAC) have been collected during the setline survey since 2010. Otoliths in this collection are not aged, but are stored dry for use in future studies. In 2016, COAC otoliths were collected from regulatory areas where sampling rates were not already 100%. A total of 530 otolith pairs were collected on the 2016 setline survey (Tobin and Forsberg 2017).

Extra otoliths are also collected along with tissue samples from Pacific halibut that are sampled for environmental contaminants and for parasite studies. These otoliths are aged, but the ages are not included in the setline survey age distribution.

Age distribution

The age distribution of Pacific halibut sampled from the 2016 IPHC setline survey is summarized in [Tables 1-3](#). The 2005 year class (11-year-olds) accounted for the largest proportion (in numbers) of sampled Pacific halibut for all areas and sexes combined ([Table 1](#)). The next most abundant year classes were 2004 and 2006 (12- and 10-year-olds, respectively).

Eleven-year-olds were the most abundant age class for female Pacific halibut sampled from all areas combined, as well as for females in Regulatory Areas 2A, 2B, 3B, 4B, and 4D ([Table 2](#)). The second and third most abundant age classes for sampled females across all regulatory areas were 12- and 10-year-olds, respectively.

The 2005 year class (11-year-olds) was the largest for male Pacific halibut from all areas combined, as well as from Areas 2, 3B, 4A, and 4C ([Table 3](#)). The second and third most abundant age classes for sampled males across all regulatory areas were 12- and 13-year-olds, respectively.

Mean age and fork length (FL) by regulatory area of sampled setline survey Pacific halibut for the years 2007-2016 are presented in [Table 4](#). Average length was calculated only from fish that were aged. Average age was higher and average fork length was lower for males than females in all areas for all years with the exception of Area 4C in 2008, where average age was slightly lower for males than females.

The youngest and oldest Pacific halibut in the 2016 setline survey samples were determined to be three and 50 years old ([Table 5](#)). There was one fish determined to be three years old: a female from Area 3A measuring 52 cm FL. The 50-year-old was a male captured in Area 4B with a fork length of 121 cm. The maximum fork length recorded for setline survey-caught Pacific halibut in 2016 was 187 cm. There were two fish measuring 187 cm, both female: a 26-year-old caught in Regulatory Area 3A and a 31-year-old caught in Area 4B. The smallest Pacific halibut sampled in the 2016 setline survey measured 41 cm FL: a female from Area 3B aged at five years.

Quality control

Ten percent of annual setline survey otoliths are aged a second time by a different reader as a measure of quality control (QC). QC age readings for the 2016 survey otoliths were not complete at the time of writing. Between-reader percent agreement for setline survey ages from 2002 through 2015 is presented in [Table 6](#).

References

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Table 1. Age distribution (number of individuals sampled) of all Pacific halibut (male, female, and unknown sex combined) collected in the 2016 fishery-independent setline survey. “Sample rate” indicates the percentage of those halibut captured in each regulatory area whose otoliths were removed for subsequent aging.

	Regulatory Area									Total
	2A	2B	2C	3A	3B	4A	4B	4C	4D	
	Sample rate (%)									
	100	27	24	7	12	59	100	100	75	
Age										
3				1						1
4		3	2		2	4	1	2		14
5	2	6	1	4	8	6	9	1	1	38
6	3	7	5	7	28	21	47	3	2	123
7	11	24	19	11	30	32	61	10	8	206
8	149	119	76	54	119	112	145	27	46	847
9	107	93	85	85	134	81	146	25	83	839
10	221	219	161	174	248	202	271	43	86	1,625
11	379	487	295	305	495	306	480	85	118	2,950
12	191	319	298	350	402	310	438	93	118	2,519
13	77	130	216	240	265	215	272	65	104	1,584
14	64	113	150	206	159	139	149	55	83	1,118
15	38	84	146	223	128	97	128	26	72	942
16	24	71	118	182	83	61	89	14	29	671
17	19	54	79	147	67	44	55	6	24	495
18	10	25	66	97	48	33	31	3	14	327
19	4	15	22	43	12	19	25	1	7	148
20	1	4	27	38	15	20	33	1	5	144
21	1	7	13	24	9	19	25		13	111
22	1	4	12	12	3	5	15		7	59
23		3	6	15	5	8	12		5	54
24			1	7		3	18	1	11	41
25			4	7	4	6	10	1	8	40
≥26	1	2	3	18	1	44	93		55	217
Total	1,303	1,789	1,805	2,250	2,265	1,787	2,553	462	899	15,113

Table 2. Age distribution (number of individuals sampled) of female Pacific halibut collected in the 2016 fishery-independent setline survey. Note that halibut are not sampled at the same rate in all regulatory areas (see rates in [Table 1](#)), and that there are not separate sampling rates by sex within an area.

Age	Regulatory Area									Total
	2A	2B	2C	3A	3B	4A	4B	4C	4D	
3				1						1
4		3	1		2	3	1	2		12
5	1	3	1	4	4	4	2	1		20
6	3	5	5	5	22	14	25	2	2	83
7	10	14	13	7	17	17	37	8	5	128
8	114	83	50	36	56	51	79	26	23	518
9	80	61	54	57	69	50	61	21	52	505
10	165	147	118	117	117	96	115	38	55	968
11	278	308	215	201	231	175	213	74	81	1,776
12	143	210	228	235	177	191	158	86	74	1,502
13	52	84	152	156	111	131	73	61	73	893
14	36	59	110	130	72	70	32	49	52	610
15	19	39	107	139	39	56	26	22	53	500
16	13	42	73	88	27	37	22	13	20	335
17	7	17	52	72	20	18	12	5	17	220
18	5	7	41	33	8	13	8	3	10	128
19		6	11	17	1	6	7		4	52
20		1	19	8	1	10	9	1	2	51
21		4	8	6		9	2		8	37
22		1	5		1	1	2		1	11
23		2	4	4	1	3	1		2	17
24			1	2			4	1	7	15
25			2	2		3	1		4	12
≥26		1	2	2		11	9		23	48
Total	926	1,097	1,272	1,322	976	969	899	413	568	8,442

Table 3. Age distribution (number of individuals sampled) of male Pacific halibut collected in the 2016 fishery-independent setline survey. Note that halibut are not sampled at the same rate in all regulatory areas (see rates in [Table 1](#)), and that there are not separate sampling rates by sex within an area.

Age	Regulatory Area								Total	
	2A	2B	2C	3A	3B	4A	4B	4C		4D
4			1			1				2
5	1	3			4	2	7		1	18
6		1		2	6	7	22	1		39
7	1	10	5	3	13	15	24	2	3	76
8	34	36	24	17	63	61	66	1	23	325
9	25	30	31	28	65	31	83	4	31	328
10	55	70	39	53	129	105	153	5	31	640
11	96	179	79	103	261	131	261	11	36	1,157
12	47	107	68	112	224	119	274	7	43	1,001
13	24	46	62	84	153	84	195	4	30	682
14	28	54	38	73	86	69	116	5	31	500
15	19	45	39	84	85	41	98	4	17	432
16	11	29	45	94	56	24	66	1	9	335
17	12	36	27	75	47	26	41	1	7	272
18	4	18	25	62	40	20	22		4	195
19	4	8	11	25	11	13	16	1	3	92
20	1	3	7	30	14	10	23		3	91
21	1	3	5	18	9	10	23		5	74
22	1	3	7	12	2	4	13		6	48
23		1	2	11	4	5	11		3	37
24				5		3	14		4	26
25			2	5	4	2	9	1	4	27
≥26	1	1	1	16	1	33	84		32	169
Total	365	683	518	912	1,277	816	1,621	48	326	6,566

Table 4. Mean age (in years) and mean fork length (in centimeters) of sampled Pacific halibut caught on standard survey skates by sex and regulatory area (CLS = Bering Sea closed area), 2007–2016 (F = female, M = male).

Reg. Area	Year	2007		2008		2009		2010		2011		2012 ¹		2013		2014		2015		2016	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
		2A	Age	11.3	13.1	11.3	11.4	10.3	11.0	11.0	11.1	11.4	12.0	11.8	12.0	11.2	11.6	10.5	11.4	10.6	11.1
	Length	94.6	83.5	90.3	78.8	89.5	79.4	93.1	79.1	95.6	81.5	95.1	80.1	94.7	80.4	95.8	81.3	93.0	80.5	92.1	78.5
2B	Age	9.7	10.5	10.6	11.1	11.2	11.8	10.9	11.4	11.1	11.6	11.4	12.3	11.4	12.3	11.2	12.6	11.3	12.4	11.5	12.3
	Length	89.7	76.6	91.0	77.2	93.5	77.4	93.8	78.2	94.6	78.5	95.2	79.8	94.4	79.1	92.1	78.8	91.8	78.7	93.4	78.1
2C	Age	10.5	11.5	11.4	11.5	10.9	11.7	11.0	11.5	11.9	12.0	11.2	11.6	11.9	12.4	11.7	12.3	11.9	12.3	12.8	13.3
	Length	92.3	80.2	93.4	78.8	90.6	78.2	91.0	77.0	96.9	79.8	95.8	80.1	96.4	79.4	97.0	80.0	97.7	80.4	96.7	81.0
3A	Age	12.3	15.5	12.9	16.0	11.7	14.6	12.1	15.0	12.2	14.9	12.2	14.6	12.7	14.3	11.8	13.8	11.8	13.7	12.9	14.7
	Length	94.5	82.3	93.7	81.8	89.5	79.6	89.4	78.7	87.6	78.3	90.1	78.6	89.4	76.4	87.7	75.5	88.5	75.3	90.4	76.0
3B	Age	11.0	14.4	11.1	14.4	10.6	13.5	10.7	13.0	10.8	12.9	10.7	12.5	11.3	13.3	10.9	12.7	11.3	12.8	11.5	12.5
	Length	87.6	81.6	83.0	78.1	82.3	77.6	81.8	75.9	81.5	74.2	81.7	74.9	80.3	73.3	80.5	73.4	82.3	72.2	83.9	71.2
4A	Age	10.7	12.9	10.7	13.5	10.5	12.6	10.6	12.7	10.8	13.2	11.1	13.2	11.3	13.4	12.3	14.7	11.5	13.9	12.3	13.0
	Length	85.2	79.8	82.4	78.6	84.1	77.6	82.6	76.6	83.4	76.5	82.8	76.6	85.8	78.3	88.2	79.7	84.7	77.0	89.1	74.1
4B	Age	12.2	14.1	12.6	15.8	13.1	15.9	12.2	14.9	12.2	15.2	11.8	13.9	11.0	13.6	11.2	13.7	11.0	13.6	11.4	13.6
	Length	102.5	90.1	103.4	92.1	103.8	92.7	100.3	90.3	98.4	89.7	96.6	86.5	89.4	84.1	92.0	84.1	94.6	86.2	91.1	82.1
4C	Age	9.8	10.8	10.5	10.4	9.6	10.8	10.2	10.8	10.4	11.2	11.3	13.2	10.6	11.2	11.3	11.4	10.7	11.4	11.9	12.0
	Length	89.4	76.0	88.0	72.7	84.1	75.1	84.3	73.8	82.0	72.8	86.3	78.8	80.7	74.2	84.7	72.9	83.1	72.2	87.0	74.9
4D	Age	13.3	15.8	13.4	16.1	13.8	16.6	14.4	17.4	13.2	14.9	12.0	13.7	13.8	15.2	12.3	13.1	12.5	13.3	13.4	14.3
	Length	99.0	88.9	93.8	85.3	94.4	86.7	96.6	87.3	88.4	80.9	86.6	78.5	91.9	81.5	88.2	77.6	88.2	77.6	88.1	77.7
4E	Age	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10.1	12.5	---	---
	Length	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	89.0	79.9	---	---
CLS	Age	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10.4	11.2	---	---
	Length	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	86.9	73.4	---	---

¹Does not include otoliths from fish sampled on experimental bait skates that were fished concurrently with standard survey skates during 2012 bait study (Webster et al. 2013).

Table 5. Maximum and minimum age (in years) and fork length (in centimeters) of Pacific halibut for which sex was determined, collected in the 2016 fishery-independent setline survey, by regulatory area and sex.

Reg. Area	Sex	Max. age	Min. age	Max. length	Min. length
2A	Female	18	5	146	67
2A	Male	28	5	113	62
2B	Female	27	4	182	62
2B	Male	31	5	173	57
2C	Female	35	4	185	57
2C	Male	27	4	136	59
3A	Female	27	3	187	52
3A	Male	36	6	108	55
3B	Female	23	4	147	41
3B	Male	33	5	111	47
4A	Female	32	4	164	47
4A	Male	39	4	116	42
4B	Female	32	4	187	52
4B	Male	50	5	141	53
4C	Female	24	4	141	46
4C	Male	25	6	102	46
4D	Female	38	6	180	54
4D	Male	34	5	131	55

Table 6. Between-reader percent agreement for fishery-independent setline survey ages 2002-2015. (CV = coefficient of variation, APE = average percent error, % -bias = % of ages where the second age estimated for a fish (age 2) was younger than the initially-estimated age (age 1), % +bias = % of ages where age 2 > age 1.)

Year	Total aged	Number aged twice	% agreement (± 1 year)	CV (%)	APE	% -bias	% +bias
2002	13,635	2,229	81.2	4.3	3.0	24.8	33.6
2003	12,613	1,633	83.3	4.3	3.0	22.0	29.3
2004	14,474	1,257	83.3	4.8	3.4	18.5	38.8
2005	14,552	1,361	85.1	3.9	2.8	20.4	30.2
2006	14,977	1,556	90.4	3.2	2.2	23.7	18.8
2007	16,022	1,566	87.2	4.5	3.2	28.1	28.6
2008	15,545	1,579	89.5	3.4	2.4	25.8	21.3
2009	15,706	1,567	91.1	3.4	2.4	26.2	19.0
2010	14,080	1,407	92.8	2.8	2.0	23.7	19.5
2011	14,451	1,448	89.8	3.7	2.6	30.3	19.3
2012	¹ 17,459	¹ 1,751	91.7	3.5	2.5	26.0	21.1
2013	12,717	1,438	91.9	2.6	1.8	16.9	17.7
2014	16,193	1,848	90.6	2.9	2.0	14.6	19.2
2015	16,023	2,044	86.8	3.5	2.5	10.1	26.7

¹Includes extra otoliths collected on standard skates and experimental bait skates from 2012 bait study (Webster et al. 2013).