

2.10 Age distribution of Pacific halibut in the 2016 commercial catch

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Abstract

Pacific halibut (*Hippoglossus stenolepis*) otoliths are collected annually by International Pacific Halibut Commission samplers to provide age data for use in the stock assessment. Otoliths collected from the commercial catch provide age data that are representative of the directed fishery removals. The age distribution of Pacific halibut sampled from the 2016 commercial catch is summarized from 10,938 otoliths aged thus far. Fish from five to 43 years old were captured, with 12-year-olds comprising the largest age group in the overall catch. Average age for all areas combined was 13.4 years, slightly increased from 2015.

Otolith sampling

Pacific halibut otoliths are collected to provide age data for use in the International Pacific Halibut Commission's (IPHC) stock assessment. IPHC age readers only use the left- or blind-side otolith of the sagittal pair for age determination; growth patterns of right- or eyed- side otoliths are harder to interpret and the ages derived from right-side otoliths are less accurate (Forsberg 2001). Left-side sagittal otoliths are obtained from Pacific halibut caught on the IPHC's fishery-independent setline survey and on National Marine Fisheries Service (NMFS) trawl surveys, as well as from the commercial fishery. 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 catch over time, 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 setline and NMFS trawl survey collections are presented in Forsberg (2017) and Sadorus et al. (2017a, b).

Otoliths collected from the commercial catch (also called market samples) provide age data that are representative of the directed fishery removals. The commercial otolith-collection target is 1,000 otoliths for IPHC Regulatory Area 2A and 1,500 (± 500) per regulatory area for each of Areas 2B, 2C, 3A, 3B, 4A, and 4B, and Areas 4C/4D combined. Otolith targets were met in all areas in 2016 with the exception of Area 2A. Commercial catch-sampling procedures, including port- and area-specific otolith sampling rates, are detailed in Erikson et al. (2017).

In 2016, IPHC port samplers reported collecting 12,108 market sample otoliths for stock assessment; however, only 11,431 otoliths had been received in the office at the time of writing. Of the latter, ages could not be determined for 493 otoliths because they were crystallized (i.e., composed of vaterite), right-sided, or badly broken.

In British Columbian ports, Pacific halibut were sampled from several deliveries from vessels that had participated in a voluntary sex-marking study (Loher et al. 2017) in which vessel crew marked individual fish to indicate their sex as they dressed the catch at sea. Most of these sex-marked trips were sampled at the normal rate and were included in the market samples. However,

31 ‘extra’ otoliths were collected from two marked trips that were sampled at a higher rate or in a non-random manner. These extra otoliths were aged but not included in the assessment.

An additional 372 sagittal otolith pairs were collected by port samplers for the clean otolith archive collection; these otoliths were not aged but were dried and stored for future studies (Tobin and Forsberg 2017). The otolith collection numbers presented in the text and tables of this report do not include clean otolith archive samples or the extra otoliths collected from sex-marked Pacific halibut.

Age distribution

The 2004 year class (12-year-olds) accounted for the largest proportion (in numbers) of the sampled commercial catch (18%) for all areas combined in 2016 ([Table 1](#)). The next most-abundant year classes for all areas combined were 2005 and 2003, accounting for 17 and 13% of the sampled catch, respectively. Twelve-year-olds were the most abundant age class in Regulatory Areas 2C, 3A, 3B, 4A, and 4B, and the second most abundant in all other areas. Eleven-year-olds (the 2005 year class) were the most abundant age class in Areas 2A, 2B, and 4C, while 13-year-olds (the 2003 year class) were the most abundant age class in Area 4D.

The average values for age, length, and estimated weight by regulatory area for 2016 are presented in [Table 2](#). Average fork length of sampled Pacific halibut increased in Areas 2A, 3B, 4A, 4C and 4D in 2016, but decreased in all other areas. Average fork length for all areas combined increased by 1.0 cm in 2016.

The average age of fish sampled from Areas 2, 3B, 4C, and 4D increased in 2016 relative to 2015, while average ages from all other areas decreased ([Table 3](#)). The average age from all areas combined in 2016 (13.4 years) was slightly higher than it was in 2015.

The youngest and oldest Pacific halibut in the 2016 commercial samples were determined to be five and 43 years old, respectively. There were three fish determined to be five years old: two from Area 2B measuring 82 cm and 99 cm, and one from Area 3B measuring 84 cm. The 43-year-old was captured in Area 4A, and had a fork length of 112 cm. The largest Pacific halibut in the 2016 commercial sample was a 200-cm fish from Area 4B, which was determined to be 37 years old. The smallest Pacific halibut in the 2016 commercial catch sample was a 74-cm fish from Area 2A, aged at 19 years old. Length frequencies by regulatory area for Pacific halibut sampled in the 2016 commercial catch are presented in [Table 4](#).

Quality control

[Table 5](#) contains percent agreement values for quality control (QC) readings. All QC readings from 2002 through 2015 were conducted on burned or baked otolith sections (Forsberg 2001). QC readings for years prior to 2002 were read from either surface ages or burned/baked section ages. Ten percent of each year’s market samples are read twice for QC. At the time of writing, QC readings for the 2016 commercial samples were not complete. The remainder of the QC readings of 2016 market samples will be performed over the winter of 2016-17.

References

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Table 1. Age distribution of commercial catch of Pacific halibut by IPHC regulatory area, 2016.

Age (years)	Regulatory Area									Total
	2A	2B	2C	3A	3B	4A	4B	4C	4D	
5		2			1					3
6		3	1		1					5
7	1	11	9	1	15	4		3		44
8	30	35	37	20	34	41	4	11	6	218
9	40	55	81	25	72	61	20	11	33	398
10	119	151	148	87	134	124	72	29	62	926
11	236	349	250	178	247	273	159	59	120	1,871
12	142	331	259	197	280	301	214	56	142	1,922
13	82	199	193	165	188	222	177	56	182	1,464
14	54	156	169	163	143	145	101	43	133	1,107
15	37	100	172	151	91	95	117	13	106	882
16	33	93	128	124	53	56	62	6	47	602
17	22	74	90	96	36	36	34	8	35	431
18	13	40	44	58	33	26	24	2	20	260
19	11	15	30	26	12	19	28	1	20	162
20	5	16	18	27	10	11	33	1	9	130
21	4	12	7	24	7	6	19	1	12	92
22	1	5	7	15	5	11	11		10	65
23		4	7	15	3	2	22		6	59
24		6	3	13	3	6	15		4	50
25		2	6	9		5	14	4	4	44
≥26	1	7	7	16	6	51	66	8	41	203
Total	831	1,666	1,666	1,410	1,374	1,495	1,192	312	992	10,938

Table 2. Statistic associated with 2016 commercial Pacific halibut fishery samples by IPHC regulatory area: mean age, mean length, mean net weight, and the number of otoliths collected and aged.

Regulatory Area	Mean age (years)	Mean length (cm)	Mean weight (lbs) ¹	Mean weight (kg) ¹	Otoliths collected ²	Otoliths aged ³
2A	12.1	96.9	19.9	9.0	882	831
2B	12.8	99.7	22.6	10.2	1,905	1,666
2C	13.3	108.5	29.8	13.5	1,771	1,666
3A	14.3	95.9	19.4	8.8	1,477	1,410
3B	12.6	99.1	21.8	9.9	1,549	1,374
4A	13.3	101.1	23.7	10.7	1,638	1,495
4B	14.9	100.1	22.8	10.3	1,466	1,192
4C	12.9	102.7	25.5	11.6	319	312
4D	14.2	98.4	21.2	9.6	1,101	992
All Areas	13.4	100.5	23.1	10.5	12,108	10,938

¹Weights calculated from measured fork lengths for fish aged through November 9, 2016 (excludes otoliths collected for clean archive and extra otoliths collected for sex-marking project).

²From market sample data entered through November 14, 2016 (excludes otoliths collected for clean archive and extra otoliths collected for sex-marking project).

³Numbers of otoliths aged by November 9, 2016.

Table 3. Mean age (in years), mean length (in centimeters fork length), and estimated mean net weight¹ (in pounds and kilograms) of sampled commercially-caught Pacific halibut by IPHC regulatory area, 2007-2016.

Reg. Area		Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2A	Age	12.3	12.1	11.5	11.4	11.7	11.5	11.6	11.2	11.1	12.1
	Length	96.1	93.5	95.5	94.2	93.2	92.9	96.1	94.7	93.9	96.9
	Wgt (lbs)	19.6	17.7	19.1	18.3	17.7	17.4	19.6	18.6	18.2	19.9
	Wgt (kg)	8.9	8.0	8.6	8.3	8.0	7.9	8.9	8.4	8.3	9.0
2B	Age	11.8	12.2	11.7	11.6	11.9	12.0	12.6	12.6	12.1	12.8
	Length	97.0	97.0	97.2	98.9	97.9	99.4	103.0	100.8	102.5	99.7
	Wgt (lbs)	20.9	21.2	21.4	22.5	21.5	22.8	25.7	23.9	25.4	22.6
	Wgt (kg)	9.5	9.6	9.7	10.2	9.8	10.3	11.6	10.8	11.5	10.2
2C	Age	12.7	13.1	12.9	12.2	12.7	12.4	13.0	12.9	13.0	13.3
	Length	105.7	106.7	107.5	105.1	106.5	109.2	109.4	110.0	109.1	108.5
	Wgt (lbs)	28.1	28.9	29.6	27.3	28.6	31.0	31.2	31.6	30.7	29.8
	Wgt (kg)	12.7	13.1	13.4	12.4	13.0	14.1	14.1	14.3	13.9	13.5
3A	Age	16.0	15.9	15.1	15.2	15.0	15.0	15.1	14.5	14.7	14.3
	Length	100.3	100.3	99.1	97.5	95.7	95.6	96.7	96.4	96.5	95.9
	Wgt (lbs)	22.8	22.9	22.1	20.9	19.4	19.2	20.2	20.0	20.0	19.4
	Wgt (kg)	10.4	10.4	10.0	9.5	8.8	8.7	9.2	9.1	9.1	8.8
3B	Age	13.8	14.0	12.8	12.7	12.7	12.6	12.8	12.8	12.1	12.6
	Length	99.8	97.1	97.2	96.0	95.2	95.2	95.4	94.2	95.8	99.1
	Wgt (lbs)	22.7	20.3	20.6	19.7	19.1	19.1	19.2	18.4	19.5	21.8
	Wgt (kg)	10.3	9.2	9.3	8.9	8.7	8.7	8.7	8.3	8.8	9.9
4A	Age	14.5	15.6	15.4	13.9	15.6	15.7	15.0	13.8	14.0	13.3
	Length	102.7	103.4	101.2	99.8	103.4	104.1	100.9	98.4	98.8	101.1
	Wgt (lbs)	25.4	25.9	24.0	22.8	26.0	26.3	23.7	21.5	21.7	23.7
	Wgt (kg)	11.5	11.7	10.9	10.4	11.8	11.9	10.7	9.8	9.8	10.7
4B	Age	16.0	15.5	16.7	16.4	16.0	16.3	15.8	15.9	15.1	14.9
	Length	108.5	110.6	107.2	107.5	109.0	105.5	104.4	100.9	100.5	100.1
	Wgt (lbs)	30.4	33.3	29.2	29.6	31.1	27.4	26.8	23.5	23.5	22.8
	Wgt (kg)	13.8	15.1	13.2	13.4	14.1	12.4	12.1	10.7	10.7	10.3
4C	Age	11.0	11.7	12.2	13.2	12.9	12.6	12.5	12.0	12.1	12.9
	Length	105.6	103.8	102.4	101.4	100.4	99.6	99.3	96.8	96.1	102.7
	Wgt (lbs)	27.9	26.3	25.4	23.8	23.3	22.9	23.3	21.0	20.2	25.5
	Wgt (kg)	12.7	11.9	11.5	10.8	10.6	10.4	10.6	9.5	9.2	11.6
4D	Age	15.3	16.1	15.9	16.1	14.7	14.9	15.9	13.8	14.1	14.2
	Length	104.6	103.2	104.3	102.7	99.3	99.2	100.3	98.3	97.7	98.4
	Wgt (lbs)	26.6	25.5	26.5	25.3	22.1	21.7	22.8	21.6	20.6	21.2
	Wgt (kg)	12.1	11.6	12.0	11.5	10.0	9.8	10.4	9.8	9.4	9.6
Total	Age	14.1	14.3	13.7	14.0	13.7	13.8	13.8	13.3	13.3	13.4
	Length	102.1	101.2	100.6	100.8	99.1	100.2	101.1	99.0	99.5	100.5
	Wgt (lbs)	24.8	24.2	23.6	23.8	22.4	23.2	24.0	22.3	22.6	23.1
	Wgt (kg)	11.3	11.0	10.7	10.8	10.1	10.5	10.9	10.1	10.3	10.5

¹Weights calculated from measured fork lengths. Excludes samples not aged, samples collected for clean archive, and extra otoliths collected for sex-marking project.

Table 4. Number of Pacific halibut sampled by 5-cm length category in the 2016 commercial catch by IPHC regulatory area (not including samples collected for the clean otolith archive or extra otoliths collected for special projects). The 80-84-cm category is further divided to designate the U32/O32 split within that category.

Fork length (cm)	Regulatory Area									Total
	2A	2B	2C	3A	3B	4A	4B	4C	4D	
74-79	1	10	2	1				5	1	20
80-81 ¹	13	64	2	36	23	5	8	20	5	176
82-84 ²	95	151	54	164	139	134	87	21	74	919
85-89	174	305	172	338	274	254	220	39	205	1,981
90-94	165	246	209	278	235	234	232	35	212	1,846
95-99	122	223	184	180	186	217	193	41	168	1,514
100-104	94	163	154	132	139	190	156	35	124	1,187
105-109	74	139	187	100	109	142	126	36	96	1,009
110-114	57	111	157	74	94	113	76	19	67	768
115-119	42	87	155	42	95	86	42	16	32	597
120-124	21	80	137	35	43	58	40	10	22	446
125-129	13	39	103	17	45	38	27	12	17	311
130-134	4	39	62	9	26	29	20	7	13	209
135-139	2	17	39	8	10	21	15	9	8	129
140-144		17	35	5	11	16	8	2	3	97
145-149	1	9	21	3	1	5	6	5	3	54
150-154		2	16	2	2	6	4	3	3	38
155-159		3	11	1		4	1	3	2	25
160-164		2	7			2			2	13
165-169		1	3			3				7
170-174			1			3	4	1		9
175-179			2		1	1	1			5
180-184										
185-189										
190-194						1				1
195-200										
200-205							1			1
Total	878	1,708	1,713	1,425	1,433	1,562	1,267	319	1,057	11,362

¹U32²O32

Table 5. Between-reader percent agreement for Pacific halibut market samples that were aged from 1996-2015 (CV = coefficient of variation, APE = average percent error).

Year	Total aged	No. aged twice	Percent agreement (± 1 year)	CV	APE
1996	13,452	1,839	92.3	2.8	2.0
1997	15,500	2,203	93.6	2.4	1.7
1998	14,395	2,110	91.9	2.6	1.8
1999	12,796	1,117	92.0	2.5	1.8
2000	13,982	1,002	88.8	3.0	2.1
2001	13,181	2,025	86.3	3.9	2.8
2002	17,770	2,135	87.9	3.2	2.3
2003	13,738	984	82.6	3.9	2.8
2004	11,866	809	82.6	3.6	2.5
2005	13,945	1,315	85.9	3.7	2.6
2006	12,330	1,241	88.3	3.5	2.5
2007	13,910	1,488	85.8	3.9	2.8
2008	13,460	1,337	90.3	3.1	2.2
2009	13,718	1,348	91.5	2.9	2.0
2010	16,106	1,617	91.7	2.9	2.1
2011	11,215	1,131	88.4	3.4	2.4
2012	12,981	1,364	90.3	2.8	2.0
2013	11,039	1,259	89.4	2.7	1.9
2014	12,606	1,357	90.9	2.8	2.0
2015	12,312	1,366	91.0	2.4	1.7