Age and size composition of Pacific halibut sampled during the Bering Sea NMFS trawl survey for 1998-2011

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Abstract

The International Pacific Halibut Commission has participated annually in the National Marine Fisheries Service Bering Sea trawl survey since 1998. Age and size composition data for the years 1998 through 2011 are summarized.

Introduction

The International Pacific Halibut Commission (IPHC) has participated annually in the National Marine Fisheries Service (NMFS) Bering Sea trawl survey since 1998. The survey spans the shelf area from Bristol Bay to the shelf edge and northward to St. Matthew Island (Fig. 1) and surveys stations positioned on a 20x20 nmi grid. The commercial halibut fishery and the IPHC setline survey focus effort along the shelf edge and around the islands where the larger (O32) halibut can be found, but a large abundance of halibut, mostly U32, reside on the Bering Sea shelf. The trawl survey is the only opportunity the IPHC has for observation of these younger year classes in most years. It's important to note that trawl survey estimates of abundance for halibut up to about 100 cm in length are thought to be accurate, but at larger sizes, trawl gear tends to catch the smaller animals of a given age and miss the larger ones (Clark et al. 1997). Therefore, age and catch data on halibut above 100 cm in length may not be indicative of the real composition of halibut on the grounds.

The NMFS Bering Sea trawl survey generally employs two vessels to sample the region and, in theory, the sampling scheme allows each vessel to cover the entire area, rendering a representative sample of the region. However, in practice, mechanical problems, crew delays, or any number of issues can arise that may result in one vessel sampling more or fewer stations in a region than the other. Because a halibut sampler is only placed on one vessel, bias could be introduced if that staffed vessel ends up not fishing a representative sample of the survey area. Reports presenting age and size composition for the annual NMFS Bering Sea trawl survey in the current and previous versions of the IPHC's annual Report of Assessment and Research Activities (Sadorus et al. 2012, IPHC 2011) provide tables showing the proportion of halibut of each age scaled to the abundance estimates for each year. Note that these scaled proportions do not vary widely from the sample proportions and the age data in this report have not been scaled.

Methods

The overall survey design and sampling methods for the NMFS Bering Sea trawl survey have been consistent from year to year, and detailed descriptions of gear and methods used each year are available on the NMFS website (NMFS 2011). Shipboard halibut sampling protocols and results can be found in trawl survey cruise reports which have been included annually in the IPHC Report of Assessment and Research Activities (RARA) dating back to 1998 (IPHC 2011, Sadorus and Lauth 2012). Otoliths were collected from sampled halibut and aged using 'surface' and 'break

and burn/bake' aging methods. The data presented in this report are based on raw age frequencies derived from samples and are presented irrespective of aging method. Surface aging is known to produce biased age estimates from some ages, particularly for older fish. IPHC assessment scientists have developed a methodology to estimate canonical ages from surface-aged otoliths, based on comparative readings of the same otoliths using surface vs. break/burn techniques, and those canonical ages are used in stock assessments. Interested readers are directed to Clark (2004) for details of this methodology.

Samples collected between 1998 and 2001 were all surface aged; break and burn ages were done for otoliths that met certain criteria, such as high surface age, difficult growth pattern, or for which age readings made by different readers disagreed by two or more years (Forsberg 2001). Otoliths collected in 2002 and subsequent years were aged by surface technique if less than five years old and those aged at five or greater by surface technique were also aged by break and bake. Larger otoliths that were obviously older than five were not surface-aged first but immediately aged by break and bake method (Forsberg 2004).

Age composition and abundance estimates

Average fork length at each age up to 13 years for fish sampled during the years 1998-2011 is presented in Figure 2. Some fish older than 13 years are captured in the trawl survey, but trawl gear selectivity dictates that the sample probably favors the smaller fish of those older age classes, making the corresponding average length estimates inaccurate. As halibut mature, the females grow larger and faster than the males (IPHC 1998). In Figure 2, this divergence in length with age is evident beginning at around six years old. The total size at age decline seen in commercial-sized (O32) fish in recent years (Hare 2012) is not readily apparent in these data.

IPHC uses a maturity scale (IPHC, Unpub.) which employs two maturity codes for males (immature and mature), and four codes for females (immature, ripening, spawning, resting). A halibut is assessed soon after capture by direct examination of the gonads. Currently, a female is considered mature, i.e., able to participate in the upcoming winter spawning, if it receives any of the codes except "immature". The maturity assessment for both sexes is based on criteria developed from observations and other flatfish research, but has not been confirmed with laboratory histological examination of halibut gonads. Indeed, there are still unanswered questions about halibut spawning behavior and frequency that are currently being addressed through laboratory testing and tagging studies initiated at the IPHC (Loher and Geernaert 2012, Loher and Nielsen 2012). The maturity data in this report were collected according to the current maturity assessment tool used by IPHC.

Average fork length and age for male halibut (Table 1) and female halibut (Table 2) are shown grouped by whether the animals were assessed as immature or mature. The average size and age of both mature and immature male halibut vary over time, but in 2011 were considerably lower than when sampling began in 1998. There has also been an increase in the proportion coded as mature over that time. Among sampled females, average size and age, as well as proportion coded as mature have also varied over time, but with no obvious increasing or decreasing trend.

The NMFS Bering Sea trawl survey has been conducted annually since 1979, and became fully standardized beginning in 1982 (Lauth 2011). A look at halibut abundance estimates from these surveys over the entire time series at decadal intervals (Fig. 3) indicates that the two most recent surveys represented in the figure reflect greater numbers of halibut at larger sizes than in the previous two surveys, but these larger sizes are still well below the halibut commercial size limit of 81.3 cm.

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Table 1. Average age and fork length of immature and mature male halibut sampled on the NMFS Bering Sea trawl survey for 1998-2011. Sample size is the number of fish used for averaging; see text for details of ageing methods.

	Immature males			Mature males			
Year	Avg. fork length	Avg. age	Sample size	Avg. fork length	Average age	Sample size	% coded mature
1998	53.9	6.5	357	75.5	9.9	39	9.8
1999	47.7	5.5	376	-	-	0	0.0
2000	33.1	3.6	217	69.6	9.6	98	31.1
2001	37.2	4.0	276	65.0	8.8	179	39.3
2002	39.7	4.1	266	73.3	10.8	104	28.1
2003	39.3	4.1	280	67.5	9.4	77	21.6
2004	43.4	4.0	347	76.2	11.1	49	12.4
2005	38.0	3.2	240	62.6	7.5	160	40.0
2006	26.1	2.4	1,038	58.4	6.4	292	22.0
2007	29.1	3.2	251	50.5	5.8	427	63.0
2008	35.8	3.8	530	57.8	6.8	234	30.6
2009	40.2	4.3	495	55.8	6.9	268	35.1
2010	24.7	2.7	96	48.9	6.3	686	87.7
2011	37.4	4.2	386	54.1	7.6	477	55.3

Table 2. Table 1. Average age and fork length of immature and mature female halibut sampled on the NMFS Bering Sea trawl survey for 1998-2011. Sample size is the number of fish used for averaging; see text for details of ageing methods.

	Immature females			Mature females			
Year	Avg. fork length	Avg. age	Sample size	Avg. fork length	Average age	Sample size	% coded mature
1998	58.7	6.6	421	123.8	15.8	19	4.3
1999	53.8	5.7	373	135.3	15.3	4	1.1
2000	46.3	4.8	274	109.1	13.0	14	4.9
2001	47.7	5.1	409	107.9	14.3	16	3.8
2002	50.5	5.4	381	109.4	13.9	10	2.6
2003	45.5	4.6	347	98.9	12.6	19	5.2
2004	50.0	4.6	476	91.8	11.7	22	4.4
2005	47.5	4.3	366	118.1	17.9	15	3.9
2006	34.6	3.2	1,284	128.9	17.9	7	0.5
2007	43.2	4.6	732	121.1	17.7	9	1.2
2008	45.2	4.6	753	109.0	14.3	4	0.5
2009	49.1	5.1	863	98.8	11.6	19	2.2
2010	50.8	6.0	907	136.3	18.7	3	0.3
2011	52.2	6.4	759	109.8	15.2	9	1.2

Figure 1. Standard stations fished in the Bering Sea NMFS trawl survey. Note that through the years, stations around the edges have varied slightly.

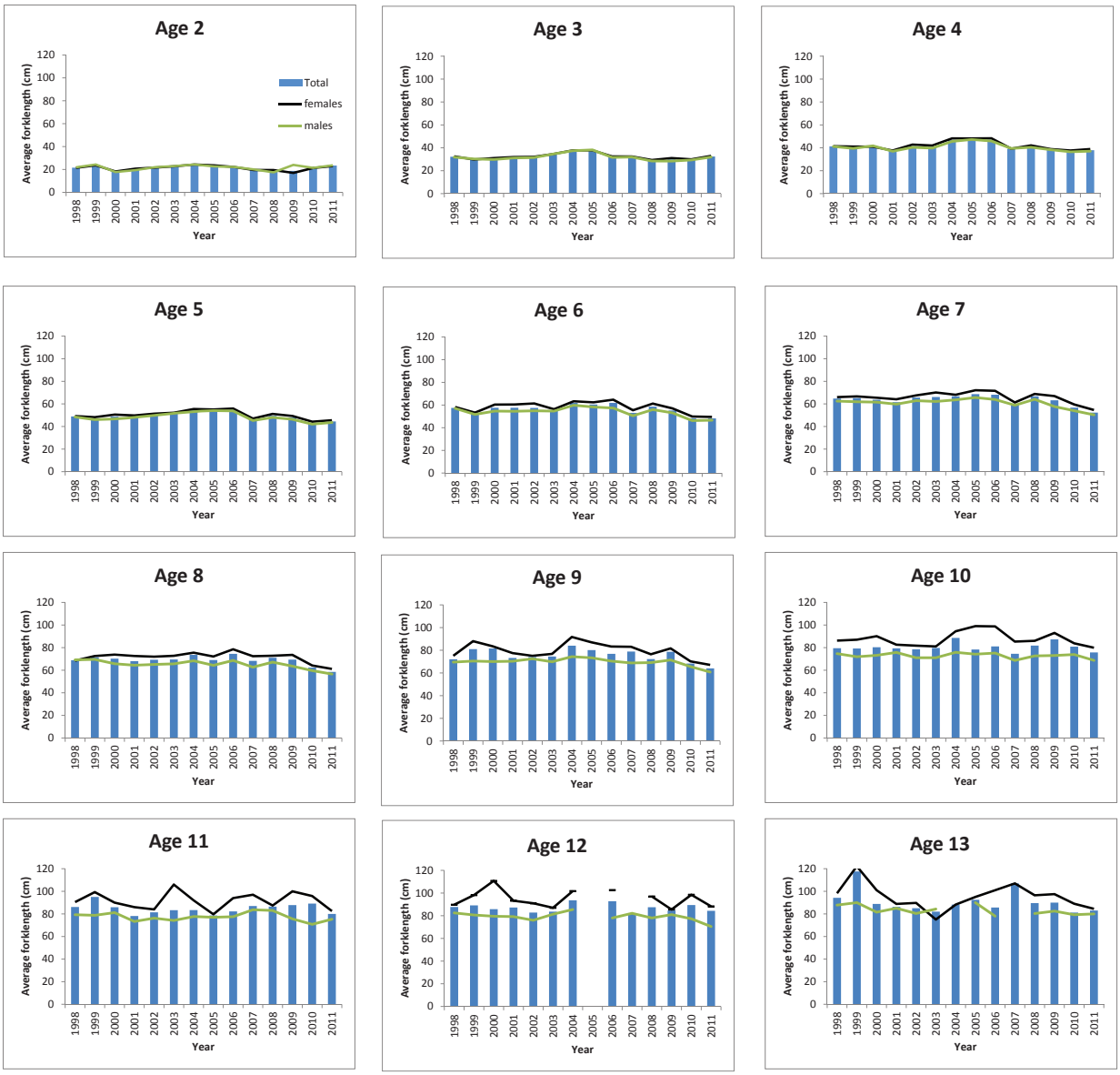

Figure 2. Average fork length (cm) at each age for halibut sampled on the Bering Sea NMFS trawl survey for years 1998-2011.

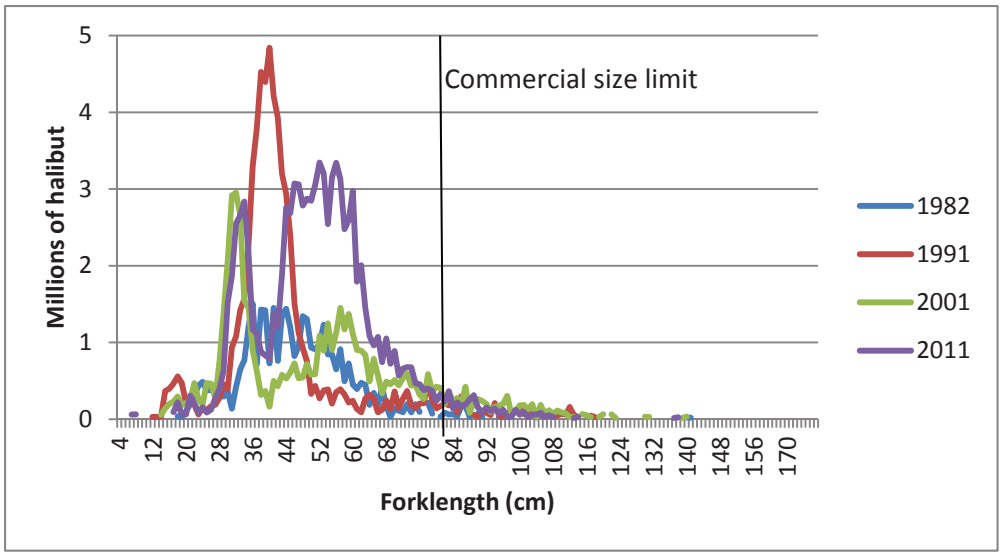

Figure 3. Halibut abundance estimates by size for the 1982, 1991, 2001, and 2011 Bering Sea NMFS trawl surveys.