INFORMATION ON THE PACIFIC HALIBUT FISHERY AND RESOURCE IN THE BERING SEA AND THE NORTHEAST PACIFIC OCEAN, 1988

Prepared on Behalf of Canada and the United States

By

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Abstract

The document reviews the 1988 commercial fishery for Pacific halibut (Hippoglossus stenolepis) and the research and stock assessment conducted by the International Pacific Halibut Commission (IPHC) on behalf of the United States and Canada. Catches of halibut by the 1988 directed fishery totalled 42,661 mt in the northeast Pacific Ocean and 2,192 mt in the Bering Sea/Aleutian Islands area, one of the highest catches in the history of the fishery. Catch per unit effort (CPUE) was highest in the Chirikof-Shumagin regions, 289 kg/skate. Over 17,100 otoliths were aged to determine the age and size composition of the catch: mean length was estimated to be 110 cm, mean age was 11.2 years, and the average weight was 19.6 kg. Exploitable biomass was estimated at 128,500 mt in 1988, a decline of six percent from 1987. This was the second year that biomass declined and is consistent with long term cycles observed in the halibut resource. Constant exploitation yield (CEY) for the directed fishery was estimated at 31,200 mt and was determined using a constant exploitation fraction of 0.35 and subtracting out other removals. Maximum sustainable yield (MSY) for all sources of removals was estimated at 48,800 mt; setline MSY was estimated at 35,000 mt. Incidental mortality has increased to 10,600 mt and is the highest since 1982. Over half of the incidental mortality occurs in the Bering Sea. During 1988 and 1989, IPHC continued to collect detailed fishery statistics from fishermen and processors, and sampled the commercial catch. In addition, at-sea experiments investigated the relationship between otolith weight and fish weight, examined abundance in the northern portion of the Charlotte region,

compared the fishing characteristics of sablefish (Anoplopoma fimbria) longline gear to halibut longline gear, and collected live halibut for rearing experiments.

Catch-Effort Statistics on Halibut by Nation, Month, IPHC, and INPFC Statistical Areas

The halibut catch in metric tons, round weight, by fishing period for Canadian and United States vessels[1] in the northeast Pacific Ocean in 1988 is shown by INPFC statistical areas and the corresponding groups of IPHC statistical areas in Table 1. The catch of halibut in metric tons, round weight, for United States vessels in the Bering Sea from 1984 to 1988 is given by area in Table 2. The number of setline vessels fishing in the Bering Sea is also shown in Table 2.

By agreement between the Canadian and United States governments, vessels fished only in their own national waters in 1988. The national boundaries between the Canadian and United States national zones have not yet been precisely determined.

Catch per unit effort data by groups of INPFC statistical areas for 1976 through 1988 is given in Table 3. However, detailed information on the number of skates fished by statistical area and fishing period is not available.

Size and Age Composition Data on Halibut Caught in the North American Halibut Fishery by INPFC Statistical Area

Length frequencies, age composition, and average weight by age are summarized by INPFC statistical areas. Fork length in cm and round weight in

[1]The statistics provided are for North American vessels without regard to nationality, which is consistent with past formats used in response to this request.

kg were calculated from the weight of all otoliths collected and ages were determined from samples of IPHC statistical regions from each fishing period. Length, age, and average weight at age are given for all areas in 1988 in Table 4.

Northeast Pacific Ocean

Halibut landings from the Columbia, Vancouver, Charlotte, Southeastern, Yakutat, Kodiak, Chirikof, and Shumagin regions were sampled during 1988. The number of samples and measurements by region in the Northeast Pacific Ocean are given in Table 5. Length, age, and average weight at age are given by INPFC statistical region in Tables 6-13.

Bering Sea/Aleutians

Halibut landings from the Bering Sea and Aleutian regions (INPFC statistical areas 1, 2, 3, and 5) were sampled during 1988 and the number of samples and measurements are given in Table 5. Length, age, and average weight at age determined from the Bering Sea/Aleutians samples are given in Table 14.

Summary Information on IPHC Tagging Experiments and Records of Recaptured Tagged Halibut by INPFC Statistical Area

Releases of tagged halibut in 1988 totalled 3,098 (Table 15). Most of the releases occurred in the Charlotte statistical area in an experiment

designed to examine patterns of localized depletion of the resource.

Recoveries of IPHC tagged halibut in 1988 totalled 1,694 fish (Table 16). Most of the recoveries were captured in the area of release.

Stock Assessments on Juvenile and Adult Halibut in the Bering Sea and Northeast Pacific Ocean

Direct estimates of Pacific halibut stock abundance are difficult to obtain due to the broad distribution of this species and the prohibitive costs involved in taking direct population measurements. However, a considerable amount of information can be obtained about the population indirectly through the commercial catch. The Commission staff uses four principle sources of information for computing stock biomass on an annual basis: (1) landing tickets, obtained from fish processors, which provide information on the total catch by area; (2) logbook data, supplied by fishermen, which provide information on the fishing effort associated with a given catch by area; (3) otoliths, obtained by port sampling, which provide information on the average weight at age of individuals in the catch as well as providing the age composition of the catch; and, (4) tags, recovered by fishermen and fish processors, which provide information on fish migration.

Overview

Estimates of halibut stock biomass are computed using the four sources of information indicated above. At present, estimating stock biomass is a

rather complicated process involving three estimation procedures that reflect different levels of statistical sophistication and a variety of biological and statistical assumptions. However, the basic principles underlying the three estimation procedures are quite similar and are expressed in two ways: how catch is related to population abundance within a given year, and how population abundances are related between years.

Relation Between Catch and Abundance

The age composition of the catch reflects the age composition of the stock after adjusting for gear selectivity. The commercial catch is proportional to stock biomass after adjusting for gear selectivity, differences in catchability among areas, seasonal and regional changes in fishing effort, and fish migration.

Consistency in Abundance Relation

The population changes over time in a consistent manner and all increases and decreases in population abundance can be accounted for by examining changes in several variables. For example, the number of 15 year old fish present on the fishing grounds this year must be related to the number of 14 year old fish that were present last year after accounting for selectivity, survival, and migration.

It is through mathematical models based on these relationships that the stock biomass can be calculated. The computation is simple enough: population abundance at age over time is calculated to be proportional to

catch at age over time. The complication is the regional and temporal adjustments that must always take place and are part of the estimation procedure, which is why catch per unit effort (CPUE) can only be used as one indicator of population change in a given area. Other factors, such as a shift in the age composition, can serve to augment or counteract the observed changes in CPUE in the determination of population abundance.

Presently, three stock assessment procedures are used to obtain the range of stock biomass estimates. The stock biomass estimates are then used to establish quota recommendations. The three stock assessment procedures can be described as follows:

(1) Combined Analysis with CPUE Partitioning. A catch at age analysis is performed over all areas combined. The resulting stock biomass estimate is then partitioned out area by area according to CPUE estimates and measures of effective habitat. Here CPUE is used as a measure of relative population density and biomass is allocated to the different management areas by multiplying relative density by relative habitat area as discussed in Table 1 of IPHC Scientific Report 72.

(2) Closed Analyses. A catch at age analysis is performed for Areas 2A-2B, Area 2C, Area 3A, and Areas 3B-4. Each area is treated separately, and thus is assumed to be closed to the effects of migration. Once the biomass estimates are obtained for each of these areas, a further split is made, i.e. a 2A-2B split and a 3B-4 split, again according to CPUE estimates and habitat area.

(3) Migratory Analysis. A catch at age analysis, which includes migration of the exploitable part of the population, is performed over the entire range of the stock. The migration rates used in the analysis are given in Table 4 of IPHC Scientific Report 72.

The three types of analyses differ in this way: (1) the combined analysis is likely to be more precise because the sample size is larger, but it does not take into account the local variation in age structure that the other methods do; (2) the closed analyses take into account local variation in age structure and effort, but do not take into account adult migration and may be less precise in some areas because the sample size is small; and, (3) the migratory analysis takes into account local variation in age structure and effort as well as the effects of migration, but the estimation procedure is more complex and may be biased and less precise.

Each approach has certain features and drawbacks. Combined together they give a range of stock biomass estimates from which quotas may be obtained. When a single biomass estimate is needed the convention is to use the midpoint of the range, i.e. the maximum estimate plus the minimum estimate divided by two. Currently we are examining the three approaches in an attempt to find a single approach which best meets the needs of the fishery.

1988 Assessment

As in the past four years, the Commission staff has used the three stock assessment procedures to establish a range of stock biomass estimates. Each biomass estimation approach has its own set of advantages and disadvantages

as outlined above and research continues in order to update and refine the approaches used to estimate biomass.

A summary of the 1988 stock assessment results is given in Table 17. The ranges of the estimates shown in the table correspond to the maximum and minimum of the estimates obtained from the three stock assessment procedures described above.

The constant exploitation yield (CEY) represents levels of removal from the stock that are optimal over a wide range of stock conditions. A constant exploitation fraction (0.35), determined under maximum sustainable yield conditions, is multiplied by the estimates of exploitable biomass to obtain the total CEY. Removals are made according to the levels of bycatch, sport catch, and wastage to obtain the setline CEY.

Maximum sustainable yield (MSY) from the resource is estimated to be 48,800 mt. Given the current rates of bycatch, sport catch, and wastage the MSY in terms of setline catch is estimated to be 35,000 mt. The MSY estimate represents the long term expected yield under optimal exploitation conditions. It is a useful reference point for examining the long term performance of the fishery.

Table 18 summarizes coast-wide estimates of exploitable biomass, total removals, and setline and total exploitation rates. The total exploitable biomass of Pacific halibut in 1988 is estimated to be about 129,000 mt coast-wide. This represents a decrease in biomass of about 6 percent from the updated estimate of 1987 exploitable biomass of 137,000 mt. This decrease is similar to a 5 percent decrease in biomass observed between 1986 and 1987.

Although the biomass remains close to historically high levels, the downward trend observed in abundance is consistent with long term cycles that have been observed in abundance for this population. The total exploitable halibut stock biomass appears to have peaked in 1986.

The exploitation rates shown in Table 18 are determined by dividing removal by exploitable biomass. These rates give an indication of percent removal relative to the optimal 0.35 constant exploitation rate. The rates reflect the changes in directed setline catch relative to total catch, which also includes bycatch, sport catch and wastage. Note that the total exploitation rates for 1986 through 1988 are higher than the optimal constant exploitation rate. Factors contributing to these increased rates include decreases in recruitment over the past several years, overestimates of stock biomass due to changes in the trend in abundance, and increasing bycatch mortality. The bycatch mortality, shown in the equivalent of adult biomass, has increased and the 1988 bycatch mortality is seen to be the highest since that observed in 1982. Sport catch and wastage also contribute significantly to the total removal, but still contribute less than the directed catch.

Analysis of Interrelationships of Halibut Stocks in the North Pacific Ocean

There is no new information on this topic.

Information on Incidental Catches of Halibut Taken in Connection with Trawl and Other Fisheries

Pacific halibut are caught inadvertently in fisheries targeting on various groundfish and shellfish species and estimates of this incidental catch indicate that the removals are substantial. IPHC is supplied with estimates of the incidental catch in foreign and joint venture fisheries by the U.S. National Marine Fisheries Service (NMFS) through the Observer Program. Estimates of bycatch in other fisheries are generated by IPHC staff from information collected on research surveys or through predictive models.

Estimates of Incidental Mortality

Most halibut that are incidentally caught are injured to some degree during the capture process. However, not all fish which are returned to the sea die, so the incidental mortality is less than the actual catch. The likelihood of a halibut being killed during incidental capture depends upon the fishing operation. Mortality in trawls with long tows, large catches and slow sorting is usually very high, approaching 100 percent. Trawling operations that transfer the trawl codends to a mothership for processing also exhibit mortality rates close to 100 percent, as the sorting process is very slow and the catches are usually large. Mortality in short trawl tows with small catches and quick sorting has been estimated at 50 percent (see IPHC Scientific Report 57). Bycatch mortality associated with longline gear is believed to be about 25 percent, as the fish are usually released with minimal damage to the jaw. However, the recent introduction of hook strippers into

the longline fisheries for sablefish (Anoplopoma fimbria) and Pacific cod (Gadus macrocephalus) may result in a higher mortality rate for longline fisheries. Mortality in crab pots is believed to be 100 percent (see IPHC Technical Report 19).

Historically, halibut incidental mortality was relatively small until the 1960s, when it increased rapidly due to the sudden influx of foreign fishing vessels off the North American coast. The total incidental mortality peaked in 1962 at about 15,000 mt. Incidental mortality declined during the 1960s, but increased to about 12,000 mt in the early 1970s. Incidental mortality dropped to a 7,900 mt level during the late 1970s and early 1980s. By 1986, the incidental mortality declined to 4,300 mt, the lowest level in recent history. However, incidental mortality has increased since 1986, reaching 6,700 mt in 1988. Incidental mortality in 1988 was estimated at 900 mt in Area 2 (Southeast Alaska, British Columbia, and the Pacific coast), 2,100 mt in Area 3 (central and western Gulf of Alaska) and 3,800 mt in Area 4 (the Bering Sea and Aleutian Islands). Estimates of the incidental mortality for 1979-1988 are shown in Table 19.

The recent increase in incidental mortality has occurred despite a reduction in foreign fishing off Alaska and is attributed to increased mortality by joint venture and fully domestic groundfish fisheries. The objectives of U.S. extended jurisdiction legislation included fully "Americanizing" the groundfish fisheries in U.S. waters. The North Pacific Fishery Management Council (NPFMC) has adopted policies and regulations that encouraged joint ventures between domestic catcher vessels and foreign

processors when U.S. processing capacity was insufficient. As domestic processing increased, both through at-sea processing vessels and shore-side plants, harvest priorities shifted to fully domestic operations. As the mix of foreign, joint venture and fully domestic fishing has changed over the past several years, so has the source of bycatch mortality.

Halibut killed as bycatch are generally sublegal in size. To incorporate the estimates of incidental mortality into the population assessment models used for halibut, the mortality must be converted into "adult equivalents", i.e. the number of pounds of adult halibut that are represented by the estimated mortality of sublegal (juvenile) fish. This process requires examining changes in the population size resulting from fish growth and natural mortality. The weight gain to the population from growth is greater than the weight loss to the population due to natural mortality; therefore, incidental mortality causes a loss in yield that is larger than the actual incidental mortality. The conversion factor used to estimate adult equivalents is 1.58, i.e. one pound of bycatch mortality equals 1.58 pounds of lost adult halibut yield. A review of this methodology is currently underway, with the objective of determining size-specific adult-equivalent adjustment factors. Incidental mortality for 1979-1988 expressed as adult equivalents is shown in Table 19.

Field Research Activities in the Bering Sea and Northeast Pacific

Research Activities During 1988

During 1988, the Commission continued collecting detailed fishery statistics from fishermen and processors and sampled the commercial catch for age and size composition information. In addition, at-sea experiments were carried out investigating differences in the effectiveness of sablefish gear in catching halibut relative to standard halibut gear in the Gulf of Alaska. Also, an intensive fishing and tagging experiment inside Dixon Entrance in northern British Columbia was conducted to obtain an independent estimate of halibut abundance in that area. In August, live halibut were collected for a rearing project being conducted jointly with the U.S. Fish and Wildlife Service and the University of Washington. Several live halibut were also provided to the Canadian Department of Fisheries and Oceans' Pacific Biological Station at Nanaimo, B.C. for a companion study.

Research Activities During 1989

As in 1988, the Commission collected fishery and catch statistics from fishermen and processors. At-sea research involved two major projects. The first project was designed to estimate the relationship between otolith weight and fish weight of halibut, attempting to confirm the present otolith weight/fish weight relationship used by the Commission. The present relationship was derived during the 1960s and may be inappropriate due to changes in halibut growth rates. This study required the collection of over

5,000 paired observations of otolith weights and fish weights. The second project involved tagging approximately 2,500 halibut off Oregon and was designed to provide an independent estimate of biomass as well as information on fish movement. Live halibut were again provided to the U.S. Fish and Wildlife Service and the Canadian Department of Fisheries and Oceans.

Table 1. North American halibut catch (*metric tons, round weight*) by IPHC/INPFC statistical areas and fishing periods in the northeast Pacific Ocean, 1988.

IPHC/ INPFC	Fishing Period: Mar 1 May 5	May 6 Jun 19	Jun 20 Jul 24	Jul 25 Sep 6	Sep 7 Oct 2	Oct 3 Oct 31	TOTAL
000-030 COLUMBIA							
Catch	--	--	--	119	--	--	119
040-080 VANCOUVER							
Catch	21	232	9	227	13	--	502
090-130 CHARLOTTE							
Catch	--	3,964	--	3,465	--	--	7,429
140-184 SOUTHEASTERN							
Catch	--	2,765	3,131	--	581	381	6,858
185-230 YAKUTAT							
Catch	--	732	619	--	901	431	2,683
240-280 KODIAK							
Catch	--	7,509	4,994	--	4,911	2,744	20,158
290-310 CHIRIKOF							
Catch	--	543	838	--	720	333	2,434
320-380 SHUMAGIN							
Catch	--	490	397	293	999	299	2,478
TOTAL							
Catch	21	16,235	9,988	4,104	8,125	4,188	42,661

Table 2. United States halibut catch (*metric tons, round weight*) and number of vessels by INPFC statistical areas of the Bering Sea and Aleutian Island region, 1984 to 1988.

Year	Area 1	Area 2	Area 5	Total[1]
1988				
Catch	582	583	1,027	2,192
No. Vessels	101	27	62	163
1987				
Catch	933	776	993	2,702
No. Vessels	186	31	62	263
1986				
Catch	691	1,095	157	1,943
No. Vessels	116	58	21	181
1985				
Catch	175	708	751	1,634
No. Vessels	100	30	52	172
1984				
Catch	142	520	666	1,328
No. Vessels	123	26	48	186

[1] Vessels that fished in more than one area are only counted once in the Total column.

Table 3. Estimates[1] of Pacific halibut catch per unit effort (CPUE) by groups of INPFC statistical areas, 1976-1988. Estimates are shown in *kg, round weight*.

Year	INPFC Statistical Areas						
	Col. & U.S. Van.	Cdn. Van. & Char.	South-eastern	Yak.-Kodiak	Chir.-Shum.	B. Sea-Aleu.	All Areas
1976	43.3	70.5	70.0	79.3	85.9	111.2	75.4
1977	110.0	81.7	75.1	81.3	97.4	106.4	83.6
1978	51.6	83.3	93.7	103.8	70.3	100.7	93.7
1979	66.4	63.9	133.3	114.1	48.8	88.2	96.4
1980	49.5	86.8	131.9	157.4	150.7	75.0	123.2
1981	81.2	106.1	165.2	151.4	177.9	143.0	140.3
1982	76.7	106.7	214.9	165.5	181.6	104.2	153.2
1983	77.0	109.0	207.0	211.1	202.6	67.7	166.1
1984	76.8	114.0	198.4	249.3	213.2	116.9	181.2
1985	66.1	106.6	213.8	242.3	253.7	179.0	188.1
1986	79.9	93.4	179.0	248.7	194.7	183.9	176.9
1987	38.0	95.3	147.6	263.9	199.2	166.9	168.1
1988	67.4	91.2	138.6	216.0	289.2	115.5	157.7

[1] The estimates are standardized for area differences in catchability and for the use of circle hooks.

Table 4. Length, age, and average round weight of halibut in North American setline landings in the Northeast Pacific and Bering Sea used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	11	0.0	4	3	0.0	1.7
67	17	0.1	5	7	0.0	5.2
72	72	0.4	6	67	0.3	6.4
77	348	2.0	7	480	2.7	8.7
82	820	4.8	8	1782	10.3	10.5
87	1337	7.8	9	2638	15.3	12.8
92	1892	11.0	10	2552	14.8	15.3
97	1872	10.9	11	3476	20.2	18.5
102	1774	10.3	12	1885	10.9	22.0
107	1673	9.8	13	1268	7.3	26.1
112	1284	7.5	14	1026	5.9	29.1
117	1225	7.1	15	775	4.5	32.1
122	1002	5.8	16	368	2.1	33.4
127	853	5.0	17	250	1.4	35.6
132	768	4.4	18	187	1.0	36.5
137	580	3.3	19	112	0.6	43.9
142	441	2.6	20	86	0.5	43.5
147	329	1.9	21	61	0.3	46.9
152	248	1.4	22	33	0.1	48.5
157	227	1.3	23	21	0.1	55.6
162	148	0.9	24	20	0.1	58.1
167	70	0.4	25	14	0.0	43.6
172	71	0.4	26	12	0.0	53.0
177	36	0.2	27	8	0.0	72.6
182	27	0.2	28	7	0.0	69.1
185+	29	0.2	29+	16	0.1	83.3
Totals	17154	100		17154	100	

Mean Fork Length = 110.1 cm
Mean Age = 11.2 years
Mean Round Weight = 19.6 kg

Table 5. Number of samples and measurements taken from the north Pacific Ocean and Bering Sea setline landings in 1988 for size composition studies by INPFC area with corresponding IPHC region.

INPFC Area	IPHC Region	Samples	Measurements
Columbia	Columbia	11	292
Vancouver	Vancouver	13	594
Charlotte	Charlotte	87	3,681
Southeastern	Southeast	167	4,014
Yakutat	Yakutat	26	626
Kodiak	Kodiak	201	3,506
Chirikof	Chirikof	26	2,077
Shumagin	Shumagin	10	416
Bering Sea	Bering Sea	30	1,948
Total		571	17,154

Table 6. Length, age, and average round weight of halibut in North American setline landings in the INPFC Columbia region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	0	0.0	5	0	0.0	0.0
72	0	0.0	6	0	0.0	0.0
77	20	6.9	7	11	3.8	6.7
82	31	10.6	8	40	13.7	8.4
87	54	18.5	9	89	30.5	9.8
92	73	25.0	10	47	16.1	10.9
97	41	14.0	11	56	19.2	11.9
102	25	8.6	12	18	6.2	13.9
107	21	7.2	13	16	5.5	14.3
112	15	5.1	14	6	2.1	19.2
117	5	1.7	15	6	2.1	16.8
122	4	1.3	16	3	1.0	15.4
127	3	1.0	17	0	0.0	0.0
132	0	0.0	18	0	0.0	0.0
137	0	0.0	19	0	0.0	0.0
142	0	0.0	20	0	0.0	0.0
147	0	0.0	21	0	0.0	0.0
152	0	0.0	22	0	0.0	0.0
157	0	0.0	23	0	0.0	0.0
162	0	0.0	24	0	0.0	0.0
167	0	0.0	25	0	0.0	0.0
172	0	0.0	26	0	0.0	0.0
177	0	0.0	27	0	0.0	0.0
182	0	0.0	28	0	0.0	0.0
185+	0	0.0	29+	0	0.0	0.0
Totals	292	100		292	100	

Mean Fork Length = 94.4 cm
Mean Age = 10.0 years
Mean Round Weight = 10.9 kg

Table 7. Length, age, and average round weight of halibut in North American setline landings in the INPFC Vancouver region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	2	0.3	5	0	0.0	0.0
72	9	1.5	6	1	0.2	4.1
77	25	4.2	7	16	2.7	7.1
82	81	13.6	8	78	13.1	7.7
87	97	16.3	9	136	22.9	10.1
92	98	16.5	10	103	17.3	10.8
97	78	13.1	11	105	17.7	12.0
102	53	8.9	12	49	8.2	15.9
107	51	8.6	13	36	6.1	18.1
112	27	4.5	14	23	3.9	18.9
117	18	3.0	15	12	2.0	20.2
122	14	2.3	16	10	1.7	24.6
127	11	1.8	17	3	0.5	34.6
132	9	1.5	18	5	0.8	26.3
137	2	0.3	19	3	0.5	48.9
142	7	1.2	20	5	0.8	35.3
147	4	0.7	21	2	0.3	73.7
152	0	0.0	22	3	0.5	27.8
157	4	0.7	23	1	0.2	32.7
162	0	0.0	24	0	0.0	0.0
167	0	0.0	25	0	0.0	0.0
172	2	0.3	26	1	0.2	39.2
177	0	0.0	27	0	0.0	0.0
182	0	0.0	28	0	0.0	0.0
185+	2	0.3	29	2	0.3	85.2
Totals	594	100		594	100	

Mean Fork Length = 98.0 cm
Mean Age = 10.7 years
Mean Round Weight = 13.2 kg

Table 8. Length, age, and average round weight of halibut in North American setline landings in the INPFC Charlotte region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	7	0.2	4	1	0.0	2.7
67	8	0.2	5	4	0.1	3.9
72	38	1.0	6	28	0.8	5.9
77	172	4.7	7	143	3.9	7.7
82	356	9.7	8	499	13.5	8.8
87	511	13.9	9	647	17.6	10.4
92	577	15.7	10	663	18.0	12.3
97	536	14.6	11	698	18.9	13.9
102	419	11.4	12	414	11.2	16.3
107	317	8.6	13	218	5.9	18.9
112	182	4.9	14	120	3.3	20.1
117	149	4.0	15	104	2.8	24.9
122	119	3.2	16	46	1.2	31.8
127	67	1.8	17	28	0.8	25.5
132	58	1.6	18	16	0.4	37.1
137	51	1.4	19	8	0.2	44.4
142	37	1.0	20	15	0.4	36.4
147	19	0.5	21	8	0.2	33.2
152	17	0.5	22	6	0.1	42.8
157	15	0.4	23	2	0.1	36.3
162	10	0.2	24	4	0.1	58.7
167	3	0.0	25	1	0.0	52.6
172	8	0.2	26	2	0.1	39.1
177	3	0.1	27	1	0.0	118.5
182	1	0.0	28	2	0.1	77.8
185+	2	0.0	29+	3	0.1	83.6
Totals	3681	100		3681	100	

Mean Fork Length = 99.8 cm
Mean Age = 10.6 years
Mean Round Weight = 14.0 kg

Table 9. Length, age, and average round weight of halibut in North American setline landings in the INPFC Southeastern region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	4	0.1	4	2	0.1	1.2
67	6	0.1	5	2	0.1	6.5
72	15	0.4	6	17	0.4	6.3
77	86	2.1	7	90	2.2	7.5
82	179	4.4	8	273	6.8	9.1
87	307	7.6	9	520	12.9	11.4
92	474	11.8	10	510	12.7	13.3
97	484	12.0	11	800	19.9	15.8
102	449	11.2	12	513	12.8	18.1
107	418	10.4	13	379	9.4	22.4
112	290	7.2	14	291	7.2	25.1
117	294	7.3	15	208	5.2	26.6
122	256	6.4	16	130	3.2	28.6
127	226	5.6	17	88	2.2	30.3
132	165	4.1	18	71	1.8	30.0
137	113	2.8	19	39	1.0	35.3
142	92	2.3	20	29	0.7	39.9
147	54	1.3	21	19	0.5	42.2
152	26	0.6	22	12	0.3	55.7
157	33	0.8	23	7	0.2	55.5
162	16	0.4	24	5	0.1	54.5
167	7	0.2	25	4	0.1	47.8
172	10	0.2	26	3	0.1	37.3
177	3	0.1	27	0	0.0	0.0
182	3	0.1	28	2	0.1	90.1
185+	4	0.1	29+	0	0.0	0.0
Totals	4014	100		4014	100	

Mean Fork Length = 108.3 cm
Mean Age = 11.7 years
Mean Round Weight = 18.2 kg

Table 10. Length, age, and average round weight of halibut in North American setline landings in the INPFC Yakutat region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	0	0.0	5	1	0.2	7.9
72	0	0.0	6	2	0.3	11.9
77	2	0.3	7	13	2.1	11.4
82	7	1.1	8	28	4.5	13.0
87	17	2.7	9	65	10.4	16.4
92	27	4.3	10	71	11.3	19.6
97	27	4.3	11	99	15.8	22.6
102	37	5.9	12	77	12.3	27.0
107	46	7.3	13	49	7.8	34.8
112	56	8.9	14	79	12.6	37.9
117	60	9.6	15	59	9.4	40.7
122	49	7.8	16	28	4.5	42.1
127	47	7.5	17	26	4.1	39.1
132	58	9.3	18	10	1.6	45.8
137	38	6.1	19	10	1.6	41.1
142	35	5.6	20	4	0.6	59.0
147	34	5.4	21	1	0.2	32.0
152	28	4.5	22	1	0.2	63.5
157	22	3.5	23	1	0.2	44.6
162	13	2.1	24	0	0.0	0.0
167	6	0.9	25	0	0.0	0.0
172	10	1.6	26	1	0.2	122.0
177	3	0.5	27	0	0.0	0.0
182	1	0.2	28	0	0.0	0.0
185+	3	0.5	29+	1	0.2	93.0
Totals	626	100		626	100	

Mean Fork Length = 125.0 cm
Mean Age = 13.4 years
Mean Round Weight = 28.9 kg

Table 11. Length, age, and average round weight of halibut in North American setline landings in the INPFC Kodiak region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	0	0.0	5	0	0.0	0.0
72	5	0.1	6	12	0.3	6.9
77	20	0.6	7	125	3.6	10.0
82	51	1.4	8	437	12.5	12.2
87	147	4.2	9	614	17.5	15.7
92	264	7.5	10	521	14.8	20.0
97	283	8.1	11	702	20.0	24.2
102	335	9.5	12	387	11.0	30.7
107	353	10.1	13	231	6.6	34.9
112	320	9.1	14	196	5.6	37.6
117	307	8.7	15	142	4.0	39.2
122	272	7.7	16	56	1.6	45.4
127	240	6.8	17	32	0.9	47.9
132	199	5.7	18	20	0.6	45.5
137	189	5.4	19	11	0.3	66.2
142	123	3.5	20	10	0.3	65.2
147	108	3.1	21	5	0.1	68.1
152	83	2.4	22	1	0.0	52.7
157	74	2.1	23	0	0.0	0.0
162	52	1.5	24	2	0.0	96.2
167	28	0.8	25	0	0.0	0.0
172	22	0.6	26	1	0.0	59.1
177	10	0.3	27	0	0.0	0.0
182	11	0.3	28	0	0.0	0.0
185+	10	0.3	29+	1	0.0	143.2
Totals	3506	100		3506	100	

Mean Fork Length = 117.5 cm
Mean Age = 10.8 years
Mean Round Weight = 23.9 kg

Table 12. Length, age, and average round weight of halibut in North American setline landings in the INPFC Chirikof region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	0	0.0	5	0	0.0	0.0
72	0	0.0	6	6	0.3	7.4
77	5	0.2	7	59	2.8	10.5
82	29	1.4	8	280	13.5	13.0
87	74	3.6	9	263	12.7	15.9
92	168	8.1	10	295	14.2	19.0
97	183	8.8	11	440	21.2	22.8
102	208	10.0	12	224	10.8	27.0
107	210	10.1	13	151	7.3	31.3
112	217	10.4	14	140	6.7	30.1
117	212	10.2	15	121	5.8	36.4
122	137	6.6	16	35	1.7	34.7
127	145	7.0	17	21	1.0	37.4
132	145	7.0	18	17	0.8	45.9
137	92	4.4	19	13	0.6	51.4
142	62	3.0	20	6	0.3	38.6
147	49	2.3	21	3	0.1	55.0
152	46	2.2	22	1	0.0	72.3
157	34	1.6	23	0	0.0	0.0
162	24	1.1	24	1	0.0	125.5
167	14	0.7	25	1	0.0	44.6
172	6	0.3	26	0	0.0	0.0
177	7	0.3	27	0	0.0	0.0
182	6	0.3	28	0	0.0	0.0
185+	4	0.2	29+	0	0.0	0.0
Totals	2077	100		2077	100	

Mean Fork Length = 116.4 cm
Mean Age = 11.1 years
Mean Round Weight = 22.9 kg

Table 13. Length, age, and average round weight of halibut in North American setline landings in the INPFC Shumagin region used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	0	0.0	4	0	0.0	0.0
67	0	0.0	5	0	0.0	0.0
72	0	0.0	6	0	0.0	0.0
77	1	0.2	7	13	3.1	9.1
82	13	3.1	8	51	12.2	11.7
87	18	4.3	9	64	15.4	14.4
92	42	10.1	10	60	14.4	16.6
97	46	11.0	11	112	26.9	21.6
102	51	12.2	12	34	8.2	22.2
107	52	12.5	13	32	7.7	29.8
112	29	7.0	14	18	4.3	41.9
117	29	7.0	15	17	4.1	36.3
122	31	7.4	16	6	1.4	56.1
127	19	4.6	17	2	0.5	82.7
132	23	5.5	18	4	1.0	18.2
137	15	3.6	19	1	0.2	31.8
142	12	2.9	20	1	0.2	22.9
147	13	3.1	21	0	0.0	0.0
152	4	1.0	22	0	0.0	0.0
157	7	1.7	23	1	0.2	107.8
162	2	0.5	24	0	0.0	0.0
167	2	0.5	25	0	0.0	0.0
172	2	0.5	26	0	0.0	0.0
177	4	1.0	27	0	0.0	0.0
182	0	0.0	28	0	0.0	0.0
185+	1	0.2	29+	0	0.0	0.0
Totals	416	100		416	100	

Mean Fork Length = 113.4 cm
Mean Age = 10.8 years
Mean Round Weight = 21.3 kg

Table 14. Length, age, and average round weight of halibut in North American setline landings in the INPFC Bering Sea regions (1, 2, 3, and 5) used for size composition studies in 1988.

Mid-point of 5 cm Length Class	No.	Percent	Age Group	No.	Percent	Average Round Weight (Kg)
62	1	0.0	4	0	0.0	0.0
67	1	0.0	5	0	0.0	0.0
72	5	0.2	6	1	0.0	1.0
77	17	0.9	7	10	0.5	8.8
82	73	3.7	8	96	4.9	9.3
87	112	5.7	9	240	12.3	12.1
92	169	8.7	10	282	14.5	14.2
97	194	9.9	11	464	23.8	17.8
102	197	10.1	12	169	8.7	22.5
107	205	10.5	13	156	8.0	26.6
112	148	7.6	14	153	7.8	27.8
117	151	7.7	15	106	5.4	32.6
122	120	6.2	16	54	2.8	28.6
127	95	4.9	17	50	2.6	38.1
132	111	5.7	18	44	2.2	39.7
137	80	4.1	19	27	1.4	44.4
142	73	3.7	20	16	0.8	44.6
147	48	2.5	21	23	1.2	48.1
152	44	2.2	22	9	0.5	44.9
157	38	1.9	23	9	0.5	57.9
162	31	1.6	24	8	0.4	42.2
167	10	0.5	25	8	0.4	40.3
172	11	0.6	26	4	0.2	56.3
177	6	0.3	27	7	0.3	66.0
182	5	0.2	28	3	0.1	49.3
185+	3	0.2	29+	9	0.5	74.9
Totals	1948	100		1948	100	

Mean Fork Length = 114.3 cm
Mean Age = 12.3 years
Mean Round Weight = 22.2 kg

Table 15. Summary of halibut tagged and released by IPHC in 1988 by release area.

Release Area	Number Released
Bering Sea	
1	-
2	-
3	-
4	-
5	-
Northeast Pacific Ocean	
Shumagin	-
Chirikof	152
Kodiak	217
Yakutat	77
Southeastern	-
Charlotte	2,652
Vancouver	-
Columbia	-
Eureka	-
TOTAL	3,098

Table 16. Summary of IPHC tagged halibut recovered in 1988 by area of release and recovery.

	Recovery Area											
Release Area	Bering Sea	Shumagin	Chirikof	Kodiak	Yakutat	Southeast	Charlotte	Vancouver	Columbia	Eureka	Unkn.	Total
Bering Sea	26	4	-	9	1	3	5	-	-	-	10	58
Shumagin	1	4	1	10	1	2	-	1	-	-	6	26
Chirikof	-	-	4	24	-	4	9	1	-	-	9	51
Kodiak	1	-	6	510	2	14	20	3	2	-	120	678
Yakutat	-	-	-	5	9	3	6	-	-	-	4	27
Southeastern	1	-	-	3	3	156	11	1	-	-	41	216
Charlotte	-	-	-	1	1	32	528	5	1	-	69	637
Vancouver	-	-	-	-	-	-	-	-	-	-	-	-
Columbia	-	-	-	-	-	-	-	-	1	-	-	1
Eureka	-	-	-	-	-	-	-	-	-	-	-	-
Total	29	8	11	562	17	214	579	11	4	-	259	1,694

Table 17. Results of the 1988 population assessment conducted by the International Pacific Halibut Commission (IPHC) using three methods of catch-age analysis. Data are shown in *thousands of mt, round weight*.

	INPFC Statistical Areas						
	Col. & US Van.	Cd. Van. & Char.	South-eastern	Yak.-Kodiak	Chir.-Shum.	B. Sea-Aleu.	Total[1]
Exploitable Biomass							
Range: Upper	0.82	20.0	24.8	73.8	31.7	9.0	148.0
Lower	0.40	9.9	19.7	58.9	13.6	6.6	109.1
Maximum Sustainable Yield							
All Gear	0.48	11.2	6.8	17.6	6.0	6.6	48.8
Setline Only	0.27	9.3	4.4	10.4	4.5	6.2	35.0
Setline Constant Exploitation Yield							
Range: Upper	0.21	4.5	4.3	17.7	7.4	3.8	38.0
Lower	0.21	2.8	2.8	11.3	4.8	2.5	24.4
Total Constant Exploitation Yield							
Range: Upper	0.42	6.4	6.8	25.0	9.0	4.2	51.8
Lower	0.42	4.8	5.2	18.6	6.3	2.9	38.2

[1]Total values are more precise than sum over ranges.

Table 18. Summary of Pacific halibut exploitation data, 1974-1988. Biomass and removals are shown in *thousands of mt, round weight.*

Year	Exploitable Biomass	Removals					Setline Expl. Rate	Total Expl. Rate
		Commercial Catch	Bycatch[1]	Sport Catch	Waste	Total		
1974	73.6	12.8	17.7	0.2	0.0	30.7	0.17	0.42
1975	76.2	16.6	10.9	0.2	0.0	27.7	0.22	0.36
1976	75.9	16.6	12.7	0.2	0.0	29.4	0.22	0.39
1977	77.2	13.2	10.7	0.2	0.0	24.1	0.17	0.31
1978	80.8	13.3	11.2	0.2	0.0	24.7	0.16	0.31
1979	85.5	13.6	14.1	0.4	0.0	28.0	0.16	0.33
1980	90.7	13.2	17.4	0.5	0.0	31.1	0.15	0.34
1981	98.6	15.5	13.7	0.7	0.0	29.9	0.16	0.30
1982	112.6	17.5	11.3	0.8	0.0	29.6	0.16	0.26
1983	124.0	23.2	9.9	1.0	0.0	34.1	0.19	0.27
1984	132.9	27.1	9.2	1.1	0.5	38.0	0.20	0.29
1985	142.8	33.8	6.9	1.6	1.0	43.2	0.24	0.30
1986	143.5	42.0	6.8	2.1	1.9	52.8	0.29	0.37
1987	136.6	41.9	9.3	2.5	1.6	55.3	0.31	0.41
1988	128.5	44.9	10.6	2.3	1.2	59.0	0.35	0.46

[1]Adult equivalents.

Table 19. Estimated incidental mortality in 1979-1988 of Pacific halibut by region of the coast in *metric tons, round weight*.

Year	Eureka-Southeast	Yakutat-Shumagin	Bering Sea/Aleutians	Total	Adult Equivalents
1979	1,613	4,050	3,269	8,931	14,111
1980	1,142	4,282	5,570	10,994	17,371
1981	1,022	3,789	3,865	8,676	13,707
1982	705	3,602	2,869	7,176	11,338
1983	752	2,951	2,575	6,278	9,919
1984	830	2,199	2,830	5,859	9,257
1985	869	952	2,538	4,358	6,886
1986	883	752	2,697	4,332	6,845
1987	876	1,877	3,168	5,922	9,357
1988	876	2,062	3,755	6,693	10,575