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IPHC Research and Management of Pacific Halibut in the Pribilof Islands through 1994

by

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ABSTRACT

The Pribilof Islands were surveyed by the International Pacific Halibut Commission five times in the 1960s, and once in 1984. Pacific halibut were collected for age, length, and gender, and a portion of the catch was tagged to try and determine utilization of halibut through interchange with other areas of the Bering Sea and the Gulf of Alaska. In all, 4,233 fish were tagged and 3,102 fish were collected for age, length, and gender. Tag returns ranged from 3 to 10 percent with the majority of out-of-area returns occurring in the Central Gulf (IPHC Regulatory Area 3A).

Beginning in 1978, the commercial fishery began to steadily build with 71,485 pounds landed that year. A separate regulatory area (Area 4C) was formed in 1986 with a seasonal fishing limit of one day open/one day closed. In 1987, trip limits were implemented at the request of the North Pacific Fishery Management Council and remained in effect through 1994.

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INTRODUCTION

The International Pacific Halibut Commission (IPHC), formed by a convention signed in 1923 between the United States and Canada, is responsible for the conservation of Pacific halibut (*Hippoglossus stenolepis*) in the north Pacific Ocean and the U.S. Bering Sea. To help fulfill this objective, the IPHC has conducted numerous research cruises to survey and collect data on halibut stocks throughout their range. Fishing grounds near the Pribilof Islands were surveyed five times during the 1960s, once in 1984, and once in 1992. All of the surveys were conducted by chartered commercial vessels using longline gear.

The surveys during the 1960s were part of exploratory studies throughout the Bering Sea designed to understand the distribution, movements, age and growth structures of halibut stocks in the eastern Bering Sea. This was an effort to determine the extent to which the halibut of the region were exploited directly by the fishery within the Bering Sea, and indirectly through emigration of individuals to fishing grounds elsewhere on the Pacific coast (Dunlop et al. 1964).

The management of the Bering Sea fishery became more complicated when a separate subarea was established for the Pribilof Islands in 1986 and designated Area 4C. The 1984 survey was designed to provide additional information for stock assessment and to establish a catch limit for the proposed Area 4C (IPHC 1985). In the 1960's and 1984 surveys, data were collected on catch per unit of effort (CPUE), age, size, and sex. In addition, a portion of the catch was tagged and released. The 1992 cruise was an extensive otolith collection effort to reappraise the relationship between otolith weight and body weight between sexes and areas. Data on the CPUE, size, age, sex, and maturity composition of the halibut catch were collected, but no portion of the catch was tagged and released, as in prior cruises.

This report summarizes the surveys conducted in the 1960s and 1984, and also reviews the history and management of the commercial fishery in IPHC regulatory Area 4C. The cruise conducted in 1992 is described in detail in St-Pierre and Larsen, (Unpub)[1].

HISTORY OF RESEARCH AND MANAGEMENT

Background

The Pribilof Islands presently play an important role in the Bering Sea resource, however, concerning halibut management, little distinction of this area from the Bering

[1] St-Pierre, G. and M. Larsen. Unpub. Setline Halibut Surveys: 1989 and 1992 Otolith Collections. Int. Pac. Halibut Comm.

Sea as a whole was made until the 1980s. Therefore, much of the history described here pertains to the entire Bering Sea including the Pribilof Islands.

The first survey concerning the southeastern Bering Sea was conducted in 1930 along the Aleutian chain. In the years following, a number of tagging operations were conducted throughout the Bering Sea and it was determined that the commercial availability of Pacific halibut appeared to be primarily confined to the narrow band on the edge of the continental shelf between Cape Navarin and Cape Sarichef, and to a lesser extent along the Aleutian Islands (Dunlop et al. 1964).

The commercial halibut fishery in the Bering Sea operated from 1953 through 1962 under an abstention policy governed by the International North Pacific Fisheries Commission (INPFC); a commission established by the 1952 convention which included Canada, the U.S., and Japan. The policy stated that Japan would abstain from fishing halibut in areas where the species was fully utilized by the U.S. and Canada, east of 175°W longitude. The INPFC decided in November 1962 that the eastern Bering Sea stocks (east of 175°W) were not fully utilized, allowing Japan to begin a directed fishery for halibut in 1963. This conclusion was drawn in spite of contradictory evidence supported by IPHC research tagging cruises concluding that halibut on the flats in the southeastern Bering Sea (waters east of 170°W longitude) were fully utilized through interchange with other regions (Dunlop et al. 1964).

Total catch by all countries (U.S., Canada, and Japan) in 1963 totalled approximately 25 million pounds (net weight) for the entire Bering Sea, and 11.9 million pounds in the area east of 175°W. In the following years, the catch from this area declined abruptly. In 1964, Japan withdrew its halibut longline fleet from the area and followed adjusted fishing regulations to attempt rehabilitation of the stocks (INPFC 1967). However, no such rehabilitation was achieved, and it was believed that the extensive trawl fishery for other species in the Bering Sea was having an adverse effect on recruitment to the halibut population. Japanese fishers withdrew from the area entirely after 1967. The INPFC continued annual utilization of fisheries reviews through 1976 at which time Canada and the United States extended their jurisdiction of fisheries resources to 200 miles (Hoag et al. 1993).

Research

The decision to allow Japan to fish the eastern Bering Sea in 1963 was unpopular with North American fishers and the IPHC, and was dubbed "the Bering Sea halibut giveaway" by critics (IPHC 1987). As a result, much of the IPHC survey research immediately following the 1962 INPFC decision was directed at determining scientifically whether the eastern Bering Sea stocks were fully utilized. This was investigated by tagging halibut as widely as possible throughout the Bering Sea regions in order to understand the interrelation of the halibut within the Bering Sea to grounds elsewhere along the Pacific coast (IPHC 1968). Among the survey research conducted in the Bering Sea as a whole, five tagging and exploratory operations were conducted in the Pribilof Islands from 1964 to 1967.

No further research occurred in the Pribilof Islands until 1984 when an extensive survey and tagging operation was conducted. The 1984 survey took place following a period of increasing halibut availability throughout the halibut range during the late 1970s and early 1980s which was translated first to an increase in CPUE for the commercial fleet, followed by a similar increase in CPUE for the IPHC grid surveys. The increase in the abundance of halibut in the Bering Sea also coincided with a loss of employment in the fur seal industry for residents of the Pribilof Islands. The Pribilof Island residents petitioned the IPHC to create a regulatory area around the Islands with its own quota so

that the proposed area would remain open, even when the quota was reached in other regions of the Bering Sea.

The biological justification for creating the area was that sufficient numbers of commercial size halibut do not move into the shallow island waters until late June. Hydrographic data and results of fishing suggest that the distribution of adult halibut in the Bering Sea is related to the zonation of temperatures (Dunlop et al. 1964). Thompson and Van Cleve (1936) reported that the abundance of halibut along the North American coast indicates that the greatest numbers of halibut are to be found where bottom temperatures of 3° to 8°C prevail. Bottom temperature information obtained from the National Marine Fisheries Service surveys (P. Goddard, pers. comm.)[2] shows that the water around the Pribilof Islands often takes longer to warm up to halibut-preferred temperatures than areas elsewhere in the Bering Sea, specifically along the edge. The development of a halibut fishery for the island residents was strongly supported by the state government.

Commercial Fishery Management

Most of the Bering Sea, including the Pribilof Island region, went primarily unharvested by commercial fishers until after World War II when the Pacific halibut fishery expanded south of the Alaska Peninsula and into the Bering Sea, due to the development of landing ports further east (Dunlop et al. 1964). The commercial fishery in the Bering Sea from the late 1950s through the late 1970s took place during the early spring (end of March to April) in deep waters on the Polaris, Clipper, and Misty Moon grounds, and on the edge between 170°W and 175°W if ice conditions permitted. Summer and early fall fishing prior to the discovery of the St. Matthew Island grounds by the F/V *Seattle* in October 1966, was concentrated along the Aleutian Islands.

The first recorded commercial landing in the Pribilofs was in 1930 with few subsequent landings by U.S. and Canadian fishers until 1978, at which time annual landings commenced and consisted exclusively of vessels not resident to the Pribilof Island region. In 1981 however, 11 local vessels made 82 trips. Table 1 reviews the U.S./Canadian commercial fishery from 1930 to 1994.

The Bering Sea halibut population, as did the population coastwide, displayed a dramatic decrease in the 1970s, but rebounded in the 1980s. During the 1980s, the number of outside fishing vessels increased and the U.S. government granted local residents special fishing privileges via the authority granted to them from the Northern Pacific Halibut Act of 1982 to allocate fishing privileges specifically to coastal villages in the Bering Sea north of 56°N latitude (McCaughran and Hoag, 1992). In response, the IPHC created a separate regulatory area for the Pribilof region in 1986 (Area 4C). The season in 1986 specified one day open-one day closed, and over 686,000 pounds were landed by 29 commercial vessels that year. However, only a little over 121,000 pounds or 18% of the total catch was landed by local fishers. The boundaries have changed slightly in subsequent years, but the area remains in effect (Figure 1).

In 1987 the North Pacific Fishery Management Council (NPFMC) required that fishing period limits be set for all vessels fishing the area (Hoag et al. 1993). This was intended to give an advantage to the smaller local vessels, so they would be better able to compete with the larger outside vessels. That year, a 10,000 pound fishing period limit went into effect for the first 25% of the catch, with subsequent trips unrestricted until the

[2] Goddard, P. National Marine Fisheries Service. 7600 Sand Point Way, Bldg. 4. Seattle, WA 98115.

Table 1. **Pacific halibut landings in the commercial fishery for the years 1930 through 1994 in Area 4C (as defined in the 1992 regulations).**

	LOCAL VESSELS			OUTSIDE VESSELS		
YEAR	No. of vessels	No. of trips	Total catch (lbs)	No. of vessels	No. of trips	Total catch (lbs)
1930				1	1	4,000
1953				3	3	12,367
1963				4	4	125,877
1964				2[1]	3	58,613
1965				1[1]	1	11,273
1967				1[1]	1	22,220
1978				2	2	71,485
1979				5	6	150,726
1980				3	3	92,058
1981	11	82	19,263	6	8	278,534
1982	21	100	18,631	7	7	224,884
1983	53	524	156,876	4	6	258,345
1984	32	461	249,725	5	18	329,999
1985	28	433	270,349	8	13	349,357
1986	16	129	121,214	13	26	564,971
1987[2]	19[3]	130	263,421	20	33	614,709
1988[4]	21	260	491,890	7	16	215,184
1989[4]	26	199	285,908	8	24	285,148
1990[5]	31	120	188,739	20	38	340,742
1991[5]	16	97	187,793	35	68	490,300
1992[5]	28	234	315,305	34	67	477,620
1993[5]	33	249	325,501	25	67	505,517
1994[5]	34	227	162,672	29	84	552,210

[1] IPHC research survey.

[2] 10,000 pound trip limit until 25% of the area catch limit is taken.

[3] Includes the *F/V Peggy Rose* (114,000 lbs) and the *F/V Garden Cove* (13,571 lbs).

[4] 10,000 pound trip limit until 50% of the catch limit has been taken, then the trip limit increases to 20,000 pounds.

[5] 10,000 pound trip limit for all openings.

catch limit was reached. In 1988, the 10,000 pound limits were required for the first 50% of the catch limit, then 20,000 pound limits for the remaining catch. However, in 1990, the 10,000 pound fishing period limit was applied to all openings, and remained in effect through 1994, the last year of open access fishing in Alaskan waters before switching to the Individual Fishing Quota system in 1995. The goal of stimulating the local fishery appears to have been moderately successful with 34 local vessels making 227 trips in 1994.

To discourage illegal fishing in the Bering Sea, the IPHC has required vessels fishing for halibut to register in and out of Bering Sea areas since the 1960s. As part of the clearance procedure, there were designated clearance ports; Dutch Harbor, Akutan, and Nazan Bay (Area 4B only). Although not originally intended to give an advantage to local fishers, this regulation required vessels fishing in Area 4C to check in and out of one of the clearance ports; the only exception being if a vessel landed its entire annual catch at St. George or St. Paul Islands. Since a clearance had to be done in person, the local fishers in the Pribilofs gained an additional advantage over outside vessels who were required to run back and forth between a clearance port and the Area 4C fishing grounds (Hoag et al. 1993).

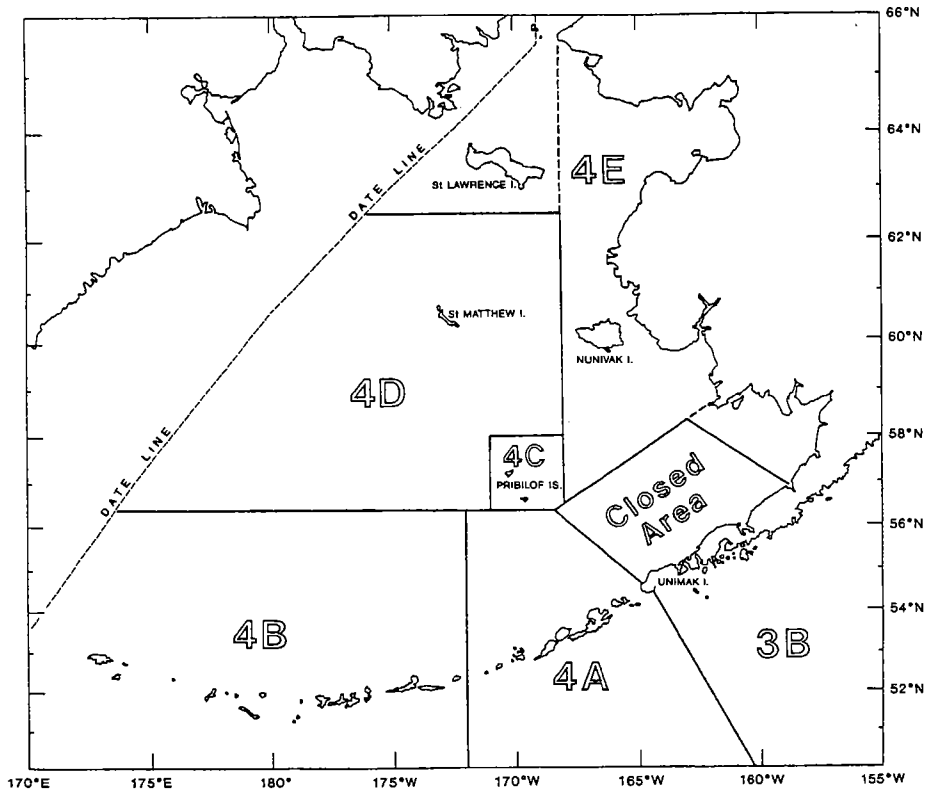

Figure 1. IPHC Bering Sea regulatory areas for 1994.

RESEARCH SURVEYS

Halibut that were not badly injured were tagged and released during all of the surveys, so the proportion of the total catch that was tagged varied among surveys. All of the individual tag releases and recoveries are available on the database. Nearly all of the fish that were not tagged were sampled for length, sex, and otoliths.

The specific objectives and the experimental design of the surveys in the Pribilof Islands in the 1960s have not been well documented beyond the fact that halibut were tagged to obtain information regarding their migration between the various fishing grounds (IPHC 1965; IPHC 1966; IPHC 1968). Trip summaries per se were not kept, but for this report have been compiled through information from logbooks, data sheets, and computer files for tagged and aged fish.

The goal of the 1984 survey was to establish CPUE by depth strata, fishing grounds, and a separate quota for the area. The 1984 station locations were placed on predetermined transects with stations located at or near the 10, 20, 30, 40, and 50 fathom contour lines. Fishing ground bottom area divided into depth strata for the survey is shown in Table 2 as well as an estimate of total area for Area 4C. Locations and set by set information are well documented for this cruise and can be found in the IPHC computer database.

Appendix 1 gives the best location and catch information available for all six charters. Figures 2a and 2b show approximate fishing locations for the six cruises.

Table 2. **Fishing ground bottom area by depth strata for the 1984 Pribilof Islands survey, and total bottom area for IPHC regulatory Area 4C using 1994 boundaries.**

1984 SURVEY		
Depth (fathoms)	**St. George Island bottom area (nmi^2)**	**St. Paul Island bottom area (nmi^2)**
<10	11.2	37.3
10-20	16.3	90.5
20-30	39.1	258.6
30-40	89.8	1,472.2
40-50	230.5	n/a

IPHC REGULATORY AREA 4C	
Depth (fathoms)	**Bottom Area (nmi^2)**
0-20	150
20-50	7,114
50-100	2,348
100-200	0
200-500	0
Total	**9,612**

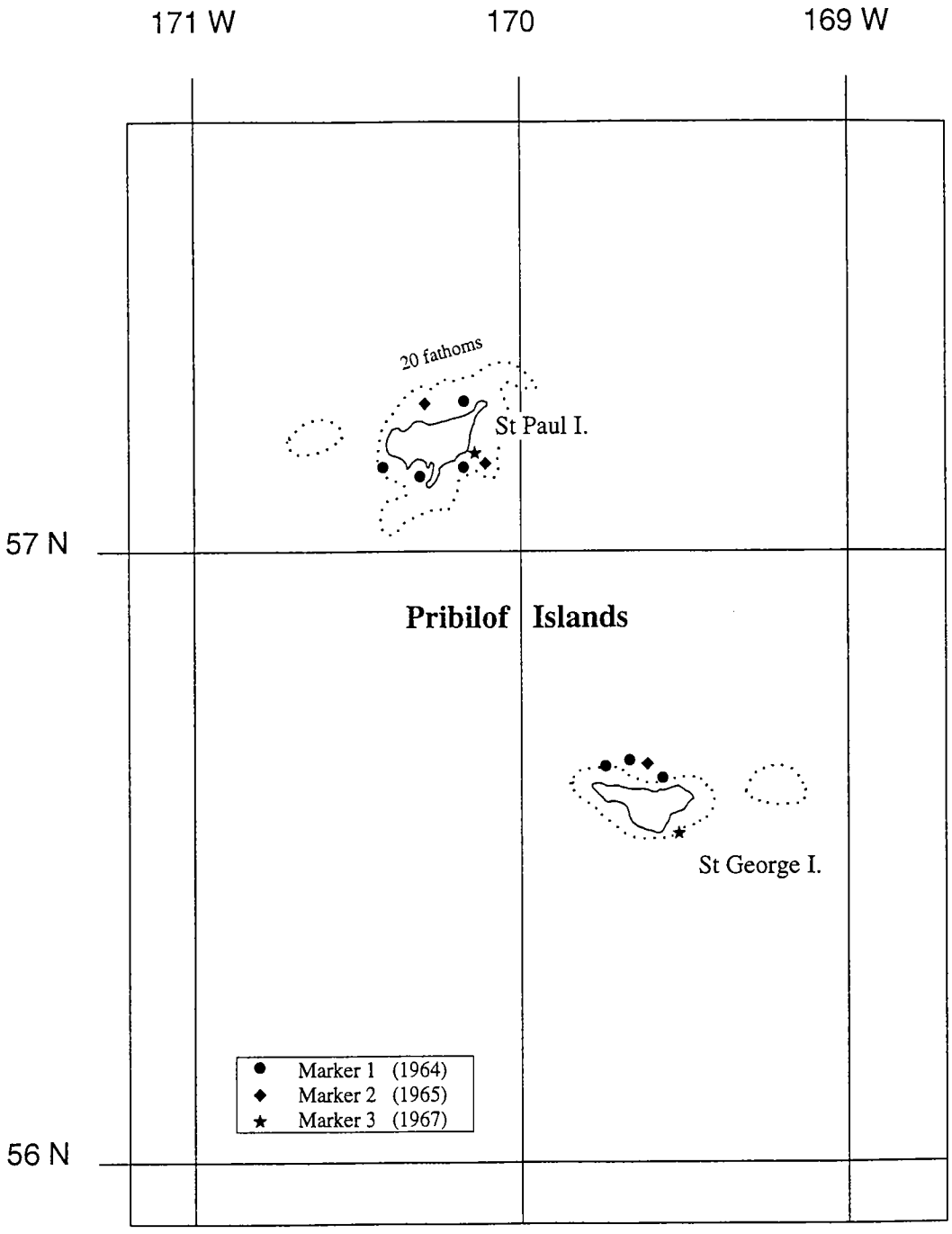

Figure 2a. Sites fished during the 1960's surveys.

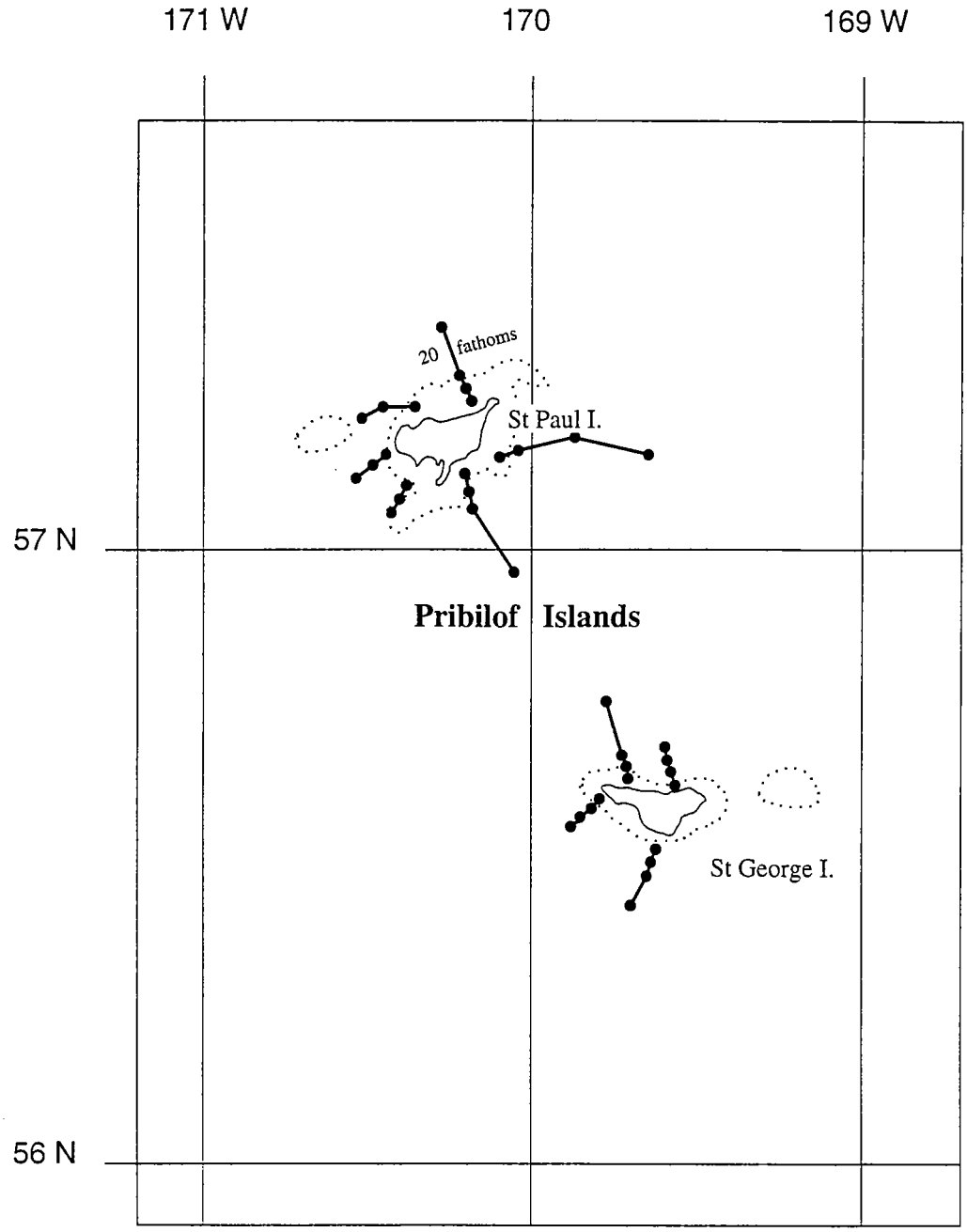

Figure 2b. Sites fished during the 1984 survey.

Computer files showing age, length, and sex for each fish that was aged are available. However, some additional fish were measured-only if, for example, the fish was badly eaten by sand fleas or sea lions, and these were not entered into the computer database. This report includes those measured-only fish which were found on data sheets, but we have no way of knowing if any additional fish were captured. However, when comparing logbook totals with those from all of the above sources, we are reasonably confident that most of the fish have been accounted for in this report. A summary of the results from the surveys is provided in Table 3.

Table 3. Summary of results from research surveys in the Pribilof Islands.

		Number of halibut				
Vessel	**Date**	**Tagged**	**Recovered**	**Aged**	**M/O**	**Pounds**
Pacific	July 19, 22-28, 1964	548	55	644	54	48,734
Pacific	Sept. 11-19, 1964	982	40	786	37	51,493
Eclipse	Sept. 4, 15-16, 1964	166	8	99	0	8,810
Chelsea	Aug. 26-29, 1965	401	17	299	32	24,987
Chelsea	June 26-30, 1967	639	22	670	3	42,465
Valorous	July 2-11, 1984	1,497	66	604[1]	271	52,458
Total		4,233	208	3,102	397	228,947

[1] Includes 112 fish which were measured and sexed only.

F/V *Pacific* - 1964

The F/V *Pacific* performed two longline surveys in the Pribilof region in 1964, the first on July 19, 22 to 28, and the second from September 11 to 19. The July survey was conducted at St. George Island off Tolstoi Pt. and Dalnoi Pt. in depths ranging between 8 and 83 fathoms. September's survey was conducted off of St. Paul Island in depths ranging from 7 to 39 fathoms. The skates for both trips averaged 1,500 feet in length and were geared with large J-hooks set 18 feet apart, resulting in 80 hooks per skate. A total of 301 skates were hauled in July and 335 skates were hauled in September.

In each portion of the experiment, two types of tags were used, large dart tags and large strap tags, to analyze the shedding rates of the two tags as described by Myhre (1966). Additionally, a Japanese, stainless steel strap tag was used during the July project. Pacific herring and octopus were used as bait.

F/V *Eclipse* - 1964

The F/V *Eclipse* spent three days in the Pribilof Islands, September 4, 15, and 16, as a continuation of the 1964 Bering Sea survey. The vessel fished south of St. Paul Island and north of St. George Island off Dalnoi point in depths ranging from 5 to 42 fathoms. A total of 82 skates of gear were hauled, and measured approximately 1,800 feet in length equipped with 104 large J-hooks set at 18-foot intervals. The tag used was the large strap variety. Pacific herring and Pacific cod were used as bait.

F/V *Chelsea* - 1965

The F/V *Chelsea* fished from August 26 to 29 on both the north and south sides of St. Paul Island along the beach in 9 to 14 fathoms depth, and the north side of St. George Island in depths ranging from 20 to 34 fathoms. A total of 180 skates were hauled, each measuring approximately 1,500 feet in length and consisting of 90 J-hooks attached to the groundline at intervals of 18 feet. Pacific cod and Pacific herring were used as bait.

F/V *Chelsea* - 1967

The F/V *Chelsea* was again chartered in 1967 to continue exploratory surveys of the Bering Sea. The Pribilof Islands were surveyed from June 26 to 30. The south side of St. George Island was fished for one day near Cascade Point in the 9 to 17 fathom depth range and the other four days were spent near Halfway Point at St. Paul Island in depths ranging between 7 and 20 fathoms. A total of 241 skates were hauled, each measuring approximately 1,500 feet and equipped with 90 J-hooks spaced 18 feet apart. Tagged fish were released with either a metal strap tag or an orange vinyl spaghetti. Pacific herring, salmon tails, and octopus were used as bait.

F/V *Valorous* - 1984

The F/V *Valorous* was chartered to fish from July 2 to 11. The first four days were fished off of St. George Island in the 15 to 50 fathom depth range, and the remaining six days off St. Paul Island in the 6 to 40 fathom range. Snap gear with circle hooks spaced 25 feet apart and totaling 75 hooks per skate was used. Two types of tags were used; the yellow wire tag and the pink wire tag. The bait used included salmon, herring, and Pacific cod.

RESULTS AND DISCUSSION

Catch per unit of Effort

All vessels fished longline gear, but each vessel's gear was unique. In order to compare results, differences in hook spacing, number of hooks per skate, and hook type must be compensated for when calculating a standard CPUE. Effort was standardized to skates of 100 hooks spaced at 18-foot intervals. The CPUE was calculated as shown (P. Sullivan pers. comm.)[3]:

CPUE = catch per standard skate of gear: C/S_s

where C = total catch on the gear hauled
S_s = total standard skates of gear hauled

[3] Sullivan, P. J. Int. Pac. Halibut Comm. P.O. Box 95009, Seattle, WA 98145-2009.

S_s are calculated as follows:

$$S_s = S_h \; x \; f_h \; x \; \frac{n_h}{100}$$

where
- h = hook spacing
- S_h = total skates hauled
- n_h = number of hooks per skate
- f_h = correction factor for hook spacing (Hamley and Skud, 1978): $= 1.52(1\text{-}e^{-0.06h})$

Further, skates from the surveys in the 1960s were standardized to reflect the use of J-hooks which are 2.2 times less efficient than circle hooks (Quinn et al. 1985). Therefore, S_s was further divided by 2.2 before calculating the CPUE for these cruises. No correction factor was used to standardize fixed hook and snap gear since there appeared to be no intrinsic difference in the efficiency of the gear types (Myhre and Quinn 1984).

CPUE was examined by depth strata using the mid-point of the depth range for each set as an observation (Table 4). The depth data for all cruises except the *Valorous* was obtained from the original logbooks since it was never entered into the IPHC computer database by set. CPUE tended to be highest at the shallower depths, from 1-29 fm.

CPUE during the 1960s tended to be higher than in 1984. However, this may not reflect lower abundance because the sampling design in 1984 included less productive fishing grounds in comparison to the 1960's surveys where stations were apparently located in order to maximize catch.

Tag Releases and Recoveries

The number of tags released ranged from 166 aboard the *Eclipse* to 1,497 aboard the *Valorous*. Appendix 2 presents length frequency data for all tagged fish. Table 5 shows the number of tag releases and area of recovery for the six projects.

In all cases except the *Eclipse* (75% of recoveries occurred in the Bering Sea), a higher percentage of tags, excluding those in the "unknown" category, were recovered in the Gulf of Alaska than in the Bering Sea/Aleutian Islands (BSAI). The percentage of recoveries in the BSAI ranging from 14% for the *Chelsea*-1965 to 45% for the *Valorous*.

Recovery rates are low overall (3-10%), but tag recoveries from the Bering Sea are typically lower than those from the Gulf of Alaska or the eastern Pacific. One possibility is that tagged halibut recovered by Japan or other fishing nations in the Bering Sea have gone unreported.

Those tags recovered outside of Area 4C but still within the BSAI ranged from 0-25% of total tags recovered. Interestingly, the three surveys which took place late in the season (August and September) showed a 0-3% recovery in other BSAI areas, whereas surveys taking place in June and July showed a recovery rate of 6-25%. Outside of Area 4C, Area 3A (central Gulf) had the largest percentage of recoveries (25-57%). There was also some migration to Canadian waters (Area 2B) where 0-15% of the recoveries occurred.

Table 4. **Summary of skates, catch (pounds, net weight), and CPUE (pounds/st. skate) by depth strata for longline surveys conducted by the IPHC in the Pribilof Island region.**

Avg. Depth (fathoms)	No. of skates	No. of St. skates[1]	Catch (lbs)	CPUE (lbs/st. skate)
		***F/V Pacific* - July 19, 22-28, 1964**		
<10	0	0.0	0	-
10-19	119	43.4	25,991	598.3
20-29	96	35.0	16,863	481.2
30-39	48	17.5	4,679	267.0
40+	38	13.9	1,201	86.4
Total	301	109.9	48,734	443.4
		***F/V Pacific* - September 11-19, 1964**		
<10	9	3.3	1,480	450.5
10-19	254	92.7	40,615	438.1
20-29	56	20.4	8,448	413.3
30-39	16	5.8	950	162.7
40+	0	1.0	0	-
Total	335	122.3	51,493	421.1
		***F/V Eclipse* - September 4, 15-16, 1964**		
<10	18	8.5	2,023	236.8
10-19	22	10.4	1,487	142.4
20-29	42	19.9	5,300	265.9
30-39	0	0.0	0	-
40+	0	0.0	0	-
Total	82	38.9	8,810	226.4
		***F/V Chelsea* - August 26-29, 1965**		
<10	36	14.8	6,124	414.2
10-19	81	33.3	8,539	256.7
20-29	36	14.8	6,804	460.2
30-39	27	11.1	3,520	317.5
40+	0	0.0	0	-
Total	180	73.9	24,987	338.1

Table 4. (continued) Summary of skates, catch (pounds, net weight), and CPUE (pounds/st. skate) by depth strata for longline surveys conducted by the IPHC in the Pribilof Island region.

Avg. Depth (fathoms)	No. of skates	No. of St. skates[1]	Catch (lbs)	CPUE (lbs/st. skate)
		***F/V Chelsea* - June 26-30, 1967**		
<10	49	19.8	10,777	535.6
10-19	181	74.0	29,752	400.3
20-29	11	4.5	1,936	428.6
30-39	0	0.0	0	-
40+	0	0.0	0	-
Total	241	98.3	42,465	432.0
		***F/V Valorous* - July 2-11, 1984**		
<10	0	0.0	0	-
10-19	40	35.4	16,353	461.6
20-29	108	95.6	27,684	289.4
30-39	71	62.9	4,992	79.4
40+	56	49.6	3,429	69.1
Total	275	243.5	52,458	215.4

[1] Skates have been standardized for hook spacing, length of skate, and type of hook used.

These results imply that significant migration occurs from Area 4C to the north Pacific, supporting Skud's (1977) conceptual model of halibut movements, and Dunlop et al.'s (1964) finding of a large emigration of halibut from the eastern Bering Sea to the eastern Pacific. Therefore, as hypothesized by the IPHC in the 1960s, utilization of the Pribilof halibut stocks goes beyond a local affect, having ramifications in other parts of the Bering Sea and the Gulf of Alaska and further south.

Size, Age, and Gender

Those halibut which came up on the gear either dead or near-dead were kept for length and gender identification. The high frequency of measured-only fish on board the *Valorous* in 1984 was due to the fact that the vessel ran low on tags and otolith envelopes which caused the scientific crew to select legal-size fish for tagging as opposed to sublegal-size fish. The frequency for each length at which fish were measured, sexed, otoliths taken, and measured-only is given in Appendix 2. In all cases, females were overwhelmingly more abundant than males. The sex ratios based on number caught for each cruise are shown in Table 6. Male halibut in the catch ranged from only 2.34% aboard the *Chelsea* in 1965, to 14.63% on the *Pacific* in September of 1964. The 1992 cruise aboard the *Kaare* showed similar results: females 98.5% and males 1.5% (St-Pierre and Larsen, Unpub.)[1]. Figure 3 illustrates the proportion of males and females by size in relation to the total fish caught which were sexed.

Table 5. **Tag releases and recoveries by vessel for tags released by the IPHC in Area 4C.**

Vessel Cruise	No. of tags released	Area of Recovery											
		2B	2C	3A	3B	4A	4B	4C	4D	4E	Unk.	Total	Recovery rate
Pacific - 1, 1964	548	2	3	21	7	3	0	12	0	0	7	55	0.10
Pacific - 2, 1964	982	4	2	19	6	1	0	7	0	0	1	40	0.04
Eclipse - 1964	166	0	0	2	0	0	0	6	0	0	0	8	0.05
Chelsea - 1965	401	0	2	8	2	0	0	2	0	0	3	17	0.04
Chelsea - 1967	639	3	1	6	4	1	0	1	4	0	2	22	0.03
Valorous - 1984	1,497	8	4	14	6	0	1	21	3	2	7	66	0.04

Two points are clear; (1) males are a much smaller proportion of the total fish in all cases, and (2) the occurrence of males above about 140 cm is rare, which is consistent with the normal size range of males in the North Pacific. The females in these surveys are seen as high as the 218-cm size category. Figure 4 presents proportion of fish by size category and sex for all cruises combined. Males were most frequent in the 88-cm size category, whereas females were most commonly found in the 98 to 113-cm size categories. This size difference is consistent with other IPHC studies (IPHC 1987).

Table 6. Percentage of males and females caught for each cruise.

	Pacific[1] 1964	Pacific[2] 1964	Eclipse 1964	Chelsea 1965	Chelsea 1967	Valorous 1984
% males	7.86	14.63	13.68	2.34	2.54	7.78
% females	92.14	85.37	86.32	97.66	97.46	92.22

The length-at-age of the retained catch is shown in Table 7. A comparison between fish from the 1960's surveys and the *Valorous* survey in 1984 suggests that the growth rate increased. Figure 5 shows the average size-at-age by sex for all the cruises combined.

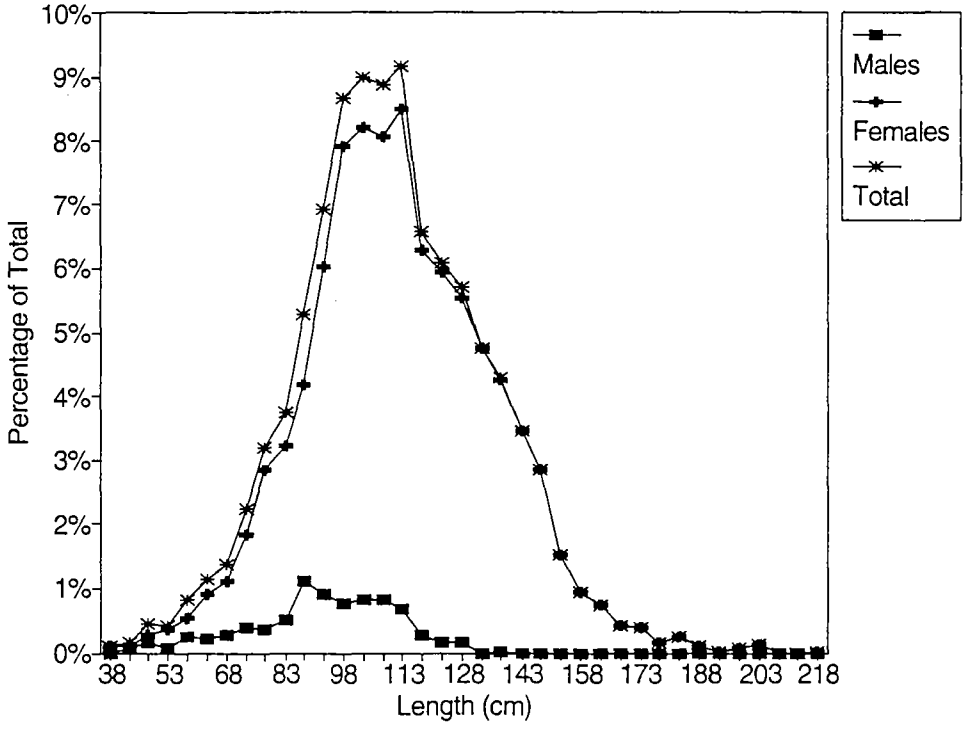

Figure 3. Proportion of males and females in relation to total catch for all cruises combined.

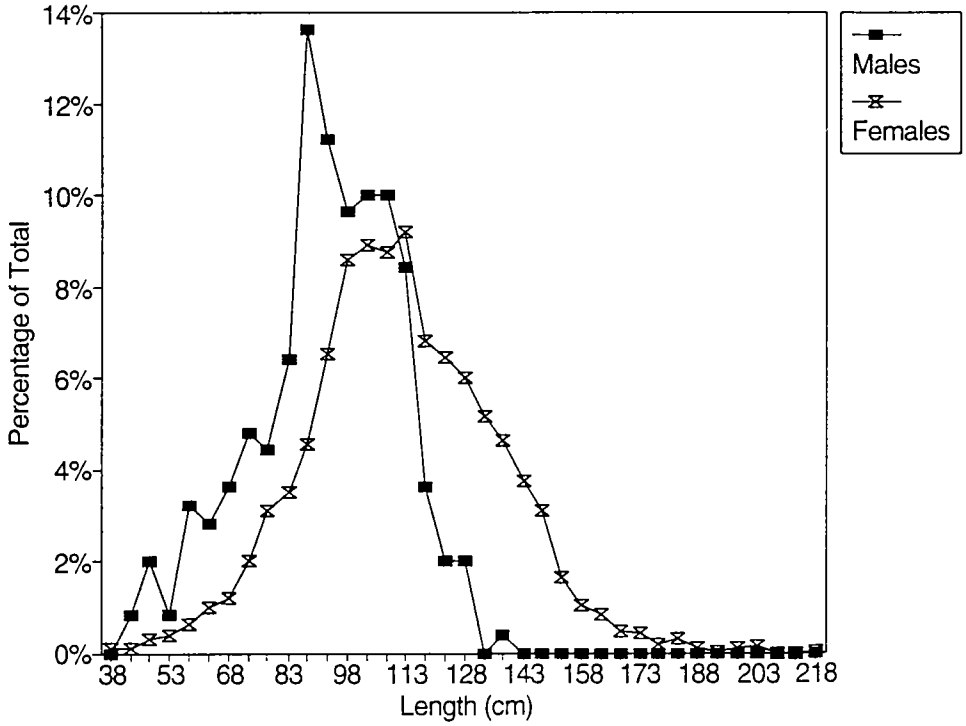

Figure 4. **Size composition of males and females for all cruises combined.**

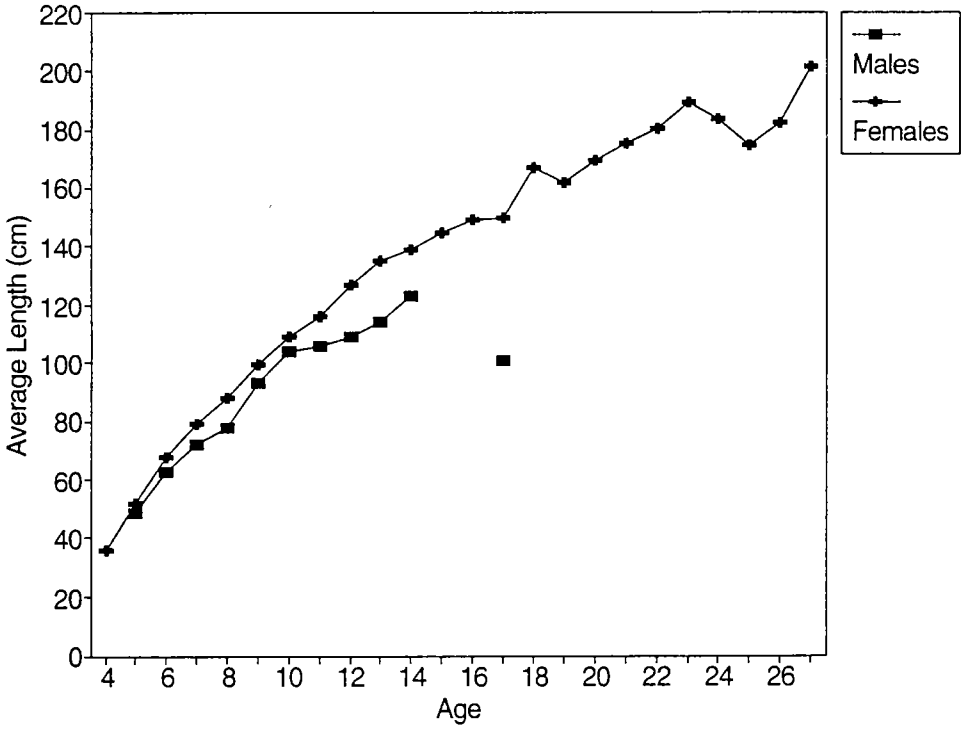

Figure 5. **Average length at age of males and females for all cruises combined.**

Table 7. Average length (cm) at age (years) of Pacific halibut caught on IPHC research cruises in the Pribilof Islands.

	Average fork length (cm)													
	Pacific[1] 1964		Pacific[2] 1964		Eclipse 1964		Chelsea 1965		Chelsea 1967		Valorous 1984		Total	
Age	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	-	-	-	36.0	-	-	-	-	-	-	-	-	-	36.0
5	-	-	51.0	54.4	45.0	43.3	-	-	-	-	50.0	38.0	48.8	51.7
6	63.0	62.8	64.9	68.8	49.0	53.3	-	85.5	-	85.5	58.5	69.2	62.9	67.8
7	57.5	75.9	76.2	79.3	59.2	76.7	69.0	78.8	-	78.8	78.0	79.2	72.1	79.2
8	69.0	88.0	83.0	92.8	79.0	81.0	81.0	89.0	76.1	89.0	69.0	90.3	78.2	88.1
9	87.7	100.4	92.7	99.3	89.0	99.0	90.0	100.4	92.3	100.4	96.7	102.8	93.0	99.9
10	115.5	111.0	99.5	110.4	-	113.0	90.0	107.2	99.0	107.2	107.7	114.8	104.1	109.2
11	102.2	112.5	107.8	116.4	100.0	114.2	-	117.6	109.0	117.6	109.0	125.7	106.2	116.1
12	101.7	128.5	112.6	125.6	-	129.7	108.0	121.6	124.0	121.6	94.0	135.4	109.2	126.6
13	108.0	134.4	117.0	136.1	-	133.7	-	133.1	-	133.1	-	138.9	114.0	135.2
14	126.0	140.4	119.0	139.5	117.0	137.0	-	144.8	-	144.8	127.0	150.5	123.2	139.2
15	-	145.7	-	141.6	-	145.7	-	144.9	-	144.9	-	147.7	-	145.2
16	-	145.9	-	143.4	-	145.2	-	162.0	-	162.0	-	165.8	-	148.9
17	-	144.8	-	147.0	101.0	150.0	-	129.0	-	129.0	-	153.0	101.0	150.0
18	-	150.5	-	172.0	-	-	-	175.7	-	175.7	-	185.0	-	166.8
19	-	158.7	-	-	-	174.0	-	148.0	-	148.0	-	-	-	161.9
20	-	162.5	-	-	-	-	-	163.0	-	163.0	-	190.0	-	169.7
21	-	167.5	-	174.0	-	186.0	-	166.0	-	166.0	-	187.5	-	175.6
22	-	-	-	172.5	-	-	-	-	-	-	-	192.0	-	180.3
23	-	184.0	-	-	-	-	-	-	-	-	-	200.0	-	189.3
24	-	189.5	-	172.0	-	-	-	-	-	-	-	-	-	183.7
25	-	-	-	-	-	175.0	-	-	-	-	-	-	-	175.0
26	-	-	-	-	-	-	-	182.0	-	182.0	-	-	-	182.0
27	-	201.0	-	-	-	-	-	-	-	-	-	-	-	201.0

[1] Cruise dates: July 22-28, 1964
[2] Cruise dates: September 11-19, 1964

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APPENDICES

Appendix 1: Summary of fishing activity for surveys in the Pribilof Islands. Pounds are net weight, and skates fished are standardized.

Appendix 2: Frequency of halibut caught by length for each vessel on IPHC Pribilof Island charters.

Appendix 1. Summary of fishing activity for surveys in the Pribilof Islands. Pounds are net weight, and skates fished are standardized.

F/V *Pacific* - July 18, 22-28, 1964

Date	Sets	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged	Tagged	M/O	Total	<82 cm		
7/19/64	1-3	56°22' N	169°20' W	54-83	10.9	10	15	0	25	20.0%	720	66.1
7/22/64	1-5	56°37' N	169°35' W	16-40	14.6	70	60	1	131	2.3%	5,793	396.8
7/23/64	1-4	56°38' N	169°41' W	22-40	11.7	34	55	1	90	7.8%	3,010	172.0
7/24/64	1-6	56°37' N	169°35' W	10-28	17.5	197	167	6	370	2.7%	14,410	823.4
7/25/64	1-5	56°37' N	169°35' W	8-20	14.6	140	102	12	254	1.6%	9,190	629.5
7/26/64	1-5	56°37' N	169°35' W	10-38	14.6	74	68	2	144	2.8%	6,270	429.5
7/27/64	1-5	56°37' N	169°35' W	12-32	12.8	94	44	12	150	0.0%	6,090	475.8
7/28/64	1-6	56°37' N	169°35' W	8-30	13.1	25	37	20	82	2.4%	3,251	248.2
Total	**36**				**109.8**	**644**	**548**	**54**	**1,246**	**3.0%**	**48,734**	**443.8**

F/V *Pacific* - September 11-19, 1964

Date	Sets	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged	Tagged	M/O	Total	<82 cm		
9/11/64	1-4	57°07' N	170°28' W	20-39	11.6	30	55	0	85	8.2%	2,520	217.2
9/12/64	1-5	57°06' N	170°18' W	18-26	14.5	76	103	4	183	10.9%	5,270	363.4
9/13/64	1-4	57°06' N	170°18' W	12-21	11.6	97	86	5	188	3.2%	6,990	602.6
9/14/64	1-4	57°07' N	170°12' W	8-30	11.6	89	92	2	183	11.5%	4,488	386.9
9/15/64	1-4	57°08' N	170°20' W	8-20	14.5	72	154	3	229	17.5%	4,990	344.1
9/16/64	1-4	57°06' N	170°18' W	8-18	14.5	148	164	13	325	4.9%	11,475	788.9
9/17/64	1-4	57°08' N	170°12' W	10-18	14.5	90	136	1	227	8.8%	6,060	417.9
9/18/64	1-4	57°06' N	170°18' W	8-20	14.5	78	107	3	188	12.2%	5,040	347.6
9/19/64	1-4	57°14' N	170°10' W	7-13	14.2	106	85	6	197	11.7%	4,660	328.2
Total	**37**				**122**	**786**	**982**	**37**	**1,805**	**9.8%**	**51,493**	**422.0**

F/V *Eclipse* - September 15-16, 1964

Date	Sets	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged	Tagged	M/O	Total	<82 cm		
9/4/64	11	57°05' N	170°13' W	9-12	4.3	4	10	0	14	14.0%	526	122.3
9/15/64	40-44	56°38' N	169°45' W	10-42	16.6	44	89	0	133	5.3%	5,045	304.9
9/16/64	45-49	56°38' N	169°45' W	5-35	18.0	51	67	0	118	19.5%	3,237	180.2
Total	**11**				**38.9**	**99**	**166**	**0**	**265**	**13.0%**	**8,810**	**226.4**

F/V *Chelsea* - August 26-29, 1965

Date	Set	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged	Tagged	M/O	Total	<82 cm		
8/26/65	39-43	57°14' N	170°18' W	9-14	18.4	105	119	14	238	5.9%	7,587	412.3
8/27/65	44-48	57°09' N	170°08' W	9-13	18.4	26	50	2	78	3.8%	3,260	177.1
8/28/65	49-53	56°38' N	169°39' W	20-29	18.4	92	113	5	210	2.4%	5,255	285.5
8/29/65	54-58	56°38' N	169°39' W	28-34	18.4	76	119	11	206	3.9%	8,885	482.6
Total	**20**				**73.6**	**299**	**401**	**32**	**732**	**4.1%**	**24,987**	**339.0**

F/V *Chelsea* - June 26-30, 1967

Date	Sets	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged	Tagged	M/O	Total	<82 cm		
6/26/67	31-35	56°32' N	169°32' W	9-17	16.0	53	44	1	98	3.1%	3,153	197.0
6/27/67	36-40	57°10' N	170°10' W	7-17	21.3	180	144	1	325	3.7%	10,984	516.3
6/28/67	41-45	57°10' N	170°10' W	11-18	21.7	141	156	0	297	4.0%	9,970	459.8
6/29/67	46-50	57°10' N	170°10' W	12-20	21.3	131	133	1	265	4.2%	7,972	374.8
6/30/67	51-55	57°10' N	170°10' W	9-12	18.0	165	162	0	327	3.1%	10,386	577.0
Total	**24**				**98.3**	**670**	**639**	**3**	**1,312**	**3.7%**	**42,465**	**432.0**

F/V *Valorous* - July 2-11, 1984

Date	Set	Latitude	Longitude	Depth	Skates	Number of halibut					Pounds	lbs/ skate
						Aged[1]	Tagged	M/O	Total	<82 cm		
7/2/84	1	56°36' N	169°47' W	15-20	5.3	3	38	0	41	22.0%	954	179.6
7/2/84	2	56°35' N	169°48' W	25-35	4.4	4	37	0	41	39.0%	1,011	228.4
7/2/84	3	56°35' N	169°49' W	30-36	2.7	6	12	0	18	16.7%	817	307.6
7/2/84	4	56°34' N	169°51' W	40-50	7.1	8	44	0	52	28.8%	1,624	229.3
7/3/84	5	56°31' N	169°38' W	30-33	7.1	0	5	0	5	40.0%	72	10.2
7/3/84	6	56°30' N	169°39' W	45-45	7.1	3	4	0	7	14.3%	221	31.2
7/3/84	7	56°29' N	169°39' W	45-49	7.1	0	4	0	4	25.0%	97	13.7
7/3/84	8	56°26' N	169°44' W	48-50	7.1	0	8	0	8	37.5%	113	15.9
7/4/84	9	56°37' N	169°33' W	20-25	7.1	4	45	0	49	36.7%	1,099	155.1
7/4/84	10	56°38' N	169°34' W	32-34	7.1	1	11	0	12	33.3%	337	47.5
7/4/84	11	56°38' N	169°32' W	40-40	7.1	0	17	0	17	52.9%	413	58.4
7/4/84	12	56°39' N	169°33' W	40-43	7.1	2	6	0	8	50.0%	185	26.1
7/5/84	13	56°37' N	169°41' W	32-35	7.1	2	19	0	21	42.9%	339	47.8
7/5/84	14	56°38' N	169°41' W	39-39	6.2	0	12	0	12	33.3%	192	31.0
7/5/84	15	56°39' N	169°42' W	39-40	7.1	3	18	0	21	66.7%	205	28.9
7/5/84	16	56°44' N	169°42' W	42-42	7.1	7	39	0	46	47.8%	776	109.5
7/6/84	17	57°11' N	170°04' W	11-14	7.1	66	126	0	192	26.0%	4,830	681.7
7/6/84	18	57°11' N	170°01' W	18-19	7.1	10	101	0	111	28.8%	2,735	386.0
7/6/84	19	57°13' N	169°50' W	25-28	7.1	2	51	0	53	49.1%	1,110	156.7
7/6/84	20	57°15' N	169°36' W	30-30	7.1	1	0	0	1	0.0%	214	30.2
7/7/84	21	57°15' N	170°11' W	10-14	1.8	9	42	3	54	29.6%	1,086	612.9
7/7/84	22	57°17' N	170°14' W	18-25	7.1	40	130	3	173	43.4%	3,257	459.7

F/V *Valorous* - July 2-11, 1984 (continued)												
7/7/84	23	57°18' N	170°15' W	26-27	7.1	10	73	8	91	61.5%	1,013	143.0
7/7/84	24	57°23' N	170°18' W	34-35	7.1	6	70	0	76	19.7%	1,795	253.3
7/8/84	25	57°14' N	170°22' W	6-15	7.1	52	140	4	196	22.4%	5,115	721.9
7/8/84	26	57°14' N	170°25' W	23-28	7.1	59	133	20	212	27.8%	4,135	583.6
7/8/84	27	57°13' N	170°27' W	27-30	7.1	57	99	41	197	32.5%	4,695	662.7
7/9/84	28	57°09' N	170°26' W	22-25	7.1	10	62	10	82	34.1%	1,750	247.1
7/9/84	29	57°09' N	170°28' W	20-30	3.5	15	29	4	48	18.8%	1,319	372.3
7/9/84	30	57°08' N	170°30' W	27-30	7.1	7	60	5	72	29.2%	1,537	216.9
7/10/84	31	57°07' N	170°24' W	25-28	7.1	25	25	28	78	52.6%	1,204	170.0
7/10/84	32	57°06' N	170°24' W	25-25	7.1	27	37	19	83	27.7%	2,619	369.7
7/10/84	33	57°04' N	170°25' W	15-25	7.1	83	0	26	109	15.6%	2,543	358.9
7/11/84	34	57°07' N	170°11' W	17-20	7.1	35	0	49	84	48.8%	1,632	230.4
7/11/84	35	57°05' N	170°10' W	20-21	7.1	16	0	27	43	62.8%	550	77.6
7/11/84	36	57°04' N	170°08' W	28-30	7.1	31	0	22	53	41.5%	853	120.4
7/11/84	37	56°58' N	170°03' W	36-40	7.1	0	0	2	2	100.0%	10	1.4
Total	**37**				**243.5**	**604**	**1,497**	**271**	**2,372**	**33.8%**	**52,458**	**215.4**

[1] Includes 112 fish which were measured and sexed, but not aged.

Appendix 2. Frequency of halibut caught by length for each vessel on IPHC Pribilof Island charters.

F/V *Pacific* - July 19, 22-28, 1964.

Length (cm)	Sexed and Aged		Tagged	Measured only	Total
	males	females			
36-40	0	1	0	1	2
41-45	0	0	1	0	1
46-50	0	0	2	0	2
51-55	1	0	2	0	3
56-60	1	3	1	0	5
61-65	2	1	2	1	6
66-70	2	4	5	0	11
71-75	0	9	7	0	16
76-80	1	8	9	2	20
81-85	2	3	11	0	16
86-90	5	15	20	0	40
91-95	5	24	23	3	55
96-100	6	39	44	9	98
101-105	10	42	61	8	121
106-110	6	65	58	4	134
111-115	5	48	54	5	112
116-120	2	41	40	4	87
121-125	0	51	39	2	92
126-130	1	39	36	3	79
131-135	0	48	27	8	83
136-140	0	39	32	0	71
141-145	0	40	28	1	69
146-150	0	36	20	1	57
151-155	0	14	11	1	26
156-160	0	11	3	0	14
161-165	0	3	4	1	8
166-170	0	6	2	0	8
171-175	0	1	4	0	5
176-180	0	0	1	0	1
181-185	0	1	1	0	2
186-190	0	0	0	0	0
191-195	0	0	0	0	0
196-200	0	0	0	0	0
201-205	0	2	0	0	2
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	0	0	0	0
Total	50	594	548	54	1,246

F/V *Pacific* - September 11-19, 1964.

Length (cm)	Sexed and Aged		Tagged	Measured only	Total
	males	females			
36-40	0	1	0	0	1
41-45	0	0	0	0	0
46-50	2	5	4	0	11
51-55	0	9	12	0	21
56-60	4	9	7	0	20
61-65	3	15	13	1	32
66-70	3	16	38	0	57
71-75	8	26	35	4	73
76-80	5	33	54	3	95
81-85	10	41	65	2	118
86-90	13	30	51	0	94
91-95	9	32	76	1	118
96-100	13	57	118	4	192
101-105	10	43	66	3	122
106-110	12	48	78	3	141
111-115	14	64	83	4	164
116-120	4	58	71	4	137
121-125	3	37	31	2	73
126-130	2	37	49	3	91
131-135	0	27	36	1	64
136-140	0	26	25	0	51
141-145	0	20	25	1	46
146-150	0	16	25	0	41
151-155	0	7	9	0	16
156-160	0	5	3	1	9
161-165	0	3	8	0	11
166-170	0	1	0	0	1
171-175	0	3	0	0	3
176-180	0	1	0	0	1
181-185	0	0	0	0	0
186-190	0	1	0	0	1
191-195	0	0	0	0	0
196-200	0	0	0	0	0
201-205	0	0	0	0	0
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	0	0	0	0
Total	115	671	982	37	1,805

F/V *Eclipse* - September 4, 15-16, 1964.

Length (cm)	Sexed and Aged		Tagged	Measured only	Total
	males	females			
36-40	0	0	0	0	0
41-45	2	3	2	0	7
46-50	2	1	4	0	7
51-55	1	1	3	0	5
56-60	1	1	0	0	2
61-65	1	0	4	0	5
66-70	0	0	1	0	1
71-75	1	1	6	0	8
76-80	1	1	9	0	11
81-85	0	3	9	0	12
86-90	1	5	0	0	6
91-95	0	1	6	0	7
96-100	1	7	15	0	23
101-105	2	6	17	0	25
106-110	0	6	14	0	20
111-115	0	5	14	0	19
116-120	1	6	7	0	14
121-125	0	4	9	0	13
126-130	0	8	11	0	19
131-135	0	5	10	0	15
136-140	0	2	10	0	12
141-145	0	7	7	0	13
146-150	0	3	3	0	6
151-155	0	4	2	0	6
156-160	0	2	2	0	4
161-165	0	0	0	0	0
166-170	0	0	0	0	0
171-175	0	2	1	0	3
176-180	0	0	0	0	0
181-185	0	0	0	0	0
186-190	0	1	0	0	1
191-195	0	0	0	0	0
196-200	0	0	0	0	0
201-205	0	0	0	0	0
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	0	0	0	0
Total	14	85	166	0	265

F/V *Chelsea* - August 26-29, 1965.

Length (cm)	Sexed and Aged		Tagged	Measured only	Total
	males	females			
36-40	0	0	1	0	1
41-45	0	0	0	0	0
46-50	0	0	2	0	2
51-55	0	0	1	0	1
56-60	0	0	1	0	1
61-65	0	0	4	0	4
66-70	1	3	3	1	8
71-75	0	5	9	0	14
76-80	2	11	8	1	22
81-85	1	14	12	2	29
86-90	2	15	20	1	38
91-95	0	15	19	0	34
96-100	0	17	30	2	49
101-105	0	36	35	2	73
106-110	1	27	38	5	71
111-115	0	36	52	6	94
116-120	0	17	32	3	52
121-125	0	22	34	1	57
126-130	0	23	28	2	53
131-135	0	14	15	2	31
136-140	0	8	19	2	29
141-145	0	5	17	0	22
146-150	0	9	9	0	18
151-155	0	3	7	0	10
156-160	0	3	1	0	4
161-165	0	5	3	1	9
166-170	0	1	0	0	1
171-175	0	0	1	0	1
176-180	0	0	0	0	0
181-185	0	1	0	0	1
186-190	0	0	0	0	0
191-195	0	1	0	1	2
196-200	0	0	0	0	0
201-205	0	1	0	0	1
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	0	0	0	0
Total	7	292	401	32	732

F/V *Chelsea* - June 26-30, 1967.

Length (cm)	Sexed and Aged		Tagged	Measured only	Total
	males	females			
36-40	0	0	0	0	0
41-45	0	0	0	0	0
46-50	0	2	0	0	2
51-55	0	1	1	0	2
56-60	0	1	4	1	6
61-65	1	6	2	0	9
66-70	1	5	10	0	16
71-75	2	8	8	0	18
76-80	1	21	19	0	41
81-85	1	16	21	0	38
86-90	3	36	26	0	65
91-95	4	63	63	0	130
96-100	1	73	71	0	145
101-105	1	72	71	0	144
106-110	1	61	54	1	117
111-115	0	62	45	0	107
116-120	0	34	48	0	82
121-125	1	32	37	0	70
126-130	0	41	37	1	79
131-135	0	21	46	0	67
136-140	0	36	38	0	74
141-145	0	18	14	0	32
146-150	0	12	14	0	26
151-155	0	8	4	0	12
156-160	0	5	5	0	10
161-165	0	5	0	0	5
166-170	0	3	0	0	3
171-175	0	4	1	0	5
176-180	0	1	0	0	1
181-185	0	5	0	0	5
186-190	0	1	0	0	1
191-195	0	0	0	0	0
196-200	0	0	0	0	0
201-205	0	0	0	0	0
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	0	0	0	0
Total	17	653	639	3	1,312

F/V *Valorous* - July 2-11, 1984.

Length (cm)	Sexed and Aged*		Tagged	Measured only	Total
	males	females			
36-40	0	1	2	0	3
41-45	0	0	2	4	6
46-50	1	1	7	5	14
51-55	0	0	17	12	28
56-60	2	3	47	37	89
61-65	0	6	56	46	108
66-70	2	6	119	60	187
71-75	1	8	115	43	167
76-80	1	14	116	40	171
81-85	2	23	113	18	153
86-90	10	29	108	0	147
91-95	10	52	127	2	190
96-100	3	52	119	2	175
101-105	2	55	136	0	193
106-110	5	43	113	0	161
111-115	2	48	63	0	113
116-120	2	39	68	2	110
121-125	1	38	51	0	90
126-130	2	24	40	0	66
131-135	0	32	24	0	56
136-140	1	21	18	0	40
141-145	0	17	18	0	35
146-150	0	12	5	0	17
151-155	0	11	4	0	15
156-160	0	3	5	0	8
161-165	0	7	2	0	9
166-170	0	2	0	0	2
171-175	0	2	0	0	2
176-180	0	3	1	0	4
181-185	0	1	0	0	1
186-190	0	0	0	0	0
191-195	0	0	1	0	1
196-200	0	2	0	0	2
201-205	0	1	0	0	1
206-210	0	0	0	0	0
211-215	0	0	0	0	0
216-220	0	1	0	0	1
Total	47	557	1,497	271	2,372

* Includes 112 fish which were sexed and measured but not aged.