INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report
1988

Unloading the *Oscar and Hattie* in 1888

Established by a Convention between
Canada and the United States of America

Commissioners

Linda J. Alexander	Dennis N. Brock
Richard Eliason	Steven Pennoyer
George A. Wade	Gary T. Williamson

Director

Donald A. McCaughran

Seattle, Washington
1989

PREFACE

The International Pacific Halibut Commission (IPHC) was established in 1923 by a convention between Canada and the United States for the preservation of the halibut (*Hippoglossus stenolepis*) fishery of the North Pacific Ocean and the Bering Sea. The convention was the first international agreement providing for the joint management of a marine resource. The Commission's authority was expanded by several subsequent conventions, the most recent being signed in 1953 and amended by the protocol of 1979.

Three IPHC commissioners are appointed by the governor general of Canada and three by the president of the United States. Each country pays one-half of the Commission's annual expenses, as required by the Halibut Convention. The commissioners appoint the director who supervises the scientific and administrative staff. The scientific staff collects and analyzes the statistical and biological data needed to manage the halibut fishery. The IPHC headquarters and laboratory are located on the campus of the University of Washington in Seattle, Washington.

The Commission meets annually to review all regulatory proposals, including those made by the scientific staff and the Conference Board, which represents vessel owners and fishermen. Regulatory proposals are discussed with the Advisory Group composed of fishermen, vessel owners, and processors. The measures recommended by the Commission are submitted to the two governments for approval. Upon approval, the regulations are enforced by the appropriate agencies of both governments.

The International Pacific Halibut Commission publishes three serial publications: Annual Reports (U.S. ISSN 0074-7238), Scientific Reports — formerly known as Reports—(U.S. ISSN 0074-7246), and Technical Reports (U.S. ISSN 0579-3920). Until 1969, only the Report series was published; the numbering of that series has been continued with the Scientific Reports.

Unless otherwise indicated, all weights in this report are dressed weight (eviscerated, head-off). Round (live) weight may be calculated by multiplying the dressed weight by a factor of 1.33.

INTERNATIONAL PACIFIC HALIBUT COMMISSION
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ACTIVITIES OF THE COMMISSION

In 1988, the Commission held several meetings, including its annual meeting in Sitka, Alaska, an interim meeting in Seattle, Washington and several telephone conference calls throughout the summer. This section summarizes the activities of the Commission during these occasions.

ANNUAL MEETING

The 64th Annual Meeting of the Commission was held on January 25-28, 1988, with Mr. Robert W. McVey presiding as chairman and Mr. Dennis N. Brock as vice chairman. The Commission staff reviewed the 1987 Pacific halibut fishery, summarized the results of scientific investigations, and presented its regulatory proposals for the 1988 fishery. The Conference Board, representing vessel owners and fishermen also presented its regulatory proposals to the Commission. In addition, the Commission received proposals from the Pacific and North Pacific Fishery Management Councils pertaining to allocating the halibut resource among fishing groups. The Commission reviewed all proposals and adopted regulations for the 1988 halibut fishery in the presence of the Advisory Group, consisting of fishermen, vessel owners, and processors. The regulations were then sent to the Canadian and United States governments for approval.

Also during the meeting, the Commission considered administrative and fiscal matters, approved research plans for 1988, and adopted the budget for fiscal year 1990-1991. Mr. Brock was elected chairman for 1988 and Mr. McVey was elected vice chairman. After the meeting, the Commission issued a news release expressing encouragement about the condition of the resource and summarizing the regulations that were being recommended to the governments.

Following the meeting, a letter was sent to each government, noting that halibut stocks in the Gulf of Alaska are at levels that permit catches higher than the long-term maximum sustained yield. This condition was attributed to the Commission's past management practices, controlled halibut bycatch in other fisheries, and favorable environmental conditions. Stocks at both ends of the range (Bering Sea and British Columbia-Washington-Oregon coast) were observed to be growing at a modest rate. The letter alerted the governments that future yields were likely to begin a period of decline due to natural environmental cycles.

The letter expressed concern for the problems created by the short, intense, fishing seasons in Alaska that were necessary because of uncontrolled fishing effort. The following problems were identified: (1) wastage of halibut caused by abandoned fishing gear at the close of each fishing period, (2) poor quality of some catch, (3) unsafe fishing conditions, (4) increased violation of regulations, and (5) difficulty in collecting accurate fishery statistics needed to manage the fishery. The Commission stated that the long-term solution is for the North Pacific Fishery Management Council to reduce the number of participants in the fishery. Short-term solutions were discussed, but not adopted because of a lack of support by the Conference Board.

The letter explained the Commission's decision to: (1) provide funding for monitoring the recreational fishery in Area 2A, and (2) keep Bristol Bay closed to halibut fishing to protect juvenile halibut. Further, the Commission expressed concern for halibut bycatches in the developing domestic trawl and longline fisheries off Alaska and urged the governments to establish limits on bycatch mortality.

Finally, the Commission expressed its gratitude to the Canadian Department of Fisheries and Oceans, the U.S. National Marine Fisheries Service, the U.S. fishery management councils, and various state and provincial agencies for their help in Commission deliberations.

Regulatory Proposals for 1988

The Commission received regulatory proposals for the 1988 halibut fishery from fishermen, vessel owners, processors, government agencies, and the Commission's scientific staff. A summary of all proposals and their sources was distributed to all interested groups prior to the annual meeting.

The Commission's staff recommended a total catch limit for the commercial fishery of 65.73 to 77.63 million pounds for 1988, compared to the 1987 total catch limit of 68.8 million pounds. The staff recommendations by regulatory area were as follows: Area 2A — 0.43 million pounds, Area 2B — 10.3 to 12.2 million pounds, Area 2C — 10.0 to 11.8 million pounds, Area 3A — 32.9 to 39.0 million pounds, Area 3B — 7.4 to 8.7 million pounds, Area 4A — 1.7 to 2.0 million pounds, Area 4B — 1.7 to 2.0 million pounds, Area 4C — 0.6 to 0.7 million pounds, Area 4D — 0.6 to 0.7 million pounds, Area 4E — 0.1 million pounds. The staff recommendation in Area 2A was compatible with the allocation decisions of the Pacific Fishery Management Council and was based on keeping total removals from Area 2A below 0.75 million pounds (0.33 million pounds for non-Indian commercial fishermen, 0.1 million pounds for treaty Indian commercial fishermen, 0.05 million pounds for a reserve for treaty Indian commercial fishermen, and 0.27 million pounds for recreational fishermen). The staff also proposed trip limits for all areas of Alaska which open simultaneously to partially alleviate management and conservation problems associated with short openings. To avoid unfairly penalizing large vessels with greater fishing power and overhead, the staff recommended that trip limits vary with vessel size. The staff also proposed trip limits for Areas 4C and 4E that were compatible with allocation decisions by the North Pacific Fishery Management Council.

Further, the staff recommended a series of fishing periods that were chosen to provide landings over an extended period while avoiding fishing on large tides, landings on weekends and holidays, and conflicts with other fisheries. The staff also suggested taking a larger proportion of the catch in the late summer or fall in Areas 2B and 2C than in recent years. The staff asked that the Commission review last year's decision to prohibit "hook strippers" because anecdotal information suggested that this regulation is difficult to enforce and that mortality of juvenile halibut may be just as high on vessels not using hook strippers.

The Conference Board, made up of representatives of fishermen's and vessel owner's organizations, met during the first two days of the annual meeting. The Board proposed that all areas remain the same as in 1987 and proposed the following catch limits for 1988: Area 2A — 0.75 million pounds for all fisheries (i.e. recreational, commercial, and treaty Indian); Area 2B — 14.0 million pounds; Area 2C — 11.5 million pounds; Area 3A — 36 million pounds; Area 3B — 9.5 million pounds; Area 4A — 1.7 to 2.0 million pounds; Area 4B — 2 million pounds; Area 4C — 0.8 to 0.9 million pounds; Area 4D — 0.7 million pounds; and Area 4E — 0.1 million pounds.

The Board recommended 5-day fishing periods in Area 2A for commercial fishing beginning on June 26, July 25, and August 31, and supported the recreational seasons proposed by the Pacific Fishery Management Council. For Area 2B, the Board proposed a 9-day period ending on May 14, followed by fishing periods ending on June 12 and August 25. The Board further asked that 4.5 million pounds of the catch limit be available for the August period and that the June period be allowed only if enough catch limit remained to accommodate the August period. One-day fishing periods were proposed for Areas 2C, 3A, and 3B on May 23, June 20, September 7, October 3, and October 17. The Board also suggested that the June period be cancelled if insufficient catch limit remained for the September and October periods. The Conference Board further recommended a 2-day fishing period beginning August 5 for Area 4A, a 4-day period beginning August 4 for Area 4B, and a 7-day period beginning August 2 for Area 4D. Six additional 1-day openings were recommended for Area 4B, along with a 3,000 pound trip limit on June 18, June 28, July 7, July 12, July 18, and July 23. The Board supported the fishing periods and trip limits proposed by the North Pacific Fishery Management Council for Areas 4C and 4E.

The Conference Board also recommended the following: (1) that the prohibition of hook-strippers be continued, (2) penalties for fishing violations should be made more severe, (3) that vessels fishing during periods when trip limits are in place should not be allowed to tender fish for other vessels, (4) clearance procedures for the Bering Sea should be maintained, (5) that hold inspections be required on most vessels, (6) that trip limits not be used unless needed to avoid exceeding the catch limit, i.e. "clean-up openings", (7) that the possession limit in the recreational fishery in Alaska be increased to include a 2-day bag limit.

After discussing all proposals with the staff and other advisors, the Commission adopted the regulations which were recommended to the Canadian and United States governments. The regulations were approved by the United States Secretary of State and the Governor General of Canada by Order in Council, and are summarized below and in later sections of this annual report.

Summary of Major Regulatory Decisions

(1) Recommended catch limits for the 1988 commercial fishery totaling 73.88 million pounds.

(2) Proposed fishing periods for the commercial fishery.

(3) Adopted allocation regulations for Area 2A that divided the catch among commercial, treaty Indian, and recreational fishery. These regulations were developed and approved by the Pacific Fishery Management Council.

(4) Adopted allocation regulations for Areas 4C and 4E that included fishing periods and trip limits. These regulations were developed and approved by the North Pacific Fishery Management Council.

(5) Adopted a regulation allowing for in-season changes in regulations.

(6) Approved a procedure for setting fishing period limits (i.e. trip limits) by vessel size class to be used for "clean-up" fishing periods. The procedure was developed by the Halibut Conference Board.

(7) Approved regulations for the recreational fishery including an increase in the possession limit in Alaska to two daily bag limit.

INTERIM MEETING

The Commission met on November 22, 1988, in Seattle, Washington with Mr. Dennis Brock presiding as chairman. Mr. James Brooks of Juneau, Alaska, replaced Mr. Robert McVey as a United States commissioner. The staff reviewed the 1988 fishery and management actions taken during 1988. One significant action taken in 1988 was delaying the commercial fishing period in Area 2A from June 26-July 1 to July 25-30. This action was requested by commercial fishing groups to help spread fresh fish landings throughout the season.

The Commission reviewed management actions and research programs for 1989. Particular attention was given to developing ways of reducing bycatch in the Alaska groundfish fisheries and long-term solutions to management problems in the halibut fishery. The Commission agreed to meet with the North Pacific Fishery Management Council in January, 1989 to discuss issues of mutual concern.

OTHER ACTIVITIES

A list of reports published by the Commission staff during 1988 is appended to this annual report. The staff also prepared various documents at the request of the governments. The staff assisted in the development of fishery management plans for the United States fishery management councils.

Expenditures during the 1987-1988 fiscal year (April 1987 through March 1988) were $1,607,944. The Commission expenses were shared equally by both Canada and the United States as required by the Halibut Convention.

RETIRED COMMISSIONERS

Robert W. McVey
United States Commissioner
1983-1988

Robert W. McVey was appointed to the Commission by the United States in 1983. During his tenure as commissioner he was Director of the Alaska Region of the National Marine Fisheries Service. He also served concurrently on the North Pacific Fishery Management Council, the American Land Use Council, as a commissioner on the International North Pacific Fisheries Commission, and as a member of the Northern Panel of the Pacific Salmon Commission. He retired from government service on May 3, 1988.

DIRECTOR'S REPORT

The year 1988 celebrates the 100th anniversary of the Pacific halibut fishery. I would like to take this opportunity to reflect on the historical highlights of the halibut stocks and the men who harvest them.

The first fishing for Pacific halibut took place along the Pacific Coast by North American Indian tribes. The archeological evidence indicates that Indians have been fishing for halibut for several thousand years.

The beginning of the present commercial fishery is considered September 20, 1888 with the landing of 50,000 pounds from Cape Flattery by the sailing ship *Oscar and Hattie*. A train carload from that trip was sent to the east coast from Tacoma on the Northern Pacific Railroad. The halibut were caught by 5 or 6 dories fishing from the mother ship. Each dory typically fished two skates per day. The next major step in the development of the fishery was a conversion to company owned steamships. These ships were larger and carried 8 to 14 dories, and fished into the 1920s. Beginning around 1910 new, smaller vessels of the schooner class with internal combustion engines began to enter the fishery. Typical of these vessels were the *Tordenskjold*, the *Vansee*, and the *Polaris*, all of which are still fishing halibut today. A gradual conversion to longline fishing by these vessels replaced the dangerous dory fishing. In 1920, 60 percent of the fleet fished with dories and by 1930 99 percent of the fleet was longlining. Dory fishing was prohibited everywhere by 1944.

Donald A. McCaughran
Director

The early catches were excellent as the ships moved north to Alaska and continually fished new grounds. The total catch was 70 million pounds by 1915 but dropped to between 40 and 50 million pounds by 1920. The early large removals from a virgin stock soon made fishing more difficult and catches declined. This stimulated fishermen to call for a government investigation into the biological condition of the stocks. The governments responded positively and because the fishery was made up of both U.S. and Canadian vessels a treaty was agreed to and the International Fisheries Commission was founded in 1923.

Under more restrictive management by the new international commission, the stocks began a steady increase until the late 1950s. The highest domestic (commercial) harvest was 75 million pounds in 1962.

The foreign trawl fleets began fishing for groundfish in the early 1960s in the Bering Sea and the Gulf of Alaska. The halibut bycatch in the foreign fisheries was underestimated and the Commission could not properly account for the removal in its management of domestic commercial catches. The stocks declined to the lowest recorded levels by the mid-1970s. The halibut fleet size at this time was well balanced with the stock size and fishing took place over a six month period.

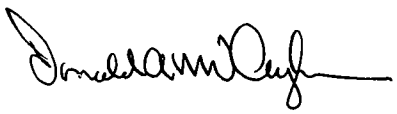
A major change in the fishery took place in the late 1970s with the formation of the national 200-mile zones by the U.S. and Canada. Nationals of both countries were restricted to fishing their own zones and a greater level of control was enacted over foreign fleets. Considerable dislocation of the Canadian fleet occurred and Canada took steps to reduce its fleet size in 1979 and to place the halibut fleet under limited entry.

The U.S. government placed bycatch controls on the foreign fleet and instituted an observer program. More accurate estimates of bycatch and the consequent reduction in bycatch allowed the Commission to rebuild the stocks to their present high levels.

With the removal of Canadian fishing vessels from the U.S. zone, an increase in the U.S. fleet size occurred to fill a perceived gap in fishing effort. At the same time halibut stocks began to improve and the increased catches attracted many new vessels to the fishery. The result was a dramatic increase in the U.S. fleet. Requests for limited entry were discussed in the early 1980s by the North Pacific Fishery Management Council which recommended a moratorium on halibut licenses in 1983. However, the moratoriumwas unacceptable to the U.S. Office of Management and Budget, and in the interim a large number of new vessels entered the fishery, anticipating a time when limited entry permits would have some value. In addition, new electronic technology and circle hooks greatly increased the fishing power of the fleet. The result is a fleet far too large for the allowable catch, fishing time has been reduced from many months to a few 24-hour openings, although the stock is almost at record high levels and catches over 60 million pounds occur annually. In fact, the Centennial catch of halibut was probably the highest ever if the bycatch removals, sport harvest, and waste from all sources are added to the 74 million pound commercial catch.

A U.S. domestic trawl fleet has recently replaced the foreign fleet fishing in the U.S. zone and its halibut bycatch rate is higher than that of the foreign fleets. A desirable goal would be to bring the bycatch of the domestic groundfish fleet down to the same levels that the foreign fleets were able to achieve. It is clear from the experience gained with the foreign fleets that the total groundfish allocations can be taken with tolerable effects to halibut stocks. It remains to be seen if the will exists in the U.S. management authority to provide the necessary incentives to do so.

Pacific halibut stocks have withstood many insults and rebounded when removals were below annual surplus production and positive environmental conditions prevailed. Whether or not the fishery continues for another one hundred years will depend on whether halibut conservation is given a high priority in the fisheries regime of both countries. Certainly halibut will respond if given the opportunity.



Donald A. McCaughran
Director

THE 1988 FISHERY AND THE CENTENNIAL

The year 1988 is being heralded as the centennial year of the halibut fishery. The fishery has undergone many changes since September, 1888, when the sailing vessel *Oscar And Hattie* landed 50,000 pounds of halibut in Tacoma, Washington. Gone are the days of dory fishing and long fishing seasons. Circle hooks and modern "high-tech" navigational equipment have made the fishery more efficient, but also contributed to problems of too many vessels and wasteful fishing practices. To help celebrate the centennial year of the fishing, the pictorial section of this report is dedicated to the fishing industry and the many changes that have occurred over the last 100 years.

It is only fitting that 1988 was a year of near record landings: 74.3 million pounds were landed by the commercial fishery, surpassed only by the 74.8 million pounds landed in 1962. The recreational fishery landed an additional 4.0 million pounds in 1988. If it were not for losses due to bycatch in other fisheries (11 million pounds) and waste due to lost gear and juvenile mortality in the halibut fishery (2 million pounds), the total harvest in 1988 would have almost 100 million pounds. This high production is due to both the scientific management of the resource as well as good environmental conditions.

Stock assessment studies indicate that stock biomass increased during the 1970s and peaked in 1986. Although stocks are still healthy, a decline in biomass appears to have begun and will probably continue if cyclic environmental conditions are less favorable. Another cloud on the horizon is the increasing bycatch in domestic groundfish fishing. Total bycatch mortality has increased sharply since 1986 and may continue to increase as the domestic groundfish fishery continues to expand.

Studying the effect of bycatch on the halibut fishery and methods of controlling bycatch were important research topics during 1988. A study which focused on bycatches in the Bering Sea yellowfin sole joint venture fishery (see Economics of Halibut Bycatch Regulations, page 42) indicated that high halibut bycatches occur in a relatively small part of this fishery, suggesting groundfish can be successfully harvested with only a minor effect on halibut.

Another special research project (see Continuous Fishing and Tagging Study in British Columbia, page 38) was designed to study the distribution and catch per unit effort of halibut in British Columbia (Area 2B). Area 2B is of special concern because our stock assessment investigations indicate that stocks are below optimal levels and that exploitation rates are higher in Area 2B than in other areas of the coast. The study involved intensive fishing on a small ground in northern Area 2B and tagging over 2,600 fish.

A final highlight in 1988 was the use of fishing period limits by vessel length group to achieve the catch limit during the final fishing period in Areas 2C and 3. Increased fleet size along with more efficient gear and an abundant resource has resulted in daily catch rates that are so high that the Commission would not have been able to allow another opening without exceeding the catch limit if fishing period limits were not in place. The Halibut Conference Board (an industry advisory group) worked with the Commission staff to develop a plan in which the period limit increased with vessel size. The vessel limits resulted in closely achieving the catch limit. Some enforcement problems were encountered, but overall, the new system seemed to work relatively well.

THE FISHERY

The Pacific halibut resource is harvested by commercial and sport fisheries and is also taken incidentally in fisheries targeting on other species. The following sections present the results of the 1988 commercial and recreational fisheries. In addition, information of the incidental catch of halibut during 1979-1988 is provided.

COMMERCIAL FISHERY

Regulatory Areas for 1988

Regulatory areas for the 1988 commercial halibut fishery are shown in Figure 1. Boundary lines for the regulatory areas are the same as in 1987. The southeastern flats in Bering Sea remained closed in 1988 to all halibut fishing. A brief description of the regulatory areas for the 1988 halibut fishery is as follows:

Area 2A — all waters off the coast of California, Oregon, and Washington.
Area 2B — all waters off the coast of British Columbia.
Area 2C — all waters off the coast of Alaska, south and east of Cape Spencer.
Area 3A — all waters between Cape Spencer and Cape Trinity, Kodiak Island.
Area 3B — all waters between Cape Trinity and a line extending southeast from Cape Lutke, Unimak Island.

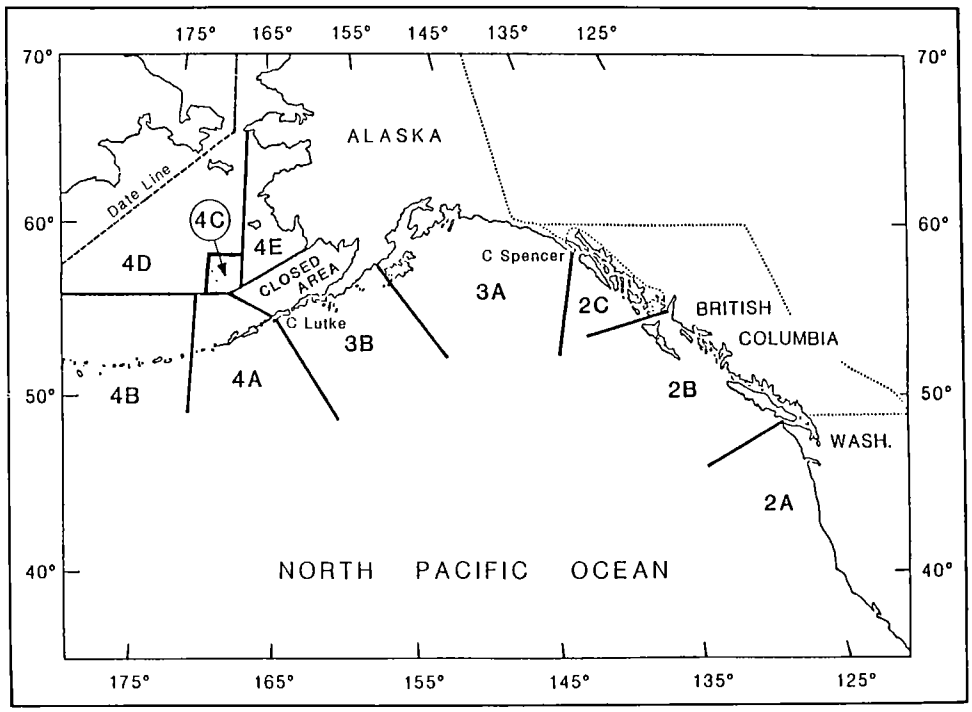


FIGURE 1.
Regulatory areas for the 1988 Pacific halibut fishery.

Area 4A — all waters west of Area 3B and of the Bering Sea closed area, south of 56°20′ N. and east of 172°00′ W.
Area 4B — all waters west of Area 4A and south of 56°20′ N.
Area 4C — all waters in the Bering Sea north of Area 4A and northwest of a line running from Cape Newenham to a point at latitude 56°20′ N., longitude 168°30′ W., which are east of longitude 171°00′ W., south of latitude 58°00′ N., and west of longitude 168°00′ W.
Area 4D — all waters in the Bering Sea north of Areas 4A, 4B, and 4C, and west of longitude 168°00′W.
Area 4E — all waters in the Bering Sea north of the closed area, east of Areas 4C and 4D, and south of 65°34′ N.

Other Regulations in 1988

The Commission adopted a policy of flexibility in establishing and modifying regulations within season and specifically indicated that the June fishing period in Areas 2B, 2C, 3A, 3B, 4A, and 4B would be eliminated, if need be, to ensure fishing in August or September.

The Commission adopted a catch sharing plan developed for Area 2A by the Pacific Fishery Management Council (PFMC). Area 2A was managed to provide a maximum total allowable catch for all user groups of 750,000 pounds. It was projected that the treaty Indian commercial fishery would catch 150,000 pounds, the non-Indian commercial fishery 330,000 pounds and the sport fishery 270,000 pounds.

The Commission established fishing period limits in Areas 4C and 4E where allocation regulations were recommended by the North Pacific Fishery Management Council (NPFMC). Area 4C had a fishing period limit for all vessels of 10,000 pounds until 50 percent of the catch limit was taken, after which the fishing period limit was increased to 20,000 pounds. A fishing period limit of 6,000 pounds was in effect for fishing in Area 4E throughout the season. Fishing period limits were also established in-season for the September 7 opening in Area 2C and for the October 3 opening in Areas 2C, 3A, 3B, 4A, and 4B as a means of attaining, but not exceeding the catch limits in each of the respective areas. During any season when fishing period limits were imposed, boats that fished were not allowed to serve as a tender prior to offloading and selling their own catch. Other regulations remained the same as in 1987.

Catch Limits, Commercial Catches, and Seasons

The commercial catch by regulatory area for 1984 through 1988 is shown in Table 1. The catches for all years are shown by 1988 regulatory area, enabling a comparison of the same geographic regions over time. A more detailed summary of the 1988 seasons and catches for each regulatory area is provided in Table 2.

Fishing seasons in all areas consisted of a series of fishing periods, each of specific length. When further fishing would surpass the catch limit for an area, it was closed to commercial halibut fishing and subsequent fishing periods were cancelled. Fishing periods in all regulatory areas began and ended at 1200 hours local time.

TABLE 1.
Commercial catch of Pacific halibut by regulatory area* (in thousands of pounds), 1984-1988.

Regulatory Area	1984	1985	1986	1987	1988
2A	431	493	581	592	486
2B	9,054	10,389	11,225	12,246	12,858
2C	5,847	9,207	10,611	10,685	11,369
3A	19,971	20,852	32,790	31,316	37,862
3B	6,503	10,888	8,831	7,758	7,082
4A	1,053	1,711	3,381	3,713	1,930
4B	1,104	1,236	261	1,501	1,593
4C	580	620	686	878	707
4D	392	681	1,223	703	453
4E	35	36	43	90	9
Total	44,970	56,113	69,632	69,482	74,349

The total 1988 commercial catch was 74.35 million pounds, just slightly over the 73.88 million pound catch limit and 4.9 million pounds more than was taken in 1987. The fishery was characterized by a continued increase in the number of vessels fishing in all areas and continued short seasons. Only the imposition of fishing period limits and marginal weather conditions experienced during some fishing periods enabled the Commission to allow as many fishing days as it did.

Area 2A had a commercial catch limit of 480,000 pounds, 150,000 pounds of which were allocated to 12 northwest Washington Indian treaty tribes under the PFMC catch sharing plan. The actual catch for the area was 486,000 pounds, 6,000 pounds more than the catch limit. The non-Indian commercial catch was 392,000 pounds taken during a five-day fishing period, compared to 548,000 pounds taken during a 12-day fishing period in 1987. The number of vessels reporting landings decreased from 322 in 1987 to 220 in 1988, a 32 percent decline. Twelve treaty tribes caught 94,000 pounds during a 245-day season in 1988, whereas eleven treaty tribes caught 44,000 pounds during a 214-day season the previous year. The treaty Indian fishery was closed to commercial fishing on October 31.

In Area 2B, the catch was 12.86 million pounds, 0.36 million pounds greater than the catch limit. The catch was taken during two fishing periods totalling 14 days, with the best catch rate occurring during August. A scheduled June fishing period was eliminated in accordance with Conference Board

TABLE 2.
Summary of the 1988 commercial fishery catch of Pacific halibut in each regulatory area by fishing period.

Area	Catch Limit (millions lbs.)	Opening Date		Closing Date		Fishing Days	Catch (000's lbs)
2A	0.33	July	25	July	30	5	392
*	0.15	Mar.	1	Oct.	31	245	94
						250	486
		May	6	May	14	8	6,930
2B	12.5	Aug.	19	Aug.	25	6	5,928
						14	12,858
		May	23	May	24	1	4,582
		June	20	June	21	1	5,191
2C	11.5	Sept.	7	Sept.	8	1	964
		Oct.	3	Oct.	4	1	632
						4	11,369
		May	23	May	24	1	13,660
		June	20	June	21	1	9,306
3A	36.0	Sept.	7	Sept.	8	1	9,633
		Oct.	3	Oct.	4	1	5,263
						4	37,862
		May	23	May	24	1	1,710
		June	20	June	21	1	2,041
3B	8.0	Sept.	7	Sept.	8	1	2,302
		Oct.	3	Oct.	4	1	1,029
						4	7,082
		May	23	May	24	1	11
		June	20	June	21	1	59
		Aug.	5	Aug.	6	1	986
4A	1.9	Sept.	7	Sept.	8	1	124
		Sept.	16	Sept.	17	1	724
		Oct.	3	Oct.	4	1	26
						6	1,930
		May	23	May	24	1	<1
		June	20	June	21	1	10
		Aug.	4	Aug.	7	3	460
4B	2.0	Sept.	7	Sept.	8	1	4
		Sept.	16	Sept.	25	9	1,119
		Oct.	3	Oct.	4	1	0
						16	1,593
4C	0.7	June	20	July	23	17[1]	707
		Aug.	2	Aug.	9	7	402
4D	0.7	Sept.	16	Sept.	21	5	51
						12	453
4E	0.1	June	1	Oct.	31	102[2]	9
Total	**73.88**						**74,349**

*Treaty Indian fishery.
[1]17 1-day fishing periods.
[2]51 2-day fishing periods.

guidelines when it became apparent that not enough of the catch limit remained following the May opening to provide both a June and an August fishery. During 1987, 12.2 million pounds were taken during three fishing periods totaling 16 days. The number of vessels reporting landings increased from 436 in 1987, to 446 in 1988.

The catch in 1988 in Area 2C was 11.4 million pounds. The first and second fishing periods of one day each produced 4.6 and 5.2 million pounds, respectively. This left the season's total catch 1.7 million pounds below the 11.5 million pound catch limit. As this amount was judged too small for even a half-day fishing period, the Commission implemented fishing period limits based on overall vessel length during the September opening to avoid exceeding the catch limit. The fishing period limits by vessel class for the Area 2C opening are shown in Table 3. The limits reflect the average catches observed during the May, 1988 opening in Area 2C, adjusted by the anticipated fleet size to obtain the 1.7 million pounds remaining in the Area 2C catch limit. The fishing period limit is applied to the vessel, not the individual fisherman. Multiple deliveries were permitted as long as the cumulative poundage delivered did not exceed the fishing period limit. Any landings over the vessel limit were subject to forfeiture and possible fines, depending upon the extent of the overage.

TABLE 3.
Fishing period limits imposed by IPHC in 1988 during the September and October fishing periods in Area 2C and the October fishing periods in Areas 3A, 3B, 4A, and 4B.

Overall Vessel Length	Vessel Class	Area 2C	Areas 3A, 3B 4A, and 4B
less than 25 ft.	A	800 lbs.	1,600 lbs.
26 to 30 ft.	B	1,100 lbs.	2,900 lbs.
31 to 35 ft.	C	2,000 lbs.	5,500 lbs.
36 to 40 ft.	D	2,700 lbs.	8,400 lbs.
41 to 45 ft.	E	4,000 lbs.	11,100 lbs.
46 to 50 ft.	F	5,800 lbs.	23,600 lbs.
51 to 55 ft.	G	6,000 lbs.	26,900 lbs.
56 + ft.	H	6,600 lbs.	40,000 lbs.

Severe weather prevailed during the September 7 fishing period and slightly less than 1.0 million pounds were caught, leaving 700,000 pounds remaining of the catch limit. The Commission allowed another 24-hour fishing period commencing on October 3 with the same fishing period limits as in September. An additional 600,000 pounds were caught. Again, severe weather held down the catch. Area 2C was then closed to commercial fishing for the remainder of the year, 41,000 pounds short of the catch limit. The number of vessels reporting landings from Area 2C increased nearly 12 percent from the previous year.

Catch limits in Areas 3A and 3B were 36.0 and 8.0 million pounds respectively, with the stipulation that both areas would close if the combined catch limit of 44.0 million pounds was attained. The total catch in 1988 was 37.9 million pounds in Area 3A and 7.1 million pounds in Area 3B. At the end of three one-day fishing periods in May, June, and September the Area 3A and 3B catches totalled 32.6 and 6.1 million pounds, respectively, leaving 3.4 and 1.9 million pounds of the two catch limits remaining. With the extremely high daily catch rates observed, the Commission felt it could not allow a full day's fishery because of the high probability of substantially exceeding both the separate and combined catch limits for the two areas. In order to allow the halibut fleet the opportunity to reach but not exceed the 5.3 million pounds remaining of the Area 3 catch limit, fishing period limits were placed on all vessels during the October 3 opening. The fishing period limits for Areas 3A and 3B are given by vessel classes in Table 3. These values reflect Conference Board recommendations, adjusted by the anticipated fleet size, to obtain the 5.3 million pounds remaining in the combined catch limit.

The catch for the October openings were 5.3 and 1.0 million pounds for Area 3A and 3B respectively. Following the October opening, both areas were closed to commercial fishing for the remainder of the year. The final Area 3A catch was 1.9 million pounds over the catch limit, whereas the Area 3B catch was 1.0 million pounds below the catch limit. The number of vessels reporting catches from Areas 3A increased 6 percent in 1988 and declined over 52 percent in Area 3B.

The catch limit in Area 4A was 1.9 million pounds. Two one-day fishing periods in May and June produced only 70,000 pounds because most vessels fished in open areas to the east. Conversely, catches during one-day fishing periods on August 5 and September 16 were 1.0 and 0.7 million pounds respectively. The September 7 and October 3 openings produced only 124,000 and 26,000 pounds respectively, again because most of the vessels preferred to fish in Areas 3A, or 3B which were opened simultaneously. The final Area 4A catch was 30,000 pounds over catch limit. The number of vessels reporting catch from Area 4A decreased by 33 percent from 1987.

Area 4B had a catch limit of 2.0 million pounds. Only 11,000 pounds were caught by local fishermen in two one-day fishing periods in May and June. The August 4 and September 16 openings produced 0.4 and 1.1 million pounds respectively, whereas the September 7 and October 3 openings totaled only 3,000 pounds. The total catch amounted to just under 1.6 million pounds, about 0.4 million pounds under the catch limit for this area. The number of vessels reporting catches from Area 4B was the same as in 1987.

In Area 4C, the total catch was 0.7 million pounds, the same as the catch limit and was taken during 17 one-day fishing periods. All vessels were limited to a maximum catch of 10,000 pounds per fishing period until 50 percent (350,000 pounds) of the catch limit had been taken, and a maximum catch of 20,000 pounds of halibut per fishing period for the remaining 50 percent of the catch limit. The 10,000 pound catch restriction extended through the first eleven fishing periods and the last six fishing periods were under the 20,000 pound restriction. A total of 492,000 pounds were caught by resident fishermen compared to 263,000 pounds in 1987. Seven non-resident vessels caught 215,000 pounds in 1988, compared to 615,000 pounds caught by 20 non-residents vessels last year.

The catch limit in Area 4D was 0.7 million pounds. Twelve vessels caught 0.4 million pounds during a seven-day fishing period in August and an additional 51,000 pounds were caught by two vessels during a five-day fishery in September. In contrast, twelve vessels caught 0.7 million pounds during a single seven-day fishing period in 1987.

Area 4E had a total catch limit of 0.1 million pounds and 51 two-day fishing periods. A total catch of only 9,000 pounds was caught; 4,000 pounds by one vessel from outside of the area and 5,000 by the residents of Nelson and Nunivak Islands. The low catch taken by resident fishermen was the result of marketing difficulties. In 1987, a total catch of 90,000 pounds was taken during 15 two-day fishing periods. Area 4E was closed October 31 to commercial halibut fishing for the remainder of 1988.

Number of Vessels

In 1988, 435 Canadian vessels were eligible under the Canadian limited entry system to fish for halibut. IPHC licenses were issued to 420 of these vessels, an increase of about four percent from the 403 licenses issued in 1987.

In the United States, which does not restrict the number of vessels that may participate in the halibut fishery, 6,459 commercial license applications were processed. This represents a nine percent increase in the number of IPHC commercial licenses issued over 1987. In 1988, 3,988 vessels reported halibut landings; the remaining 2,471 vessels that were issued a commercial license did not fish. The 1988 U.S. fleet which reported halibut landings was 2.5 percent larger in number than in 1987.

A summary of the number of vessels which fished each regulatory area in 1988 and the catch by vessel length class is shown in Table 4.

Landings by Port

Landings in British Columbia totalled 11.1 million pounds, an increase of 244,000 pounds over 1987. Forty-one percent of this total, 4.5 million pounds, was landed in the greater Vancouver area, and 4.1 million pounds (37 percent) was landed in Prince Rupert. This represents a decrease of 0.5 million pounds in Vancouver and an increase of 0.4 million pounds in Prince Rupert over 1987.

Nearly 14 percent of the Canadian halibut catch (1.8 million pounds) was delivered directly to United States ports, a decrease of 0.2 million pounds from 1987. United States landings in Canada, mainly in Prince Rupert, amounted to 77,000 pounds in 1988, compared to 565,000 pounds in 1987.

United States landings in Washington, Oregon, and California declined 30 percent, from just over 5.7 million pounds in 1987 to 4.0 million pounds in 1988. In contrast, landings in Alaskan ports, at 57.7 million pounds, were 6.7 million pounds greater than the previous year. The leading United States halibut port was Kodiak, with landings of 18.1 million pounds, followed by Homer (8.3 million pounds), Sitka (4.6 million pounds), and Seward (4.5 million pounds). Landings in the same ports in 1987 were 17.0, 7.5, 3.3, and 4.2 million pounds respectively. Table 5 lists the landings at other Canadian and U.S. ports in 1988.

TABLE 4.
Number of vessels and catch of Pacific halibut by vessel length class in the 1988 commercial fishery. Information shown for Area 2A does not include the treaty Indian commercial fishery.

	Area 2A		Area 2B	
Overall Vessel Length	**No. of Vessels**	**Catch (000's lbs.)**	**No. of Vessels**	**Catch (000's lbs.)**
Unk. Length	9	1	47	561
< 26 ft.	56	10	6	55
26 to 30 ft.	16	2	12	147
31 to 35 ft.	25	10	79	1,304
36 to 40 ft.	36	45	126	2,956
41 to 45 ft.	25	59	64	2,154
46 to 50 ft.	19	71	49	2,201
51 to 55 ft.	11	46	18	1,014
56 + ft.	23	148	45	2,466
Total	220	392	446	12,858

	Area 2C		Area 3A	
Overall Vessel Length	**No. of Vessels**	**Catch (000's lbs.)**	**No. of Vessels**	**Catch (000's lbs.)**
Unk. Length	30	71	40	308
< 26 ft.	412	734	343	362
26 to 30 ft.	162	393	169	450
31 to 35 ft.	257	1,225	358	2,991
36 to 40 ft.	356	2,537	371	4,800
41 to 45 ft.	183	2,215	187	2,976
46 to 50 ft.	131	2,013	153	4,162
51 to 55 ft.	57	857	77	2,819
56 + ft.	92	1,324	293	18,994
Total	1,680	11,369	1,991	37,862

	Area 3B		Area 4	
Overall Vessel Length	**No. of Vessels**	**Catch (000's lbs.)**	**No. of Vessels**	**Catch (000's lbs.)**
Unk. Length	6	53	5	17
< 26 ft.	12	20	44	195
26 to 30 ft.	5	13	19	285
31 to 35 ft.	29	127	39	358
36 to 40 ft.	42	313	6	50
41 to 45 ft.	39	479	4	40
46 to 50 ft.	41	560	10	312
51 to 55 ft.	15	385	7	131
56 + ft.	96	5,132	89	3,304
Total	285	7,082	223	4,692

TABLE 5.
Commercial landings of Pacific halibut by port and country (in thousands of pounds), 1988.

Port	Canada	United States	Total
California & Oregon	—	491	491
Seattle	47	1,763	1,810
Bellingham	725	910	1,635
Misc. Washington	996	805	1,801
Vancouver	4,512	—	4,512
Misc. So. B.C.	2,027	—	2,027
Namu	91	—	91
Prince Rupert	4,038	77	4,115
Misc. No. B.C.	393	—	393
Ketchikan	29	781	810
Wrangell	—	795	795
Petersburg	—	2,830	2,830
Juneau	—	762	762
Sitka	—	4,648	4,648
Pelican	—	774	774
Misc. SE Alaska	—	3,380	3,380
Kodiak	—	18,064	18,064
Homer	—	8,339	8,339
Seward	—	4,530	4,530
Misc. Central Alaska	—	12,542	12,542
Total	12,858	61,491	74,349

Waste From Lost or Abandoned Gear

Since 1984, fishermen have attempted to maximize their fishing opportunities by setting more gear during a fishing period than they can retrieve before the period closes. Other fishermen inadvertently lose gear during fishing, either from gear conflicts with other fishermen or due to chafing and snagging with the bottom. The fish which remain on the lost or abandoned gear die, so this wastage must be included in the accounting of total removals from the population.

Commission port samplers have been collecting information on the amount of lost or abandoned gear since 1986. These data have been used to estimate the amount of waste occurring in the fishery. Data are unavailable prior to 1986, but 24-hour fishing periods have taken place since 1984 and waste probably occurred during 1984 and 1985. Waste was estimated for 1985 by reducing the 1986 value by 50 percent and by reducing the 1985 value by 50 percent for 1984.

The information collected during the 1988 fishery indicates that waste declined from 2.7 million pounds in 1987 to 2.0 million pounds in 1988 (Table 6). The decline was observed in all areas, but declined the least in Area 3A. Although the reason for the decline is unknown, one hypothesis is that the weather conditions during the major fishing periods were better. This would

likely result in a lower amount of gear loss, as fishermen would have opportunities to free snagged gear from the bottom or untangle gear in conflict with other fishermen, rather than cutting and discarding the gear.

TABLE 6.
Estimates (thousands of pounds) of the amount of waste occurring in the 1984-1988 commercial fisheries for halibut.

Regulatory Sub-Area	1984	1985	1986	1987	1988
2A	n/a	n/a	n/a	3	<1
2B	n/a	n/a	n/a	173	49
2C	n/a	n/a	n/a	368	206
3A	n/a	n/a	n/a	1,580	1,506
3B	n/a	n/a	n/a	341	122
4	n/a	n/a	n/a	257	69
Total	800	1,600	3,200	2,722	1,952

n/a indicates data not available

Value of the Commercial Catch

The coast-wide ex-vessel price ($U.S.) in 1988 averaged $1.28 per pound, resulting in a total catch value of $94.9 million, the third highest value recorded in the history of the fishery. In comparison, the coast-wide ex-vessel price in 1987 averaged $1.58 per pound for a total catch value of $109.8 million. Ex-vessel value of the commercial fishery since 1929 is shown in Appendix II. A poor market for small sized (10-20 pound) halibut and a corresponding price reduction during the latter half of the 1988 fishing season, contributed to the reduced total coastwide value.

The United States halibut catch of 61.5 million pounds had a landed value of $75.7 million, whereas the Canadian halibut catch of 12.9 million pounds was valued at $18.9 million (U.S.) to fishermen. United States fishermen received a season average price of $1.23 per pound compared to $1.47 for Canadian fishermen. As usual, halibut landed in the southern ports continued to receive higher prices than those landed in Alaskan ports.

SPORT FISHERY

Regulations

Sport fishing regulations changed significantly for most areas in 1988. Recreational fishing regulations are summarized in Table 7. In Area 2A, off the coast of California, Oregon, and Washington, shorter seasons, reduced bag limits, size limits, catch limits, and the creation of sub-areas were all used to reduce

recreational harvest and to allocate a portion of the harvestable biomass among recreational fishermen. The possession limit was increased in Alaskan waters (Areas 2C, 3 and 4) from one to two daily bag limits at the request of charter boat operators operating in remote areas on extended trips. The daily bag limit remained at two fish in all areas except the Puget Sound where only one halibut per day was allowed. In all areas, an IPHC license was required for sport charter boats that intended to pursue halibut. Sport fishing regulations remained unchanged in British Columbia (Area 2B) in 1988.

TABLE 7.
Summary of 1988 recreational fishing seasons and catch limits for Pacific halibut by area.

Regulatory Area	Opening Date		Closing Date		Bag Limit	Possession Limit
Area 2A						
Washington						
Puget Sound	March	1	June	15	1 Fish	1 Fish
	August	1	Sept.	5	1 Fish	1 Fish
North Coast	May	1	June	30	2 Fish	2 Fish
South Coast[1]	April	1	Sept.	30	2 Fish	2 Fish
Oregon-Calif.[2]	April	1	July	6	2 Fish	2 Fish
Area 2B	Feb.	1	Dec.	31	2 Fish	2 Fish
Area 2C	Feb.	1	Dec.	31	2 Fish	4 Fish
Area 3	Feb.	1	Dec.	31	2 Fish	4 Fish
Area 4	Feb.	1	Dec.	31	2 Fish	4 Fish

[1]Effective July 22 the southern boundary was moved south to Cape Falcon, Oregon.
[2]Effective June 16 a minimum size length of 32 inches was implemented by the IPHC at the request of the Oregon Department of Fish and Wildlife in an effort to extend the season.

Catch Estimates

The sport fishery data for halibut are available from state and federal fishery agencies, and are summarized by regulatory area for 1984-1988 (Table 8). After a decade-long series of increases, the recreational catch in numbers of halibut decreased in Alaska in 1987. Nearly 14,000 fewer halibut were harvested in the central Gulf of Alaska (Area 3), with the most notable drop occurring along the Kenai Peninsula. However, an increase in the average weight of halibut caught (from 16.6 pounds in 1986 to 19.9 pounds in 1987) offset the decrease in numbers so that the recreational catch in weight increased in Area 3. Although the harvest increased by 130,000 pounds in Southeastern Alaska (Area 2C) in 1987, it, too, was principally the result of an increase in average weight. Otherwise, the catch in number of fish in Area 2C is showing signs of leveling off. Catches in British Columbia (Area 2B) continue to slowly increase. Catch estimates for Area 2B may be unreliable, however, and are currently under review. Recreational catches increased rapidly in Area 2A, the waters off Washington, Oregon and California, and peaked in 1987. However, in 1988 the

recreational catch in Area 2A decreased by almost 50 percent, partly as a result of a total catch reduction required by the Commission. The 1988 sport quota was the result of an allocation agreement forged by the Pacific Fishery Management Council between commercial and sport fishermen. Catch estimates for the Area 2A sport fishery are shown in Table 9. Catch estimates for 1988 are preliminary for Areas 2B, 2C, 3, and 4 and will be updated as data become available.

TABLE 8.
Catch (thousands of pounds) of Pacific halibut by the sport fishery, 1984-1988.

Area	1984	1985	1986	1987	1988[1]
2A	98	181	264	467	256
2B	124	525	560	805	885
2C	621	682	730	780	830
3A	1,042	1,227	1,924	2,045	2,150
4	—	10	13	15	18
Alaska Total	1,663	1,919	2,667	2,840	2,998
Coast-Wide Total	1,885	2,625	3,491	4,112	4,139

[1]Preliminary estimates.

TABLE 9.
Catch limits and estimates for the 1988 Pacific halibut sport fishery in IPHC Area 2A by subarea.

Sub-Area	Catch Limit	Catch Estimate
Washington		
Puget Sound	207,000[1]	45,000
North Coast		134,000
South Coast	3,000	3,000
Oregon-California	60,000	74,300
Total	270,000	256,300

[1]Combined catch limit for the Puget Sound and North Coast.

Voluntary Logbook Program

There was renewed interest in the Voluntary Sport Charterboat Logbook Program (VSLP) in 1988, after participation declined to less than 30 boats in 1987. Over 100 logbooks were requested by charter operators during the first half of 1988. A few logbooks have been returned already, but more are expected when charter operators renew their IPHC licenses in 1989. The principal reason for the greater interest is likely related to the allocation decisions in Area 2A that affected the division of the harvest between commercial and sport fisheries. The sport fishing community is also taking a more active role in management discussions and was significantly involved in the deliberations of the Conference Board at the 1988 Annual Meeting in Sitka, Alaska.

INCIDENTAL CATCH AND MORTALITY

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 25 million pounds. Incidental mortality declined during the 1960s, but increased to about 20 million pounds in the early 1970s. Incidental mortality dropped to a 13 million pound level during the late 1970s and early 1980s. By 1986, the incidental mortality declined to 7 million pounds, the lowest level in recent history. However, incidental mortality has increased

since 1986, reaching 11.1 million pounds in 1988. Incidental mortality in 1988 was estimated at 1.5 million pounds in Area 2 (Southeast Alaska, British Columbia, and the Pacific coast), 3.4 million pounds in Area 3 (central and western Gulf of Alaska) and 6.2 million pounds in Area 4 (the Bering Sea and Aleutian Islands). Estimates of the incidental mortality for 1979-1988 are shown in Table 10.

TABLE 10.
Estimated incidental mortality of halibut by regulatory area and year for 1979-1988 and calculated loss in adult equivalents. Estimates are in thousands of pounds (net weight) and are preliminary for 1988.

	IPHC Regulatory Area					Coast-wide	Adult
Year	2A	2B	2C	3	4	Total	Equiv.
1979	1	1,852	821	6,715	5,419	14,808	23,397
1980	1	1,372	520	7,098	9,235	18,226	28,797
1981	tr	1,188	507	6,283	6,408	14,386	22,730
1982	tr	867	302	5,972	4,756	11,897	18,797
1983	1	943	304	4,892	4,269	10,409	16,446
1984	tr	1,074	302	3,647	4,692	9,715	15,350
1985	tr	1,139	301	1,578	4,207	7,225	11,416
1986	1	1,161	303	1,246	4,472	7,183	11,349
1987	tr	1,150	303	3,113	5,253	9,819	15,514
1988	1	1,150	303	3,419	6,225	11,098	17,535

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. Figure 2 shows 1980-1988 bycatch mortality in Alaskan waters attributed to foreign, joint venture and fully domestic groundfish fishing, with projected bycatch mortality for 1989.

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 10.

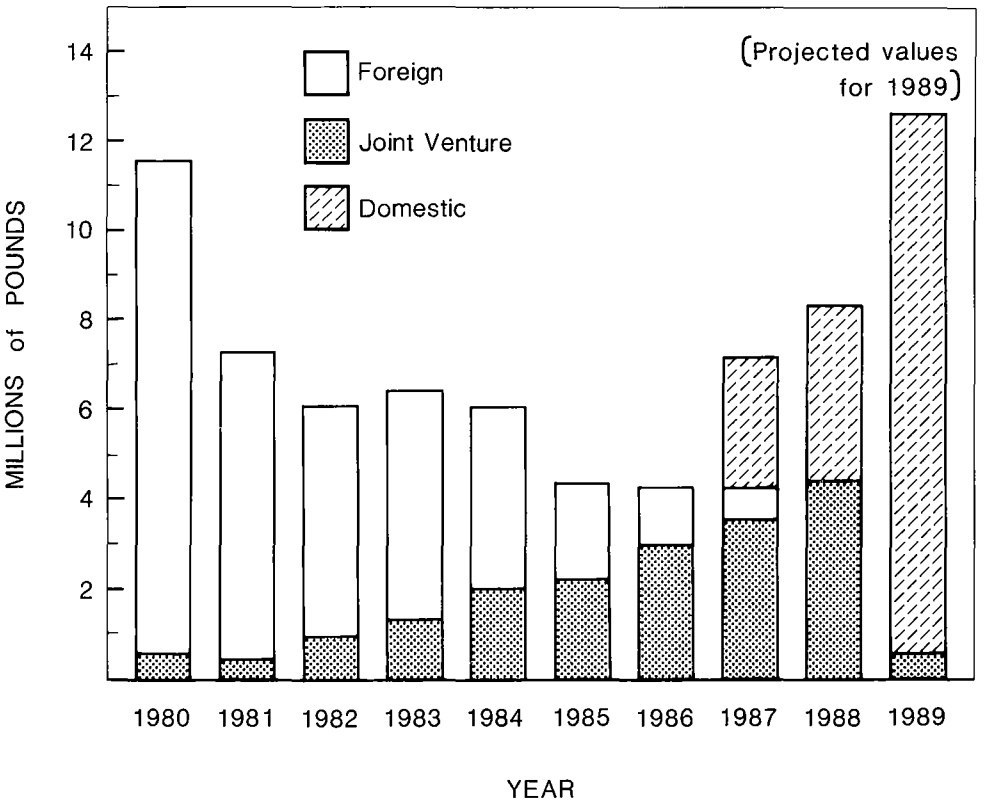


FIGURE 2.
Halibut bycatch mortality in the groundfish fisheries off Alaska, 1980-1989.

Bycatch in U.S. Fully Domestic Fisheries

U.S. domestic fisheries have grown significantly in the past two years, almost completely replacing foreign and joint venture fisheries, and halibut bycatches could potentially be quite large. Observer programs are being conducted on various segments of the domestic fishery, but a comprehensive program for monitoring halibut bycatch is not available. Methods for predicting bycatches in these fisheries have been developed and the resultant estimates have been incorporated into IPHC's assessment procedures.

The NPFMC staff and the Council's Gulf of Alaska Groundfish Plan Team have developed a model which predicts the amount of bycatch taken by fully domestic fisheries in the Gulf of Alaska based on the groundfish catch, bycatch rates observed in recent domestic and joint venture fisheries and assumptions about the proportion of the catch taken the various gear types and likely mortality rates. The model estimates that bycatch mortality was 1.4 million pounds in 1987 and 2.7 million pounds in 1988.

Bycatch mortality in the Bering Sea and Aleutians can be estimated in much the same way. If it is assumed that bycatch rates observed in joint venture fisheries are representative of the domestic fishery, and that mortality on trawl operations is 100 percent and 25 percent in longline fisheries, total mortality can be estimated using a model similar to that developed for the Gulf of Alaska. Such a model developed by the IPHC staff estimates bycatch mortality to have been 1.6 million pounds in 1987 and 1988.

The assumption that the fully domestic fishery has the same bycatch rates as the joint venture fishery has been the subject of much debate. The amount of information currently available for estimating halibut bycatch in the domestic fishery is believed to be insufficient. Research in 1989 will examine the use of observations from the fully domestic fishery for estimating halibut bycatch.

Summary of North Pacific Fishery Management Council Actions in 1988

Gulf of Alaska. The groundfish Fishery Management Plan for the Gulf of Alaska requires that the NPFMC annually set a bycatch mortality limit for halibut. The Council set the 1989 mortality limit at 3.3 million pounds, dressed weight (2,000 mt round weight). NMFS will be monitoring the 1989 Gulf groundfish fishery as it progresses, and has been directed by the NPFMC to close the fishery if the 3.3 million pound bycatch limit will be exceeded.

The current bycatch management plan for the Gulf of Alaska includes only halibut. The Council-established Bycatch Committee was directed to develop recommendations by December, 1988 for a comprehensive bycatch management plan that includes king (*Paralithodes camtschatica*) and Tanner crab (*Chionoecetes bairdi*) and also reviews halibut. The Committee recommended separate halibut bycatch mortality limits for trawl and longline groundfish fisheries of 3.3 million pounds, dressed weight (2,000 mt round weight), and 1.2 million pounds, dressed weight (750 mt round weight), respectively. The NPFMC is expected to establish its bycatch management plan for the Gulf during 1989.

One option in the recommendation would include allowing some retention of halibut bycatch in other longline groundfish fisheries, such as those for sablefish and Pacific cod. The retained halibut would be subtracted from the directed halibut longline fishery. Another option would use established bycatch and mortality rates to estimate when 80 percent of the bycatch mortality limit was reached and require observers on board fishing vessels during the remaining 20 percent of the mortality limit.

Bering Sea. The Council's Bycatch Committee worked in 1987 to recommend a comprehensive bycatch management plan for halibut and king and Tanner crab in the Bering Sea/Aleutian Islands groundfish fisheries. Industry opposition to bycatch allocation and NMFS objection to implementation requirements caused the Council to reject the Committee's proposal. However, the Council adopted an interim plan for 1989 and possibly 1990. NMFS was directed by the Council to prepare a long term plan for the June or September, 1989 Council meeting.

The interim plan divided the Bering Sea into two parts (see Figure 3) for the purpose of bycatch management. Portions of the eastern Bering Sea, made up of Zones 1 and 2H, will close to trawling when halibut bycatch reaches 6.63 million pounds, dressed weight (4,400 mt round weight). The remainder of the Bering Sea would close at a total bycatch of 8.84 million pounds, dressed weight (5,333 mt round weight). The NPFMC used target bycatch mortality limits of 5.5 million pounds, dressed weight (3,300 mt round weight) for Zones 1 and 2H, and 6.6 million pounds, dressed weight (4,000 mt round weight) for the total Bering Sea. Attaining these mortality limits would require a halibut discard mortality of 75 percent. The Council's Scientific and Statistical Committee (SSC) provided advice that the discard mortality rate would probably be near 100 percent, based on limited data that did not represent all classes of vessels. If so, 1989 bycatch mortality will be approximately 8.3 million pounds, dressed weight (5,000 mt round weight) and mortality and yield loss will be substantially greater than has occurred in recent years.

The Council submitted the interim plan to the U.S. Secretary of Commerce as an amendment to the Bering Sea/Aleutian Island Groundfish Fishery Management Plan. Approval and implementation of the amendment is expected about June, 1989. NMFS will begin accounting for bycatch in the Bering Sea when the amendment goes into effect. A Group of Experts, which includes an IPHC staff member, will provide advice to NMFS on halibut bycatch rates appropriate for the fully domestic groundfish fishery.

U.S. HALIBUT ALLOCATION BY REGIONAL COUNCILS

The commercial fishery has consistently dominated removals from the resource and the Commission has provided management of the fishery since soon after its inception. The U.S. regional fishery management councils recently became involved with halibut management with the advent of the Magnuson Fishery Conservation and Management Act of 1976 and the attempted control of halibut bycatch, first by foreign fleets and later by domestic fisheries. During the 1980s, fisheries by sport fishermen and treaty Indians increased off the coasts of Washington and Oregon, and fisheries by residents of the Pribilof Islands and the Nelson Islands in the Bering Sea were encouraged by the U.S. government. The Commission responded by assuming limited allocative responsibility, but made decisions that had allocative implications only after consultation with the U.S. government.

Opposition to 1987 Commission regulations with an allocative nature occurred after the 1987 IPHC Annual Meeting. Oregon sport fishermen objected to sport fishing regulations off Washington and Oregon (Area 2A), and commercial fishermen objected to fishing seasons benefiting residents of the Pribilof

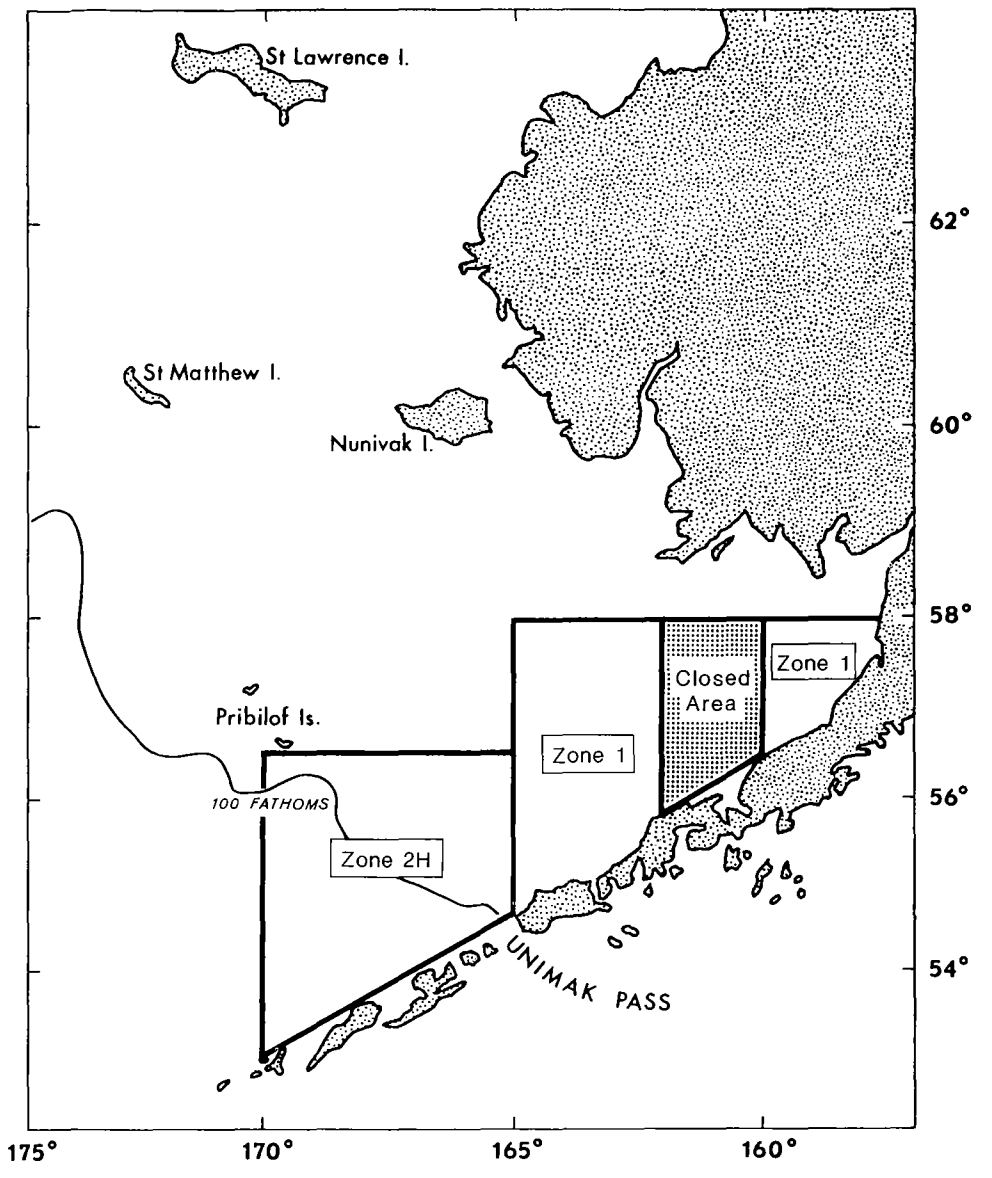


FIGURE 3.
Halibut bycatch management zones in the Bering Sea adopted by the North Pacific Fishery Management Council for 1989 and 1990.

Islands (Area 4C). The Area 4C regulations were subsequently modified following an appeal to the Secretary of Commerce. Later in 1987, the U.S. National Oceanic and Atmospheric Administration determined that, in future years, the Pacific Fishery Management Council (PFMC) and the NPFMC should undertake the responsibility for allocating halibut among various U.S. domestic user groups. The IPHC maintained responsibility for international allocation and for basic management of the fisheries.

The NPFMC adopted a formal procedure by which: (1) the public was requested to submit proposals for allocative measures; (2) a management group reviewed proposals and recommended action by the Council; (3) a technical team determined the effects of implementing the proposals; and, (4) the Council decided allocative measures and forwarded the decisions to the IPHC for review. After IPHC review, the NPFMC passed its own regulations. The PFMC did not directly address allocation because treaty Indians preferred to deal with IPHC directly. The PFMC followed roughly the same procedures as the NPFMC, but with the use of informal groups. The PFMC approved a catch sharing plan for the 1988 treaty Indian and non-treaty fisheries, which IPHC incorporated in its regulations by reference.

The NPFMC requested allocative proposals in July, 1987 for the 1988 fishery. The Council received 73 proposals, of which two were selected for further Council review. The two proposals constituted a continuation of previous IPHC allocation to Areas 4C and 4E; the other proposals were either beyond Council responsibility or the Council could not adequately address them in the limited time available. The two selected proposals, with alternatives, were analyzed by the technical team and the Council selected preferred actions at a December, 1987 meeting. Area 4C had a fishing period limit (trip limit) of 10,000 pounds until 50 percent of the catch limit was taken, after which the fishing period limit increased to 20,000 pounds. Area 4E had a fishing period limit of 6,000 pounds and fishermen not landing all their catch in the area could not fish until 80 percent of the catch limit was taken. Check in-check out from Dutch Harbor was required for both Areas 4C and 4E. The IPHC reviewed and approved the Council's proposed regulations at its January, 1988 Annual Meeting. Both IPHC and NPFMC recommended that the proposed regulations be adopted. The 80 percent provision for Area 4E was subsequently disapproved by the Secretary of Commerce, and not incorporated in final IPHC regulations.

Participants in the Area 2A allocation process established several ad hoc groups to coordinate development of allocative recommendations. The members of the groups were from state agencies (Washington and Oregon), federal government (NMFS and the Bureau of Indian Affairs), Indian tribes (Northwest Indian Fisheries Commission and various tribes), and IPHC. Meetings of a managers group, a technical group, and advisory groups were structured to meet PFMC requirements, but were not officially Council groups. These groups identified issues, analyzed proposals, and negotiated agreements. A negotiated catch sharing plan was approved by the Council and by the IPHC. Area 2A was managed for a 750,000 pound total catch limit. Of the total, 150,000 pounds (including a 50,000 reserve) were allocated to treaty Indian tribes for ceremonial and subsistence (C&S) fisheries and for commercial fisheries. The non-treaty portion was subject to an agreed allocation of 45 percent sport and 55 percent commercial harvest, or 270,000 and 330,000 pounds, respectively. The sport

catch limit was subdivided for Oregon, southern Washington coast, and northern Washington coast including the Strait of Juan de Fuca and Puget Sound.

The catch sharing plan and the IPHC implementing regulations contained several items that caused misunderstandings or management difficulties: (1) the plan allowed the treaty ceremonial and subsistence (C&S) fishery to retain sublegal halibut caught on commercial vessels, in direct contradiction of the IPHC regulations; (2) the Tribes interpreted the plan as allowing the Indian fishery to be managed by fixed season, rather than by numerical catch limit; and, (3) sub-allocation of the Area 2A catch limit to treaty, non-treaty sport, and non-treaty commercial fisheries was not specified in the IPHC regulations, so the non-treaty fishery was not closed when its 600,000 pound allocation specified in the plan was reached. These difficulties point to the need for close coordination of the catch sharing plan and the IPHC regulations in the future.

POPULATION ASSESSMENT

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.

It was a long voyage, covering 15,000 miles. In October, 1887, the 79-foot sailing vessel departed from its home port in New England on a trip that would include a winter passage around Cape Horn. The crew had heard the stories of great amounts of halibut off the west coast and decided to try their hand at fishing and sealing in the North Pacific Ocean. The *Oscar and Hattie* arrived in Port Townsend, Washington in late spring, 1888, too late to participate in pelagic sealing. With little else to do, they fished for halibut off British Columbia, but this proved unprofitable. Refusing to quit, the crew of the *Oscar and Hattie* loaded ice into the hold and set out for the fishing grounds off Cape Flattery. The fishing was good and on September 20, 1888, a railroad car containing 50,000 pounds of fresh, iced halibut left Tacoma for the east coast. With that shipment, shown in this photograph, began the commercial fishery for Pacific halibut.

On the following pages, the evolution of this 100-year-old fishery is presented, from the early days of sailing ships and steamers to the modern era of combination vessels and one of the highest catches in history.

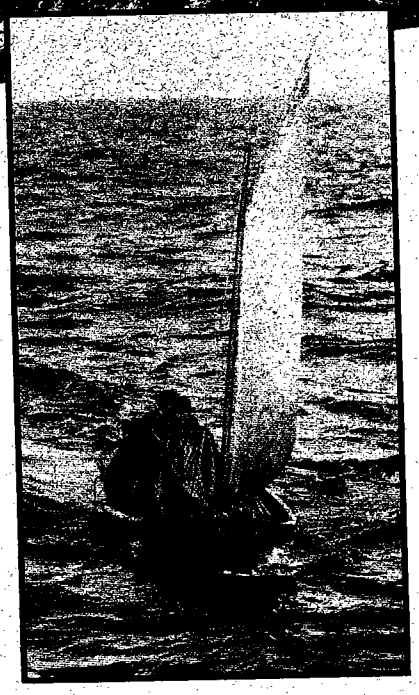
Celebrating The Pacific Halibut Fishery Centennial

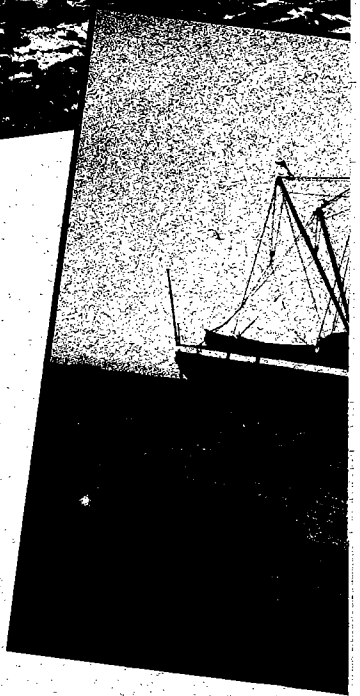
1888–1988

Centennial Section

The Early Days

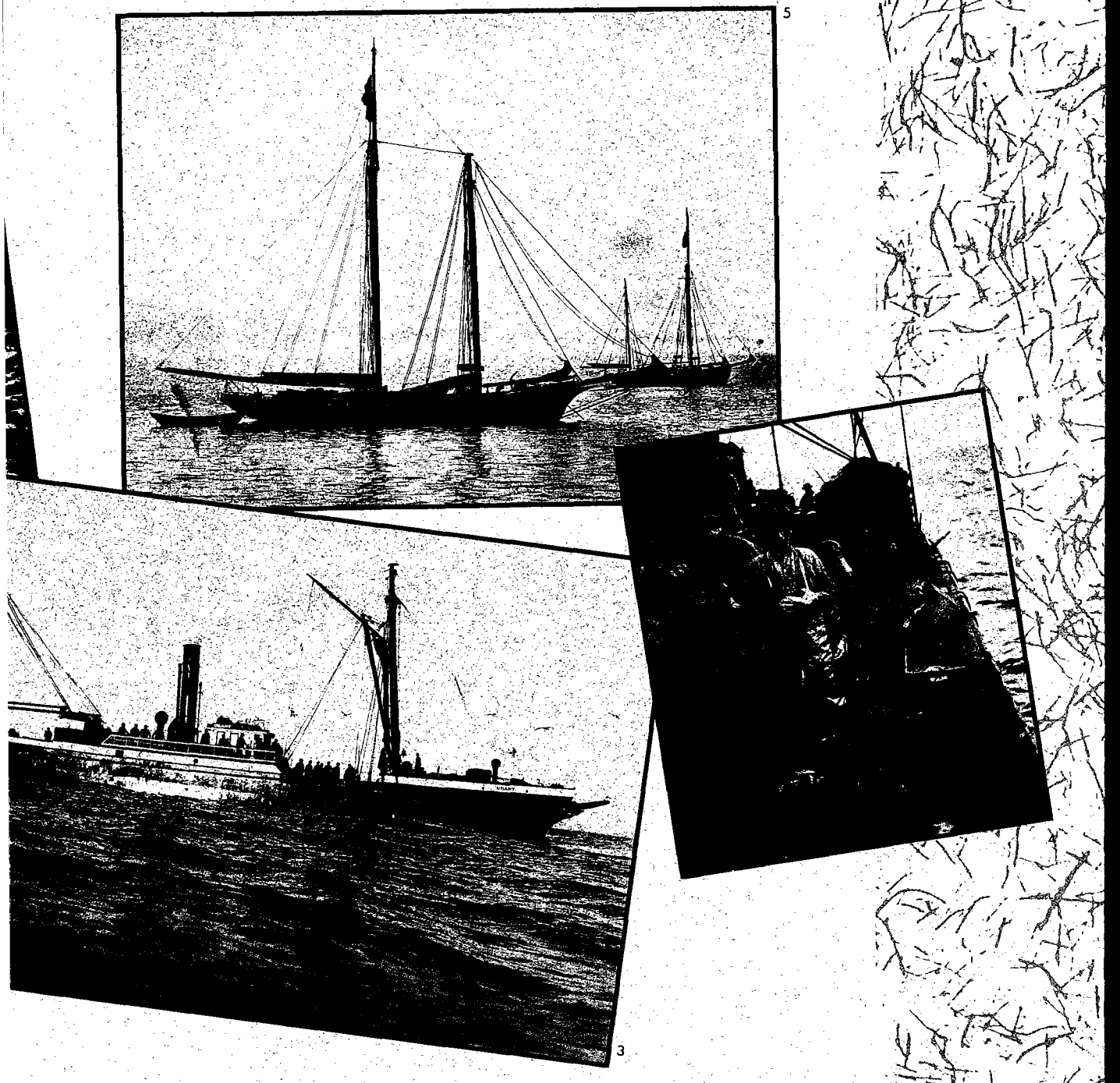
Although much attention is given to the success of the *Oscar and Hattie* in 1888, archeological records indicate that halibut was important to the Indian tribes of the Pacific coast long before the European explorers entered the region. For some tribes, such as the Haida of the Queen Charlotte Islands off the Canadian coast and the Makah of the northwest Washington coast, halibut was a part of tribal culture and lore. As the region was settled, halibut was in easy supply to the local communities within Puget Sound. However, it required the success of the *Oscar and Hattie* to demonstrate that halibut could be caught and shipped fresh to the lucrative markets of the east coast. Sadly, involvement of sailing ships in the fishery lasted only 2 years, after which they were replaced by large, company-owned steamers. The vessels could travel much





1. An Indian catch of halibut at Neah Bay, Washington, circa 1910 (photographed by A. H. Barnes). 2. A two man dory under sail, returning to unload its catch (IPHC photograph). 3. The steamer *Grant*, built in the early 1900s. (photograph by W. P. Miller). 4. Part of the crew of the steamer *Grant* (photograph by W. P. Miller). 5. The sailing vessel *Roosevelt* at anchor, circa 1908 (photograph by Muirhead).

further from port than sailing ships like the *Oscar and Hattie*. The steamers were manned by up to 35 crewmen and were capable of bringing in very large catches, such as the 320,000 pounds landed by the *Flamingo* in 1912. Halibut fishing by the steamer fleet was conducted from small dories carried on board each vessel. Each sail-powered dory was manned by 2 fishermen, who fished many hooks each day. The steamer fleet was extremely efficient at halibut fishing and it wasn't long before catches began to decline. The large steam-powered vessels had a difficult time remaining profitable with the shrinking catches. To add to their difficulty, smaller independently-owned vessels were introduced which could operate more efficiently and economically than the steamer fleet. The steamer era, which began in 1895 with such great promise and reached a peak of 16 U.S. and Canadian vessels in 1914, consisted of only one vessel by 1925 and had ended by 1930.



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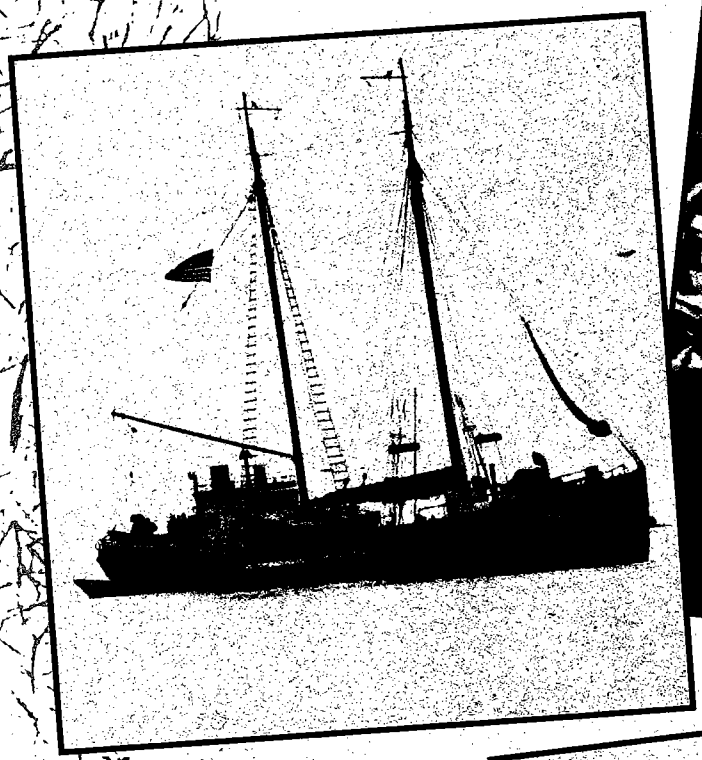
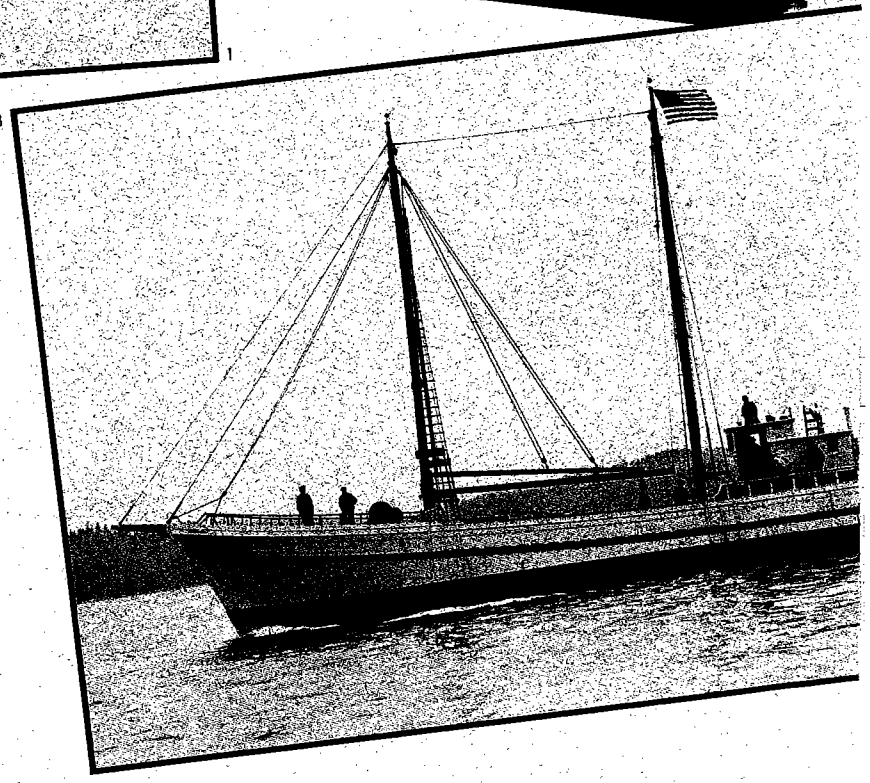
The Schooner Era

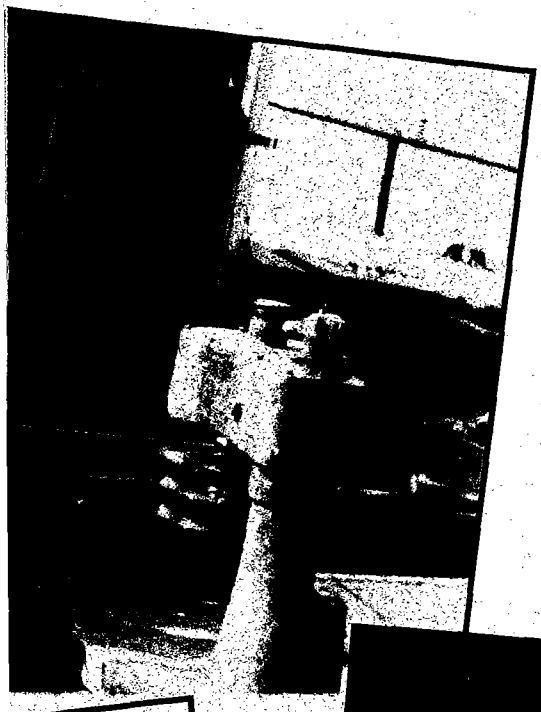
The schooner replaced the company steamer as the dominant type of vessel during the 1920s. The independently owned and operated schooners relied upon gasoline engines for power and switched to diesel when it became economical. A schooner was designed to fish dories, but the danger associated with this type of fishing, particularly in winter months, caused dory fishing to become unpopular. As a result, the schooners converted to setlining, in





1. The schooner *Dorothy* at anchor with its dories out fishing on the grounds. **2.** The schooner *King and Winge*, circa 1910. This vessel was active in the 1988 halibut fishery and is one of the oldest active fishing vessels on the U.S. west coast (IPHC photograph). **3.** Hauling setline gear aboard a schooner. The groundline is being pulled on board by the gurdy on the right and coiled by the crewman standing to the left. **4.** The stern chute, which made setting and hauling setline gear from a schooner practical (photograph courtesy of The Alaska Fisherman's Journal). **5.** The schooner *Polaris*, built in 1913, initially fished with dories but changed to setlining in 1927. The *Polaris* was part of the U.S. halibut fleet in 1988.

which the gear is set and hauled from the schooner itself. Stern chutes were designed to facilitate setting the gear and power gurdies were installed to retrieve the setline gear. Almost all schooners were built prior to the 1930s and many are still fishing today. Although a schooner was very efficient at halibut fishing, it was not easily used in other fisheries, such as salmon or herring seining, or pot fishing for crab. The lack of versatility created the need for a vessel design which could be used in any number of fisheries. This lead to the development of the combination vessel.



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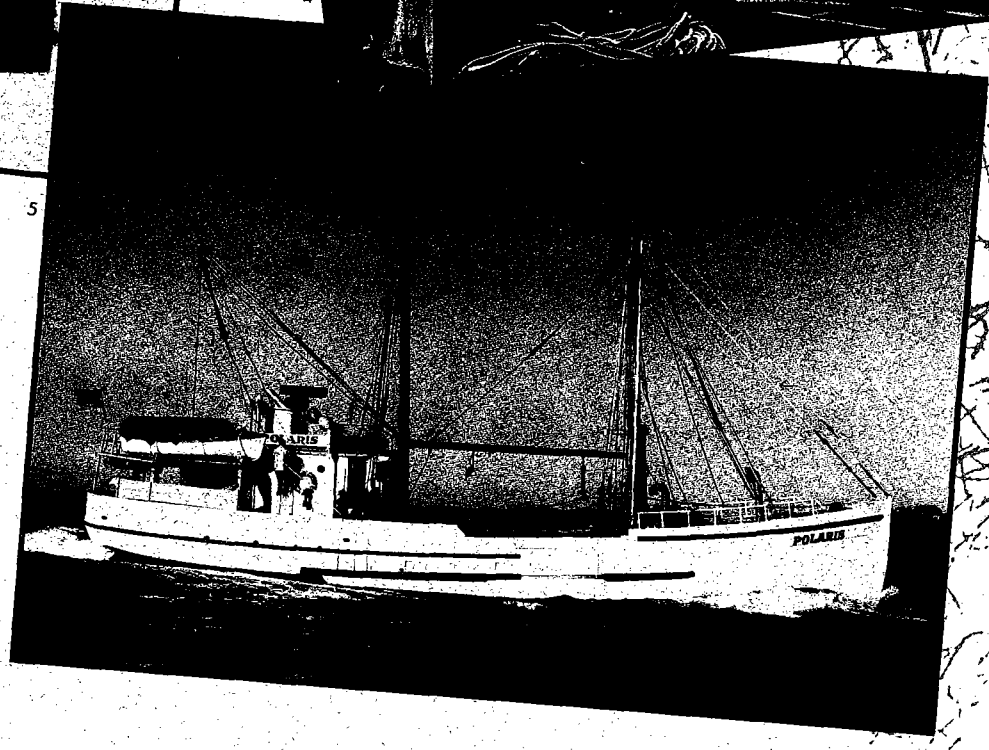
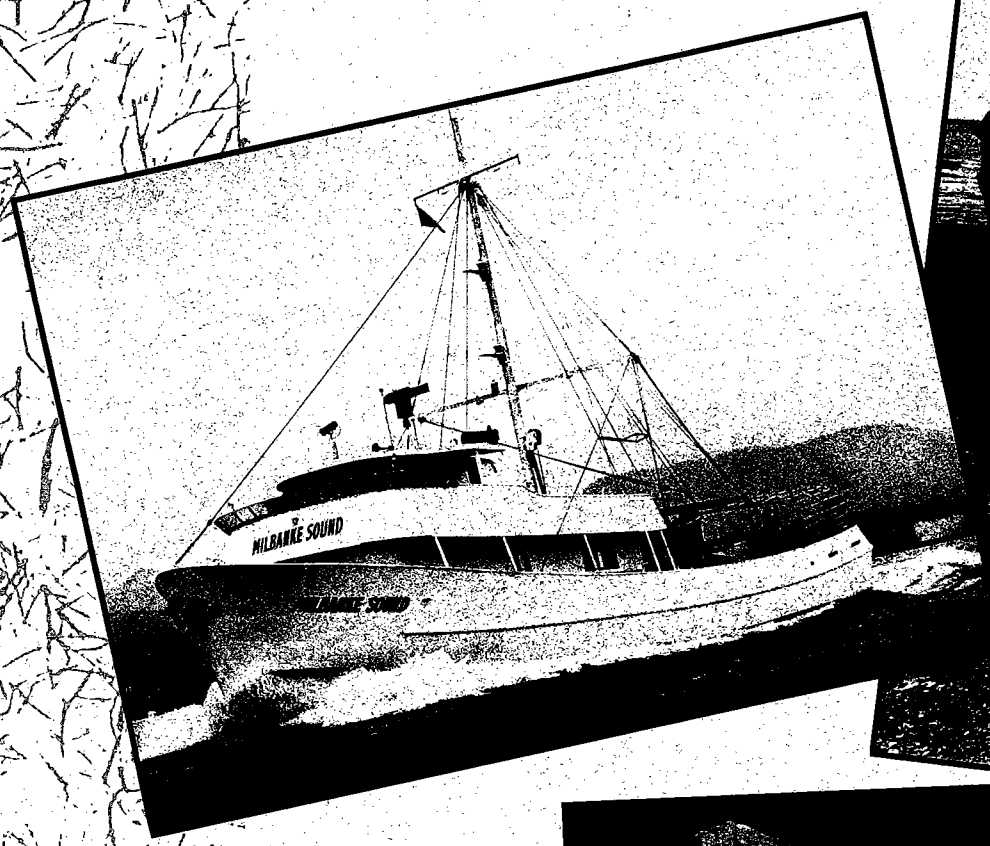


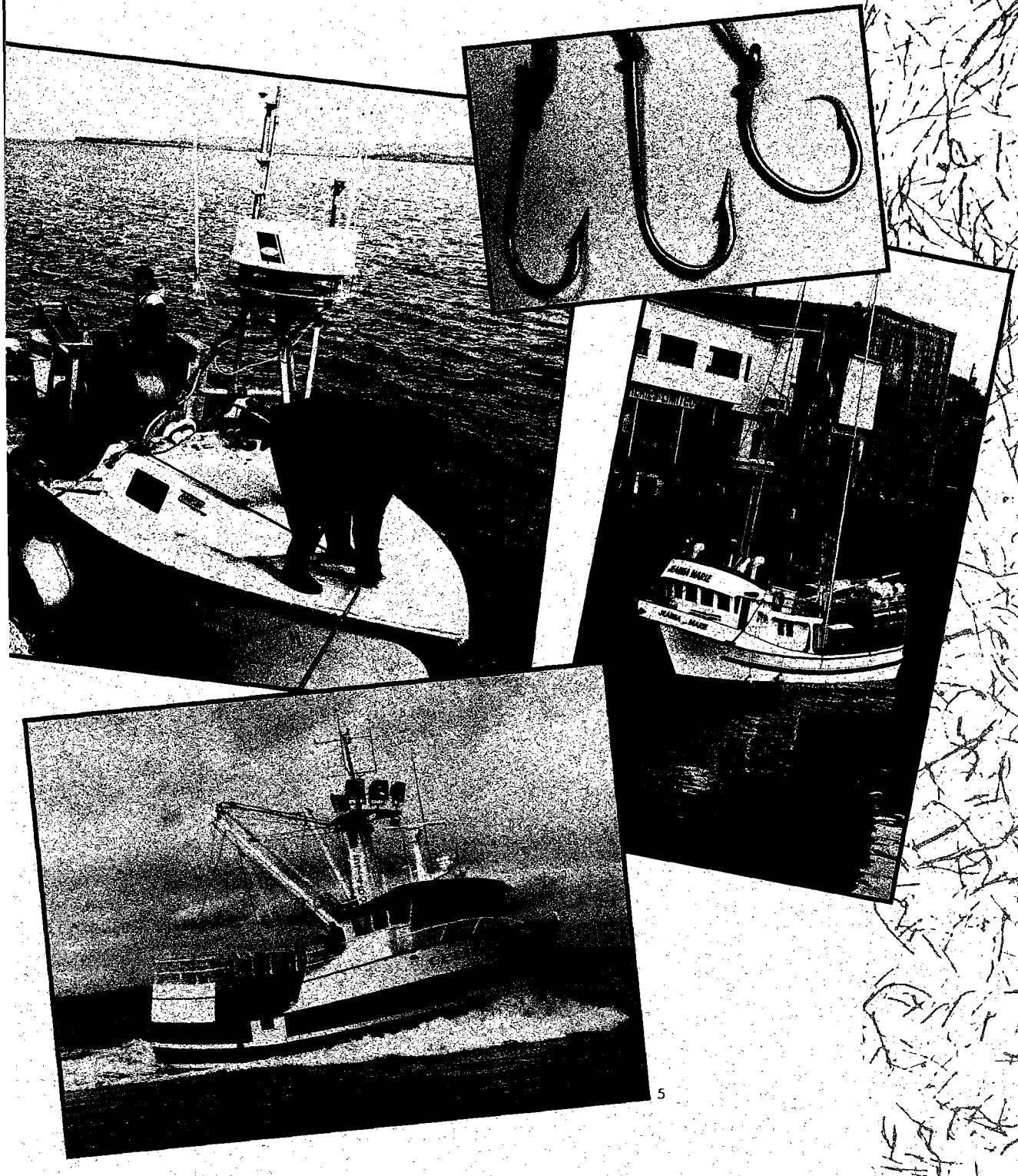
The Current Fleet

Where once the halibut fishery was dominated by a handful of company-owned steamers or a small number of independently owned schooners, the boats that currently comprise the halibut fleet are many types of vessels. Fishing seasons for many species are short due to advances in fishing technology or an excess amount of effort, requiring that fishermen be able to participate in more than one fishery. Today's halibut fisherman may use his boat for seining, or trolling for salmon, pot fishing for king or Tanner crab, trawling for flounders



1. The combination vessel *Milbanke Sound*, which fishes for sablefish, salmon, and herring. 2. A crewman intently watches the gear as it comes aboard the vessel and is wound on a reel for storage (IPHC photograph). 3. A small setliner used in 1983 by local fishermen to fish halibut around the Pribilof Islands in the Bering Sea (photograph courtesy of The Alaskan Fisherman's Journal). 4. The halibut hook has evolved from a simple J-hook, on the left and center, to the modern circle hook, which has double the catching power (IPHC photograph). 5. The *Celtic*, built in 1989, is a combination vessel, as it can setline for halibut and sablefish, and pack salmon and herring (photograph courtesy of Hansen Boat Co.). 6. The *Jeanna Marie* tied up in Prince Rupert, which fishes sablefish and trawls for groundfish.

and roundfish, longlining for tuna, or even charter the vessel for private sport fishing excursions. Schooners, many of which were built in the 1910s and 1920s specifically to fish halibut, remain in the fishery and continue to be successful. Most of these vessels are home ported in Seattle, but can be found longlining off Alaska for halibut and other species from April through October. Many of the largest vessels in today's U.S. fishery were built in the 1970s for the pot fisheries for king and Tanner crab and have successfully adapted to longlining.

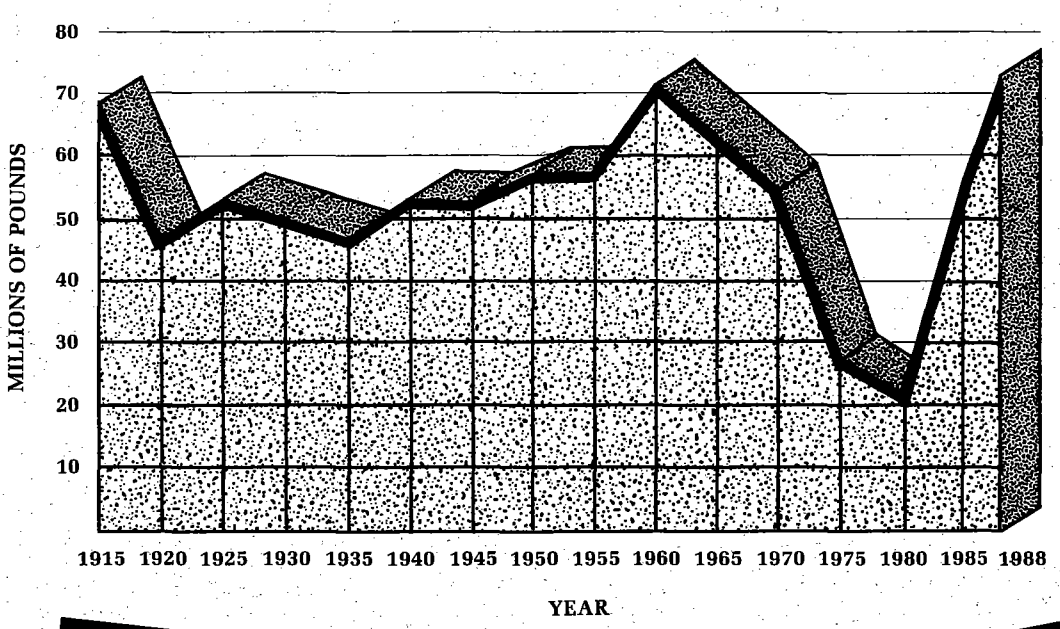


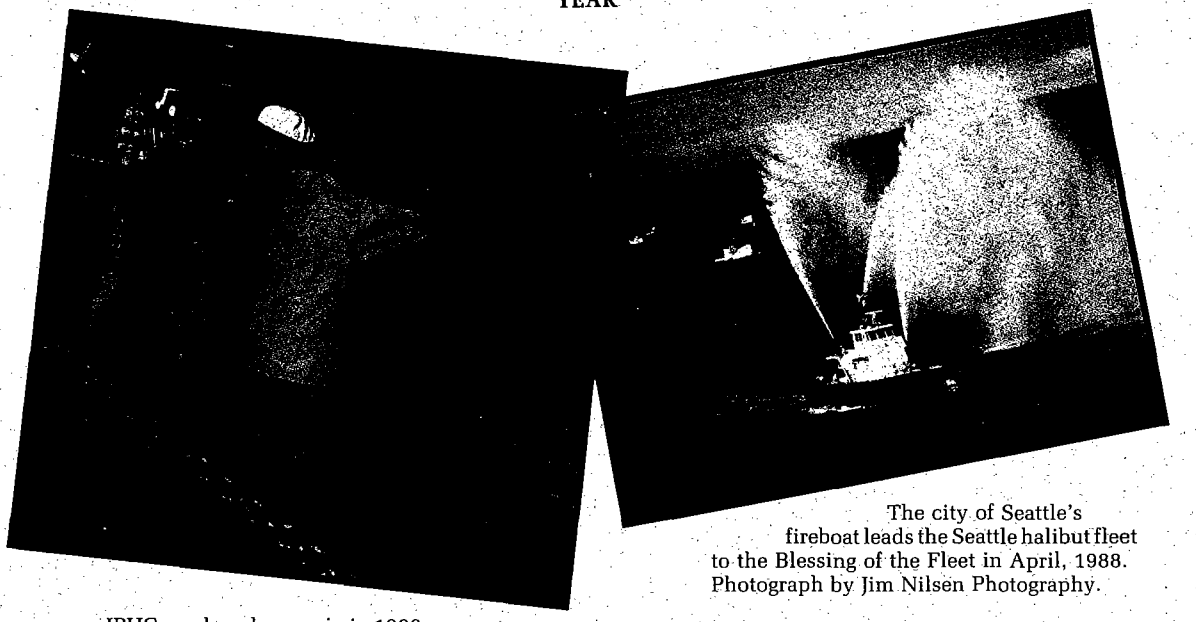
100 Years of Halibut Fishing

1988 is the 100th year of fishing for Pacific halibut and much has happened to the fishery and resource. Commercial catches have been as large as 75 million pounds in 1962 and 1988 to as low as 21 million pounds in 1974. Despite the fluctuations in catch, incidental removals by other fisheries, and the tremendously large amount of effort in the U.S. fleet off Alaska, the fishery continues, due in large part to the dedication and perseverance of the men and women that fish halibut.

Commercial Catch of Pacific Halibut, 1915-1988

In Millions of Pounds





The city of Seattle's fireboat leads the Seattle halibut fleet to the Blessing of the Fleet in April, 1988. Photograph by Jim Nilsen Photography.

IPHC produced a movie in 1988 documenting the development of the halibut fishery and describing some of its current research. The movie is available upon request for showing to large groups.

In addition, a video version (VHS) is available from Outdoor Adventure Videotapes, 511-2nd Avenue West, Seattle, Washington, 98119.

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:

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.

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.

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

This year, 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 11. 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.

TABLE 11.
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 millions of pounds.

	IPHC Regulatory Area						
	2A	2B	2C	3A	3B	4	Total
Exploitable Biomass							
Range: Upper	1.36	33.2	41.1	122.3	52.5	15.0	245.4[1]
Range: Lower	0.67	16.4	32.7	97.6	22.5	11.0	180.8[1]
Maximum Sustainable Yield							
All Gear	0.80	18.6	11.3	29.2	10.0	11.0	80.9
Setline Only	0.45	15.4	7.3	17.2	7.4	10.3	58.0
Setline Constant Exploitation Yield							
Range: Upper	0.35	7.4	7.2	29.4	12.3	6.3	63.0
Range: Lower	0.35	4.7	4.6	18.8	7.9	4.1	40.5
Total Constant Exploitation Yield							
Range: Upper	0.70	10.6	11.3	41.4	14.9	7.0	85.9
Lower	0.70	7.9	8.7	30.8	10.5	4.8	63.4

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

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 80.9 million pounds. Given the current rates of bycatch, sport catch, and wastage the MSY in terms of setline catch is estimated to be 58.0 million pounds. 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 12 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 213.1 million pounds coast-wide. This represents a decrease in biomass of about 6 percent from the updated estimate of 1987 exploitable biomass of 226.4 million pounds. 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 12 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.

TABLE 12.
Summary of Pacific halibut exploitation data, 1974-1988. Biomass and removals are shown in millions of pounds.

		Removals					Setline	Total
Year	Exploitable Biomass	Commercial Catch	Bycatch[1]	Sport Catch	Waste	Total	Expl. Rate	Expl. Rate
1974	122.1	21.3	29.3	0.3	0.0	50.9	0.17	0.42
1975	126.4	27.6	18.1	0.3	0.0	46.0	0.22	0.36
1976	125.9	27.5	21.0	0.3	0.0	48.8	0.22	0.39
1977	128.0	21.9	17.8	0.3	0.0	40.0	0.17	0.31
1978	134.0	22.0	18.6	0.4	0.0	41.0	0.16	0.31
1979	141.7	22.5	23.4	0.6	0.0	46.5	0.16	0.33
1980	150.4	21.9	28.8	0.8	0.0	51.5	0.15	0.34
1981	163.5	25.7	22.7	1.1	0.0	49.5	0.16	0.30
1982	186.7	29.0	18.8	1.3	0.0	49.1	0.16	0.26
1983	205.5	38.4	16.4	1.7	0.0	56.5	0.19	0.27
1984	220.3	45.0	15.3	1.9	0.8	63.0	0.20	0.29
1985	236.7	56.1	11.4	2.6	1.6	71.7	0.24	0.30
1986	237.9	69.6	11.3	3.5	3.2	87.6	0.29	0.37
1987	226.4	69.4	15.5	4.1	2.7	91.7	0.31	0.41
1988	213.1	74.6	17.5	3.8	2.0	97.9	0.35	0.46

[1]Adult equivalent.

SCIENTIFIC INVESTIGATIONS

Each year the Commission conducts various experiments, surveys and data collection programs designed to better understand the biology of halibut, the effects of the fishery upon the resource, and the changes taking place within the halibut population. In 1988, at-sea research was focused on assessing differences in the availability of halibut to setline gear among different regions of the coast. In addition, port sampling of the commercial fishery landings was conducted as in prior years. These activities are described in the following sections.

TAGGING STUDIES

The major tagging activity in 1988 took place at Rose Spit in northern Area 2B. The returns from this experiment will provide insight concerning the short-term utilization and movements of fish in this local area. In other studies, halibut were tagged by IPHC personnel on board trawlers fishing in July off Kodiak and also in conjunction with the filming of halibut fishing for a movie and video celebrating the Halibut Centennial. In addition, halibut were tagged during comparative fishing of halibut gear and sablefish gear. Lastly, 36 halibut were tagged and released in Cook Inlet for a sport fishing derby. Table 13 summarizes the tags released in 1988.

TABLE 13.
IPHC tag releases in 1988.

Month	Location	Regulatory Area	Gear	No. Tagged
May/July	Rose Spit	2B	Setline	2,652
April/June	Cook Inlet	3A	Sport	36
July	Sitkinak Is.	3B	Setline	152
July	Marmot Bay	3A	Setline	7
July	Portlock Bank	3A	Trawl	174
August	Yakutat Gully	3A	Setline	77
Total				3,098

Tag returns in 1988 totalled 1,694 fish. The recovery location was reported for 1,435 (85 percent) of the 1988 recoveries. Table 14 summarizes the 1988 returns by release and recovery regions of the coast. Most of the halibut (86 percent) were recaptured in the area of release, but 54 (4 percent) moved west or north and 143 (10 percent) moved east or south. The amount of interchange is greatly influenced by the size of the fish at the time of release. The smaller fish, those less than 80 cm in length, account for most of the between-region movement.

TABLE 14.
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
Southeast	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

PRELIMINARY ANALYSIS OF TAG RETURNS FROM HOOK STRIPPER STUDY

During the fall of 1986, IPHC conducted a study on the effects of automatic hook strippers on the survival of juvenile halibut. IPHC chartered a U.S. longline vessel equipped with fixed-hook gear and a hook stripper for a tag and release experiment in the Kodiak area. All fish were examined for obvious injuries due to hook removal, and hook removal injuries were recorded into seven categories. These categories, in order of apparent increasing severity, were; no injury apparent, torn cheek, torn lip, split jaw, torn jaw, torn cheek and jaw, and torn face.

Overall, 2,066 fish were tagged, 934 in the control group which were manually shaken from the gear and 1,072 fish which were removed by the hook stripper. Approximately 60 percent of the fish tagged were smaller than the commercially legal size of 82 centimeters (32 inches). Since legal-sized fish are killed at capture during the commercial fishery, we are most concerned with survival rates of the juvenile fish. Injury and survival rates of the legal-sized fish provide additional information on the effects of hook strippers. During the 1986 experiment, 1,236 sublegal fish were tagged and released, 563 which had been manually shaken from the gear and 673 which had been removed by the hook stripper. So far, 79 tagged fish have been recovered from the experiment, representing an overall recovery rate of 3.9 percent. Twenty-six of the sublegal releases have been recovered for a recovery rate of 2.1 percent. Release and recovery data for the sublegal fish are shown in Table 15.

TABLE 15.
Release and recovery data for halibut less than 82 cm in length at time of release. 'M' identifies fish manually removed from the gear and 'S' identifies fish mechanically removed by the hook stripper.

	Tag Releases			Tag Recoveries			Percent Recoveries		
Injury type	M	S	Total	M	S	Total	M	S	Total
None apparent	26	2	28	1	0	1	3.8	0.0	3.6
Torn cheek	491	55	546	14	2	16	2.9	3.6	2.9
Torn lip	5	8	13	0	0	0	0.0	0.0	0.0
Split jaw	1	37	38	0	0	0	0.0	0.0	0.0
Torn jaw	28	163	191	1	5	6	3.6	3.1	3.1
Cheek and jaw	11	299	310	0	2	2	0.0	0.7	0.6
Torn face	1	109	110	0	1	1	0.0	0.9	0.9
Total	563	673	1,236	16	10	26	2.8	1.5	2.1

A rigorous analysis of relative mortality by either handling method or hooking injury must wait on further tag recoveries. The numbers of recoveries in any one category are so small that one or two fish more or less make a large change in the overall percent recovery. With this reservation in mind, there are some very general conclusions which are justified by the preliminary data. There does appear to be a difference in the rate of tag recoveries by handling method. Of the fish manually removed from the gear, 16 of the 563 sublegal fish tagged have been recovered for a recovery rate of 2.8 percent. Of the fish mechanically removed, 10 of the 673 sublegal releases have been recovered for a recovery rate of 1.5 percent. The two-fold difference in recovery rate between the two methods indicates a mortality rate for those fish mechanically removed which is twice that for those removed manually. Although less certain because of the small number of recoveries to date, the difference in recovery rates would appear to be correlated with the type of hook removal injury. The predominance of the more serious 'torn cheek and jaw' and 'torn face' injuries in the mechanically removed fish presumably increases mortality, and possibly correlates with the lower recovery rate from this group.

CONTINUOUS FISHING AND TAGGING STUDY IN BRITISH COLUMBIA

A research operation was conducted in northern Area 2B in 1988 to investigate the effects of concentrated fishing on a small fishing ground and to systematically release tagged halibut at this location. A notice was sent to the Canadian fishing fleet prior to the study requesting that extra care be used in looking for and reporting tagged halibut recoveries during the August Area 2B commercial fishery. In conjunction with the tagging program, a special effort was taken to identify the vessels fishing on the experimental grounds during the commercial fishing periods and to meet those vessels in port to collect tags, fishing logs, and sample the catches.

The location chosen for the study, in the inside area of Dixon Entrance, is a small but productive fishing ground, with an area of about 1 by 2.5 nm. This fishing ground is normally fished by only two or three vessels during commercial fishing periods due to the small size of the productive fishing area. Depths ranged from 87 to 105 fathoms.

Two research trips were made to the survey area. The first trip used the chartered Canadian vessel *Snowfall* and was conducted from May 27 to June 24. The second trip was carried out with the U.S. vessel *Cape Flattery* and ran from July 14 to August 1. Weather problems and logistics reduced the total number of fishing days on each trip. On trip 1, fishing occurred between May 31 and June 20, a total of 12 fishing days. On trip 2, fishing occurred between July 17 and July 27, a total of nine fishing days. The trips were scheduled between the May and August Area 2B commercial fishing periods with enough of a 'rest period' so that fish tagged during either trip might be recaptured by the commercial fleet during the August fishing period. Fishing on trip 1 started 17 days after the end of the first commercial fishing period. The second commercial fishing period in Area 2B started on August 19, 23 days after the end of the second research trip.

All fishing was done with 1,500-foot skates of conventional, fixed-hook halibut gear with Number 3 circle hooks. Hooks were fixed at 18 foot intervals and baited alternately with salmon and herring. The station layout prescribed six sets per day, with four skates per set. The sets were laid out in a north-south orientation with about 0.5 mile between sets. Thus, a grid of six sets covered about 1 mile by 2.5 mile. The fishing pattern was repeated each day on the same grounds, although the setting and retrieval order was alternated to distribute soak times among the sets day to day. Gear was set between 0500 and 0600 each morning. Hauling commenced each day at 0700 and continued until all the gear was retrieved.

Four Canadian vessels were identified which fished on or very near the survey grounds during the May and August fishing periods. Fishing logs were collected from these vessels and landings from one vessel from the May fishery and three vessels from the August fishery were sampled for age and size composition. In total, 232 otoliths were collected from the first fishing period and 261 from the second. Information from these fishing trips will be included in the final analysis of this experiment.

Fishing results from the two research trips are shown in Table 16. Preliminary analysis does not show a significant trend in the catch rate across the fishing days. Although the average catch rate dropped from 151 pounds per skate to 113 pounds per skate from the first to the second trip, this could possibly be an artifact of changing vessels between trips. Catch per 4-skate set ranged from a low of 38 pounds in one set on the second trip to a high of 1,911 pounds on a set on the first trip. Of the 45 sets on the first trip, 26 (58 percent) had catches of less than 500 pounds per set, whereas 5 (11 percent) had catches of over 1000 pounds per set. On the second trip, 24 out of the total of 42 (57 percent) had catches of less than 500 pounds per set, whereas only 1 (2 percent) had a catch over 1000 pounds. Figure 4 shows average daily catch rate for the different set locations for each trip. Even though the survey area was very small, there was a consistent difference in catch rate by location within the survey area, as the third and sixth sets ranked first and second in terms of overall catch rate on both trips. The catches on the first and second sets averaged

lowest on both trips. Even with a survey area this small, there were differences in the grounds which make one or two areas consistently more productive while others are consistently less productive. The average weight of the commercial size halibut went from 21.4 pounds on the first trip to 24.4 pounds on the second trip.

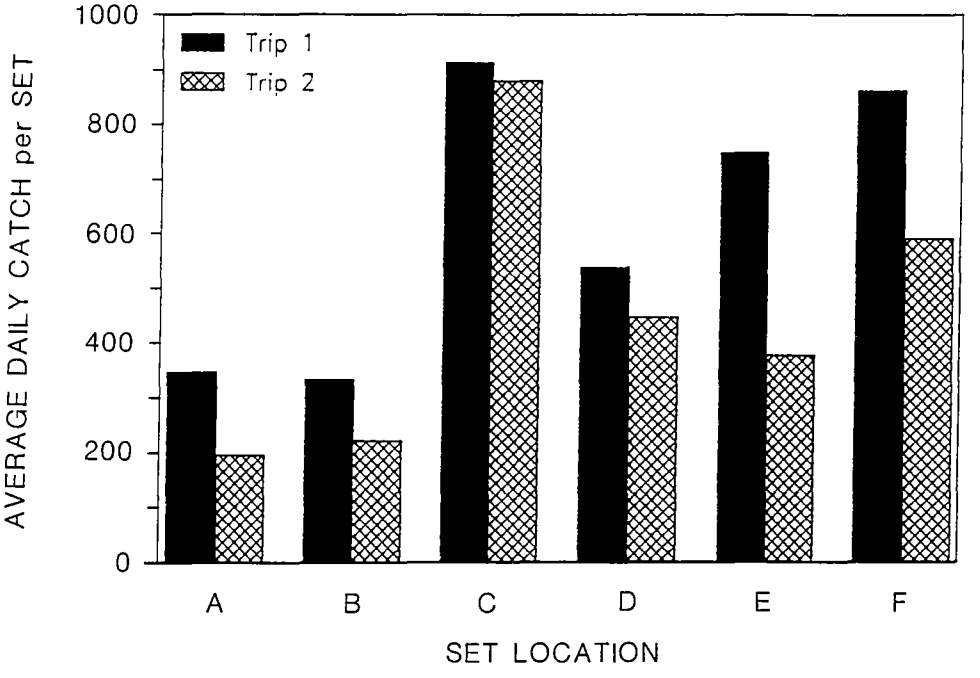


FIGURE 4.
Average daily catch rate of commercially sized halibut in pounds per set by trip from continuous fishing study in Area 2B in 1988.

TABLE 16.
Summary of research catches from continuous fishing and tagging studies in Area 2B, 1988.

Charter Results	Trip 1	Trip 2
Number of days fished	12	9
Number of 1500-foot skates fished	264	168
Number of legal halibut caught	1,873	778
Number of sublegal halibut caught	191	71
Pounds of legal halibut caught	39,956	19,018
Average catch rate (lbs/1500-foot skate)	151	113
Average weight of legal fish (net lbs.)	21.4	24.4

Of 2,654 halibut measured, tagged and released during both trips, 2,397 fish were legal sized (greater than 81 cm) and 257 were sublegals. Recoveries totalled 265, about 10 percent of the releases. Most of these recoveries occurred during the August fishing period in Area 2B, although 16 tags have been recovered by the Canadian trawl fleet, and 1 tag has been recovered by a troller in Area 2C on August 9 and a longline vessel during the October 3 fishing period in Area 2C. Tag release and recovery information is summarized in Table 17. Most of the recoveries have occurred less than 5 miles from the release site. From the first set of releases, with an average of 60 days at liberty, 56 percent of the recoveries with known recovery position were from less than 5 miles from the release site, 30 percent were from 5 to 15 miles from the release site and 14 percent were recovered more than 15 miles from the release site. From the second trip, with less than 30 days at liberty, 88 percent of the recoveries were from less than 5 miles from the release site, 7 percent were from 5 to 15 miles from the release site and 6 percent were more than 15 miles from the release site. A few of the fish had moved considerable distance. The greatest movement was by a fish recovered in early October, approximately 120 miles north of the release site. Two fish were recovered during the August fishing period in Area 2B: the first was 110 miles south of the release site, the second was recovered 60 miles west.

TABLE 17.
Summary of tag releases and recoveries on the continuous fishing and tagging study in Area 2B in 1988.

Charter Results	Trip 1	Trip 2
Release date	May 31-June 20	July 17-27
Number tagged	1,856	798
Total tag recoveries	191	74
Canadian longline recoveries	175	72
Trawl recoveries	14	2
U.S. longline recoveries	1	0
U.S. troll recoveries	1	0
Recoveries by the Canadian Longline Fleet, August 19-25, 1988		
Total recoveries	175	72
Recoveries without recovery location	32	0
Recoveries with recovery location	143	72
Distance from recovery site:		
less than 5 miles	80 (56%)	63 (88%)
between 5 and 15 miles	43 (30%)	5 (7%)
greater than 15 miles	20 (14%)	4 (6%)

LIVE HALIBUT PROJECT

A cooperative project between the IPHC, the U.S. Fish and Wildlife Service, and the University of Washington investigating the early life history of halibut continued in 1988. The main thrust of this project is to spawn and raise halibut in captivity in order to learn more of the early life history of the species. Two collection efforts were made during 1988 to add fish to the brood stock. The chartered U.S. vessel *Satin Doll* delivered fish to the Marrowstone Island facility of the U.S. Fish and Wildlife Service. The chartered U.S. vessel *Cape Flattery* delivered fish to the Nanaimo facility of the Canadian Department of Fisheries and Oceans (DFO). The DFO facility in Nanaimo has been very successful in previous spawning experiments with sablefish and expects to attempt spawning of Pacific halibut during 1989.

At the Marrowstone facility, four female fish reached maturity in captivity during 1988 and were used in the 1988 spawning. Radioimmunoassay (RIA) techniques were used during 1988 to investigate levels of sex steroids. The technique has proven to be a reliable method to predict the maturity of captive halibut. The RIA technique successfully predicted six females and one male would spawn in 1988. The mature females included four fish captured prior to 1988 which matured in captivity during 1988 and two fish which were already mature. A total of 18 egg strippings were conducted between February 7 and April 10, producing about 150,000 eggs, about half of which were viable. Milt was obtained from 14 strippings from the male fish. Eggs were fertilized in early February with a fertilization rate of about 45 percent and in early March with a fertilization rate of about 10 percent. Spawning attempts were stopped in erly March due to lack of good sperm products. About one third of the fertilized eggs were buried in a fine silt deposit and most of the remaining were destroyed by a fungal or bacterial infection, so few of the fertilized eggs reached the hatch stage. With some redesigning of the holding system, these problems should not reoccur in 1989. In total, eight halibut larvae were obtained in 1988. These survived less than a week.

Annual growth rates in the captive halibut population average 7.5 cm and 2.5 cm, respectively, for immature and mature fish. These compare with an average growth rate of 10 cm annually for wild fish. Plans for 1989 include an improved feeding regime with regular vitamin supplements.

Considering the scale of the rearing project, it has been fairly successful thus far. Information from Norwegian scientists raising Atlantic halibut suggests that the biggest hurdle in raising halibut lies in getting the hatched larvae through the yolk-sac phase and into natural feeding. Hopefully, this will be achieved during 1989.

THE ECONOMICS OF HALIBUT BYCATCH REGULATION

Catch patterns in the 1988 Bering Sea joint venture trawl fishery for yellowfin sole (*Limanda aspera*) were examined to determine the current volume and value of direct and incidental catch, and to determine the economic benefits and costs of reducing halibut bycatch.

The primary purpose of the research project was to develop methodology for the evaluation of bycatch policies, a process which is ongoing in cooperation with economists of the National Marine Fisheries Service, North Pacific Fishery Management Council and other agencies. The research in this project should be considered a step in that continuing effort. The primary economic tradeoff examined concerns the allocation of halibut between directed (longline) and bycatch (trawl) fisheries. Calculations examining this tradeoff also include impacts on king (*Paralithodes camtshatica*) and Tanner crab (*Chionoecetes bairdi* and *C. opilio*).

The 1988 joint venture yellowfin sole fishery harvested 370,705 metric tons of marketable groundfish (yellowfin sole, other flatfish, Pacific cod, and pollock). In addition, the fishery took an incidental catch of 494,680 halibut, 69,414 king crab and 568,856 Tanner crab.

The directed catch had an economic value of $8,735,808 (U.S.). The incidental catch had a comparable economic value (discounted) of $3,884,528. Of this total, $3,807,185 is attributable to halibut, $9,084 to king crab and $68,260 to Tanner crab. Overall, the 1988 yellowfin sole joint venture fishery imposed an external cost on the U.S. economy equal to approximately 44 percent of its net economic value, this external cost taking the form of lost net value of future halibut and crab catch.

The aggregate groundfish and bycatch data set was stratified into 46 subunits or grids. Stratification was by statistical week and management subarea. Economic values were calculated for each grid and the grids sorted in descending order of halibut bycatch rate (number of halibut per metric ton of directed catch). The economic consequences of increasingly severe restrictions on halibut bycatch were examined by first eliminating grids in descending order of incidental catch rate, and then cumulating economic gains and losses over all eliminated grids.

The fully optimum solution, i.e. when incremental halibut benefits equal groundfish losses, would be to reduce halibut bycatch to 53 percent of its 1988 levels (from 495,000 to 262,000 halibut). Such a step would also require reduction of the groundfish catch to 93 percent of the 1988 level (from 371,000 to 343,000 metric tons). After five to seven years of growth and natural mortality, the reduced incidental catch would make an additional 3.5 million pounds of halibut available for directed harvest. Eventual gains to the crab fishery would include the availability of an additional 605 pounds of king crab and 36,000 pounds of Tanner crab.

When harvested, these additional halibut and crab catches (after discounting to present value) would contribute $929,000 to the net economic value of U.S. fisheries production. Comparison with the loss of $649,000 in net economic value of groundfish production suggests a national benefit/cost ratio for full optimum reduction of 1.43. Greater confidence should be placed in the ratios of benefits to costs than in the absolute values of benefits, costs, and net benefits.

The most surprising result was the degree to which bycatch was concentrated in particular segments of the overall yellowfin sole fishery. Forty-seven percent of halibut bycatch occurred in reporting units that accounted for only seven percent of total groundfish landed. Detailed examination of these high bycatch grids indicates that about half of the 47 percent occurred during times and areas which suggest that the target species was Pacific cod rather than

yellowfin sole or other flatfish. No consistent explanation was found for the remaining high bycatch grids.

Except for this small segment of the groundfish catch, bycatch rates in the 1988 yellowfin sole fishery were sufficiently low that directed fishery values substantially exceeded bycatch values.

OTOLITH MICROSTRUCTURE INVESTIGATIONS OF HALIBUT

This project is directed toward investigating the structural and chemical composition of otoliths from Pacific halibut with the intent of identifying parameters which may be important for predicting halibut yearclass strength and stock composition. In addition to annular information used in age and growth studies of adults, halibut otoliths contain microstructure patterns which reflect daily growth rates and the timing of specific events in the halibut's early life history. These aspects may be important for determining halibut yearclass strength. Elements incorporated into the otolith microstructure during the early phases may also serve as a natural tag for identifying the nursery area origin of adult halibut, as shown in studies on other species.

The investigation has examined otoliths of larval and juvenile halibut from known nursery areas. Data on the microstructure patterns are gathered by grinding and polishing the otoliths into thin sections and using a micro-computer system to take measurements on the digitized image. Preliminary results indicate nonlinear early growth patterns with regional variation in instantaneous growth rates. Structural development of the otoliths however, through the placement and orientation of accessory nuclei, does not appear to be associated with area of capture. Elements in the microstructure are determined by scanning the surface of the sectioned otoliths with an X-ray microprobe. Initial trials indicate the method will work with halibut otoliths.

Based on information from the larval and juvenile otoliths, the microstructure of adult otoliths from IPHC's historical collection will be examined. A 50-year time series on larval and juvenile growth along with stock composition could provide valuable information on understanding and predicting halibut population dynamics.

SEXUAL DIFFERENTIATION IN LIVE HALIBUT

In the past, sexual differentiation between live Pacific halibut was possible only through observation of sexual products from mature individuals during the spawning season. However, it was impossible at other times of the year to differentiate the sex of live halibut with any degree of certainty. In halibut, the ovaries and testes are the primary sexual characteristics. Until recently, no secondary sexual characteristics had been identified for halibut aside from the difference in size between the sexes. Almost all halibut over 100 pounds are females, whereas male halibut seldom reach 100 pounds. The sexual determination at tagging time is preferable since this information is obtained for less than five percent of the halibut recovered. The knowledge of the sex of a tagged fish is useful in estimating growth rates, mortality rates, and migration patterns in halibut by sex.

A procedure to determine the sex of live halibut was developed during research cruises in 1988. The sex determination study was conducted on hook and line caught halibut 65 cm or greater in length. The sexual determination procedure is fast, accurate, and was incorporated into the continuous fishing and tagging study conducted in Dixon Entrance in 1988.

The procedure consists of a visual examination of the genital vent. The genital vent on halibut is located behind the anal vent, both of which are situated directly behind the pelvic fins and ahead of the anal fin. The pore of the generative duct and the pore of the urinary duct are enclosed by the cloaca. The cloaca is defined here as the terminal common external opening through which sexual products, carried by the generative duct, and waste fluids, carried by the urinary duct, are expelled from the body.

The shape of the cloaca on Pacific halibut is considered here as a secondary sexual characteristic and IPHC has had no opportunity since to observe if the cloaca changes shape as maturity approaches. The cloaca on female halibut (Figure 5) appears as a small projecting body part, cone shaped, similar in form to a small nipple, with the vent oriented at a marked angle toward the anal fin. The cloaca of an immature and maturing (prior to first spawning) female is small in mass, with the genital vent appearing tightly closed. Conversely, the cloaca of a mature female is bulkier in mass or swollen in appearance and the opening of the genital vent is larger in size and relaxed in appearance. The shape of the cloaca in male halibut is also cone shaped, but with the vent end truncated, giving it a blunt appearance not observed in the female. In addition, the opening of the cloaca is oriented nearly perpendicular to the body with the vent opening much larger in size than in female halibut. It was observed that the urinary and generative duct pores are visible at the surface interface of the vent opening in many males.

The determination of the sex of about 10 percent of the individuals studied required more than casual visual observation because of the deflated or deformed appearance of the cloaca in some older individuals of both sexes. This uncertainty is usually resolved by massaging the bladder area in a movement directed toward the genital vent in order to expel urine, at which time, if successful, the once deflated or deformed appearance of the genital vent becomes easily recognizable.

During the first cruise, the sex of 101 out of 102 halibut was accurately predicted. On a later research cruise, 869 halibut of all sizes were sexed with a 97 percent success rate. No sex or size related bias was detected in these results. This procedure was not tested on juvenile (less than 65 cm in length) halibut but it is likely to be ineffective, especially if these secondary sexual characteristics do not develop before the onset of maturity. Also, this procedure is not applicable to halibut landed commercially as the genital vent is usually cut through or scraped off during the dressing process.

CATCH SAMPLING

The catch sampling program was revised in 1987. The short, 24-hour fishing periods had made the sampling regime impractical, in that only a few vessels could be sampled each period. An analysis of the program indicated that the number of otoliths collected in the field could be reduced while increasing the

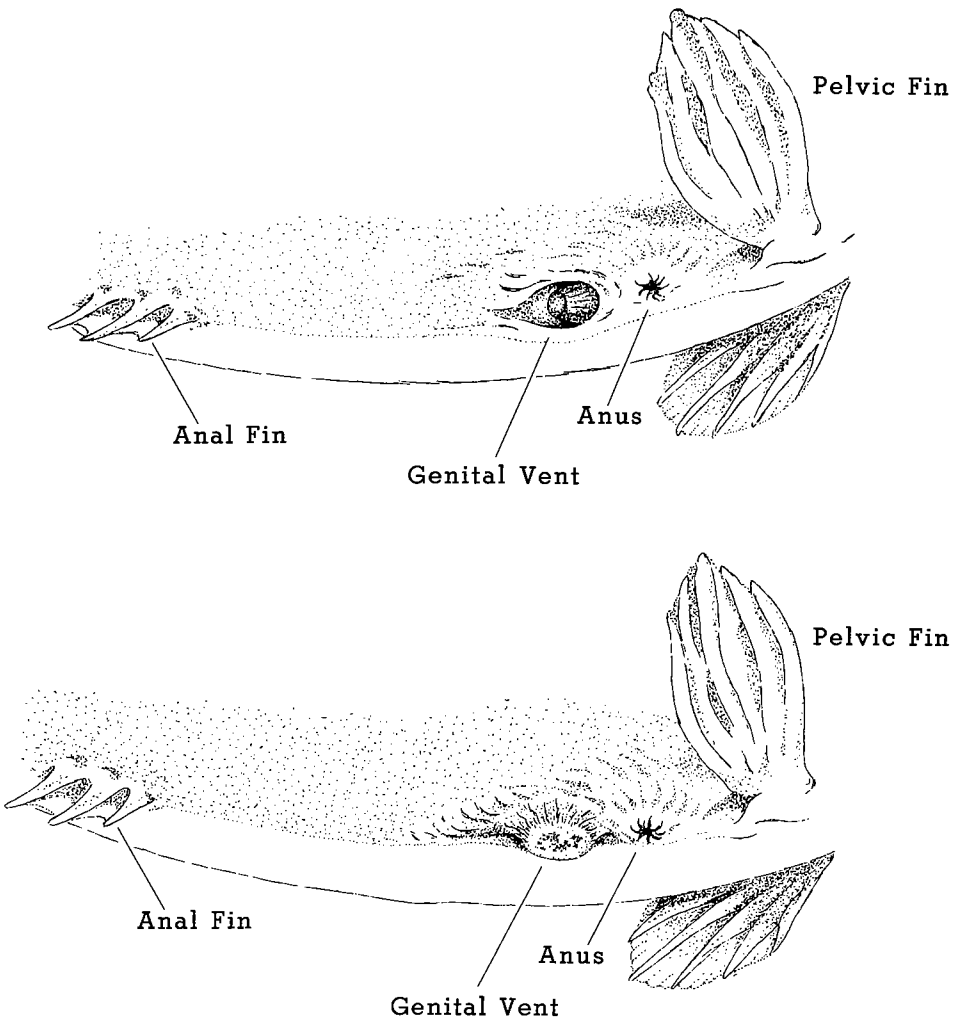


FIGURE 5.
Physical characteristics of female (top) and male (bottom) halibut.

number of otoliths aged. In addition, the revised program stresses sampling a large number of vessels, which results in collecting otoliths from a wider geographical range. The objective is to sample the catch in proportion to the harvest from each IPHC statistical area.

Nearly 17,000 otoliths were collected in 1988 in order to estimate the age composition of the catch. A sampling minimum of 4,000 otoliths for each of the regulatory area groupings of Area 2A-2B, 2C, 3A, and 3B-4 was achieved. Figure 6 illustrates the catch sampling effectiveness for Areas 2B and 3A. The catch in these areas is generally consistent across statistical areas from year to year, but the percentage of otoliths sampled will vary.

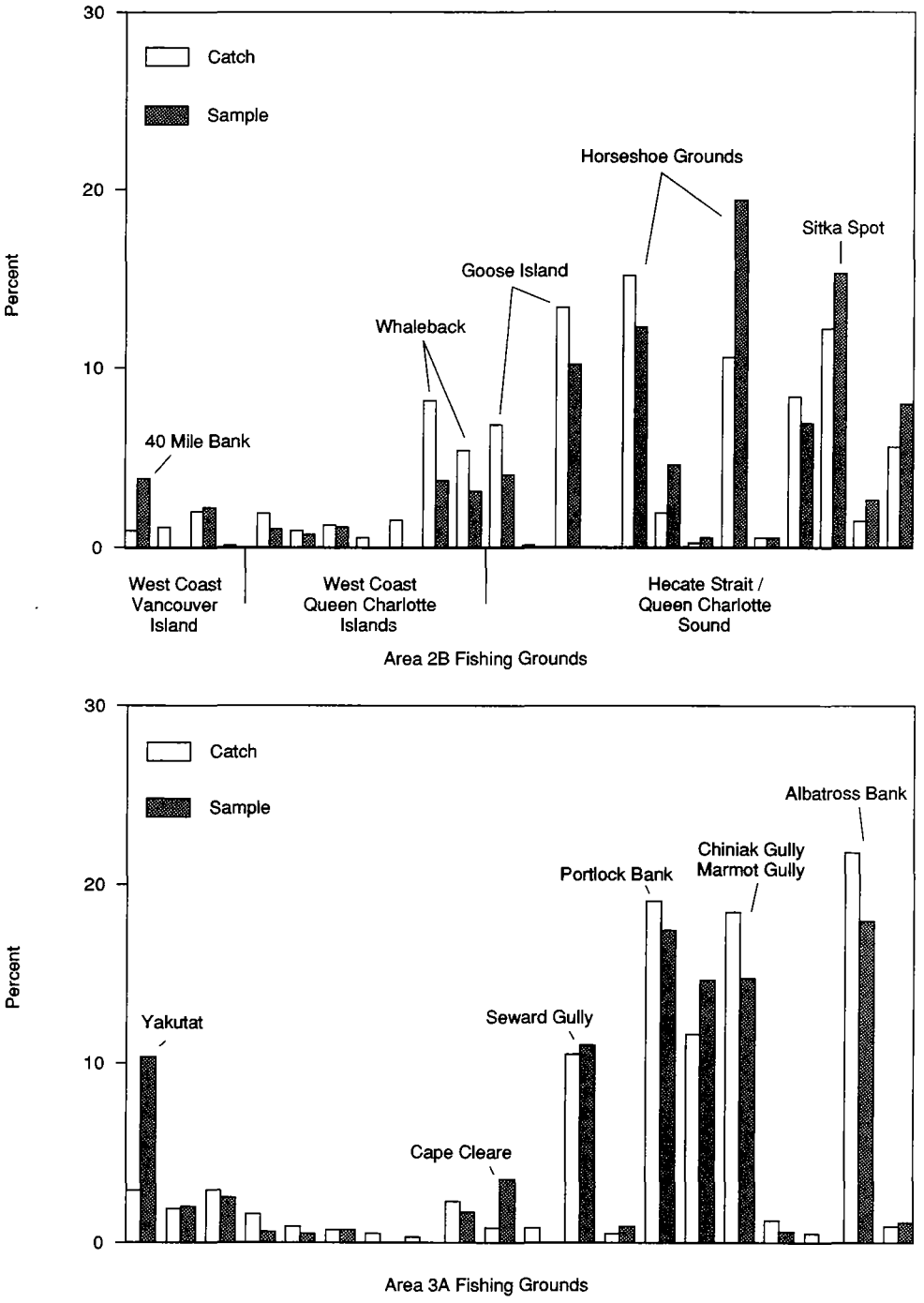


FIGURE 6.
Catch sampling effectiveness in IPHC Areas 2B (top) and 3A (bottom) in 1988.

AGE VALIDATION STUDY

During 1988 nine otoliths were collected from halibut tagged and injected with oxytetracyclene (OTC) in 1982 and 1983. Five of the otoliths were from 1982 releases in Area 3B and four from 1983 releases in Area 2B (Table 18). More OTC-injected halibut than controls were recovered in 1988 and narrowed the difference in recovery rates between the two groups (Table 19). The widest discrepancy remains with 1982 Area 2B releases where controls returned at a rate three times greater than OTC injected fish. The reasons for this difference are not understood and are under investigation.

TABLE 18.
Results of the 1982-1988 age validation study. The number of tag recoveries with otoliths is indicated in the parentheses.

Release Year	Area	No. Tagged	OTC Group Recoveries							
			1982	1983	1984	1985	1986	1987	1988	Total
1982	2B	111	2(2)	1(0)	4(2)	1(1)	3(1)	3(2)	0(0)	14(8)
1982	3B	459	1(0)	1(1)	1(1)	2(1)	2(1)	0(0)	10(5)	17(9)
1983	2B	765	—	28(19)	28(20)	24(12)	17(10)	21(17)	14(4)	132(82)
1983	3A	456	—	2(0)	15(7)	20(7)	9(5)	2(2)	1(0)	49(22)
Total		1,791	3(2)	32(20)	48(30)	47(21)	31(17)	26(21)	25(9)	212(120)
Release Year	**Area**	**No. Tagged**	**Control Group Recoveries**							
			1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**Total**
1982	2B	69	1(1)	1(1)	11(6)	8(4)	2(0)	2(1)	3(3)	28(16)
1982	3B	287	1(1)	3(1)	5(2)	4(0)	0(0)	0(0)	0(0)	13(4)
1983	2B	627	—	29(15)	16(10)	25(12)	15(6)	5(2)	9(4)	99(49)
1983	3A	472	—	2(1)	21(12)	24(11)	14(7)	1(1)	6(3)	68(35)
Total		1,455	2(2)	35(18)	53(30)	61(27)	31(13)	8(4)	18(10)	198(104)

TABLE 19.
Recovery rates for OTC and control groups in an age validation study of Pacific halibut aging techniques.

Release Year	Area	Percent Recovery	
		OTC Group	Control Group
1982	2B	12.6%	40.6%
1982	3B	3.7%	4.5%
1983	2B	17.2%	15.2%
1983	3A	10.7%	14.4%

The longest at-large period for an OTC-injected fish is just over six years. This fish (Tag 72183) was tagged in July, 1982 on the Sanak grounds (Area 3B) and recovered on Albatross Bank (near Kodiak Island in Area 3A) in September, 1988. During that period, the fish grew from 76 cm to 111 cm. A surface reading of the otolith estimated the fish to be 14 years old. Although the OTC presence was weak, growth adjacent to the mark suggests that six annual rings are present. This is consistent with the time at large for this fish. Tag release/recapture data for 1988 recoveries is summarized in Table 20.

Results indicate surface aging of halibut otoliths is a valid technique for aging most halibut. Problems occur with thick otoliths, which are often indicative of fish older than 14 years, and when annuali are stacked or cascade down the edge of the otolith. The break and burn method of aging may be better suited for examining these otoliths. For the time being, surface aging of halibut otoliths is an acceptable method for production aging. Under present time constraints, the number of otoliths required to compose the age composition prohibits using the break and burn method for each otolith, and is a problem left for future studies.

TABLE 20.
Estimated time at liberty and releaserecovery information for Pacific halibut injected with oxytetracycline (OTC) during July, 1982 and May, 1983 in Alaska and British Columbia and recovered in 1988.

Tag Number	Date of release (1982-83)	Date of recapture (1988)	Years at liberty	No. of annuli after OTC mark	Estimated age
72001	7/05/82	5/24/88	6	6	13
72090	7/06/82	9/07/88	6	no mark	14
72183	7/08/82	9/07/88	6	6	14
72188	7/08/82	6/21/88	6	6	12
72385	7/12/82	6/20/88	6	6	12
72894	5/14/83	5/10/88	5	5	13
74677	5/22/83	8/24/88	5	5	14
74703	5/22/83	5/12/88	5	5	12
74908	5/22/83	5/09/88	5	5	11

APPENDICES

The tables in Appendix I provide catch and catch-per-unit-effort (CPUE) statistics for 1988. The regulatory areas delineated in these tables are those employed for the 1988 fishery and differ from the areas used in earlier reports. Catch-per-unit-effort data have been standardized for changes in hooks and for area differences in catchability. The standardization procedures are reported in Scientific Report 71 and the 1984 Annual Report. Copies of the tables in metric units and round (live) weight are available on request. Round weight can be calculated by multiplying the dressed weight by a factor of 1.33.

The table in Appendix II provides data on ex-vessel price of halibut. The table in Appendix III shows catch and average size at each age by region of sampling.

APPENDIX I.
Catch statistics for 1988.

Table 1. Commercial halibut fishery catch (thousands of pounds) in 1988 by country, statistical area, region, and regulatory area.

Table 2. Estimates of Pacific halibut catch per unit effort (CPUE) by IPHC regulatory subarea 1975-1988. Estimates are standardized for area differences in catchability and for the use of circle hooks.

APPENDIX II.
Historical landings and value, 1929-1988.

Annual landings of Pacific halibut, value (U.S. dollars), and calculated ex-vessel price, 1929-1988.

APPENDIX III.
Age and size composition data, 1988.

Table 1. Commercial catch of Pacific halibut in numbers of fish and average weight in pounds (eviscerated, head off) at age by IPHC regulatory area, 1988.

APPENDIX I.

TABLE 1.

Commercial halibut fishery catch (thousands of pounds) in 1988 by country, statistical area, region, and regulatory area.

Country	Statistical Area	Catch	Region	Catch	Regulatory Area	Catch
United States	00-03	197	Columbia	197	2A	486
	04	36	Vancouver	832		
	05	253				
Canada	06	160			2B	12,858
	07	121				
	08	262				
	09-O	265	Charlotte			
	09-I	877	Outside	2,470		
	10-O	58	Inside	9,845		
	10-I	1,593	Total	12,315		
	11-O	227				
	11-I	2,339				
	12-O	187				
	12-I	1,435				
	13-O	1,733				
	13-I	3,601				
United States	14-O	255	Southeastern		2C	11,369
	14-I	451	Outside	4,745		
	15-O	990	Inside	6,624		
	15-I	964	Total	11,369		
	16-O	1,124				
	16-I	1,947				
	17-O	1,787				
	17-I	1,146				
	18S-O	589				
	18S-I	2,116				
	18W	1,113	Yakutat	4,448	3A	37,862
	19	706				
	20	1,108				
	21	609				
	22	374				
	23	538				
	24	1,505	Kodiak	33,414		
	25	3,994				
	26	11,563				
	27	7,686				
	28	8,666				
	29	1,862	Chirikof	4,034	3B	7,082
	30	1,546				
	31	626				
	32	1,589	Shumagin	4,107		
	33	622				
	34	837				
	35	307			4	4,692
	36	443				
	37	67				
	38	242				
	39	—	Aleutian	747		
	40	—				
	41	525				
	42+	222				
			Bering Sea	2,886		

APPENDIX I.

TABLE 2.
IPHC estimates of catch per unit effort (CPUE) for 1976-1988. Data are standardized to circle hook equivalence. Areas 2A and southern 2B CPUE based in part on conversion of "snap-on" gear to conventional gear.

		IPHC Regulatory Area					
Year	Areas Combined	2A	2B	2C	3A	3B	4
1976	124.8	71.7	116.7	116.0	131.4	142.2	184.2
1977	138.5	182.2	135.3	124.3	134.6	161.3	176.2
1978	155.1	85.5	138.0	155.1	171.9	116.4	166.7
1979	159.7	110.0	105.8	220.8	189.0	80.8	146.1
1980	204.0	82.0	143.7	218.4	260.6	249.5	124.2
1981	232.3	134.4	175.7	273.6	250.8	294.6	236.8
1982	253.8	127.0	176.7	355.9	274.1	300.7	172.5
1983	275.1	127.6	180.5	342.9	349.6	335.5	112.1
1984	300.1	127.2	188.8	328.5	412.8	353.1	193.6
1985	311.5	109.4	176.5	354.1	401.2	420.1	296.4
1986	292.9	132.4	154.7	296.4	411.9	322.4	304.6
1987	278.4	62.9	157.9	244.5	437.0	329.9	276.4
1988	261.2	111.6	151.1	229.6	357.8	478.9	191.3

APPENDIX II.

Annual landings of Pacific halibut, value (U.S. dollars), and calculated ex-vessel price, 1929-1988.

Year	Catch (000's pounds)	Price (dollars/ pound)	Value (000's dollars)	Year	Catch (000's pounds)	Price (dollars/ pound)	Value (000's dollars)
1929	56,928	0.12	6,831				
1930	49,492	0.10	4,949	1960	71,605	0.16	11,457
1931	44,220	0.07	3,095	1961	69,274	0.21	14,548
1932	44,454	0.04	1,778	1962	74,862	0.30	22,459
1933	46,795	0.06	2,808	1963	71,237	0.21	14,960
1934	47,546	0.06	2,853	1964	59,784	0.23	13,750
1935	47,343	0.07	3,314	1965	63,176	0.32	20,216
1936	48,923	0.08	3,914	1966	62,016	0.34	21,085
1937	49,539	0.08	3,963	1967	55,222	0.23	12,701
1938	49,553	0.07	3,469	1968	48,594	0.23	11,177
1939	50,903	0.07	3,563	1969	58,275	0.38	22,144
1940	53,381	0.09	4,804	1970	54,938	0.37	20,327
1941	52,231	0.10	5,223	1971	46,654	0.32	14,929
1942	50,388	0.15	7,558	1972	42,882	0.64	27,446
1943	53,699	0.19	10,203	1973	31,740	0.74	23,488
1944	53,435	0.15	8,015	1974	21,306	0.70	14,914
1945	53,395	0.15	8,009	1975	27,616	0.89	24,577
1946	60,266	0.17	10,245	1976	27,535	1.26	34,694
1947	55,700	0.17	9,469	1977	21,868	1.31	28,587
1948	55,564	0.17	9,446	1978	21,988	1.70	37,424
1949	55,025	0.17	9,354	1979	22,527	2.13	48,064
1950	57,234	0.23	13,164	1980	21,866	0.99	21,668
1951	56,045	0.17	9,528	1981	25,732	1.02	26,223
1952	62,262	0.19	11,830	1982	29,008	1.09	31,560
1953	59,837	0.15	8,976	1983	38,384	1.13	43,534
1954	70,583	0.17	11,999	1984	44,970	0.75	33,698
1955	57,521	0.14	8,053	1985	56,113	0.89	49,884
1956	66,588	0.22	14,649	1986	69,632	1.44	100,270
1957	60,854	0.17	10,345	1987	69,482	1.58	109,782
1958	64,508	0.21	13,547	1988	74,349	1.28	94,887
1959	71,204	0.19	13,529				

APPENDIX III.

TABLE 1.

Commercial catch of Pacific halibut in numbers of fish and average weight in pounds (eviscerated, head off) at age by IPHC regulatory area, 1988.

	Area 2A		Area 2B		Area 2C	
Age	Catch	Ave Wt	Catch	Ave Wt	Catch	Ave Wt
3	0	0.0	120	4.5	0	0.0
4	0	0.0	0	0.0	145	1.7
5	0	0.0	741	6.5	231	7.2
6	0	0.0	2,966	9.7	1,250	10.3
7	1,244	11.8	19,790	12.5	7,484	12.7
8	5,024	13.9	70,850	14.6	23,568	15.0
9	7,511	16.3	103,186	17.4	44,739	18.6
10	4,402	18.2	91,972	20.0	51,279	22.6
11	4,737	20.2	102,938	22.5	72,244	25.8
12	1,675	21.5	61,043	26.6	51,110	29.6
13	1,244	25.2	30,637	29.4	38,217	36.3
14	335	38.5	22,531	34.7	28,250	40.7
15	287	28.5	12,327	40.1	19,419	43.0
16	191	37.8	8,553	46.8	13,049	47.0
17	48	31.3	3,443	49.5	8,866	50.7
18	0	0.0	2,844	66.6	6,429	50.1
19	0	0.0	1,947	61.2	3,689	54.8
20	0	0.0	2,182	66.6	2,724	59.3
21+	0	0.0	4,231	95.1	4,917	90.8
Total	0	18.0	542,299	23.0	377,608	30.2
	Av Len 93.9, Av Age 9.8		Av Len 100.0, Av Age 10.6		Av Len 108.8, Av Age 11.8	
	#Oto's 558, #Aged 558		#Oto's 3,921, #Aged 3,918		#Oto's 4,003, #Aged 4,000	

	Area 2 Total		Area 3A		Area 3B	
Age	Catch	Ave Wt	Catch	Ave Wt	Catch	Ave Wt
3	120	4.5	0	0.0	0	0.0
4	145	1.7	0	0.0	0	0.0
5	972	6.6	0	0.0	0	0.0
6	4,217	9.8	4,352	14.5	233	12.3
7	28,521	12.5	32,085	17.2	5,407	15.6
8	99,451	14.6	119,309	19.9	21,730	20.9
9	155,448	17.7	162,662	25.9	21,534	25.7
10	147,663	20.9	142,853	32.5	25,093	28.5
11	179,930	23.8	187,669	39.3	40,525	36.1
12	113,833	27.9	106.672	48.2	17,820	42.6
13	70,100	33.1	67,549	53.8	13,734	49.6
14	51,118	38.0	58,219	58.9	8,962	56.3
15	32,035	41.7	44,418	62.3	7,592	60.2
16	21,794	46.8	18,268	70.6	2,621	74.3
17	12,356	50.3	14,717	69.8	1,066	74.0
18	9,274	55.2	6,101	78.3	1,448	42.7
19	5,636	57.0	4,110	86.8	1,097	92.2
20	4,906	62.6	1,522	87.6	233	61.7
21+	9,148	92.8	4,043	129.7	651	113.1
Total	946,663	25.8	974,549	39.0	169,744	36.5
	Av Len 103.4, Av Age 11.1		Av Len 117.2, Av Age 10.9		Av Len 115.3, Av Age 11.0	
	#Oto's 8,482, #Aged 8,476		#Oto's 4,133, #Aged 4,133		#Oto's 2,494, #Aged 2,494	

	Area 3 Total		Area 4		All Areas	
Age	Catch	Ave Wt	Catch	Ave Wt	Catch	Ave Wt
3	0	0.0	0	0.0	120	4.5
4	0	0.0	0	0.0	145	1.7
5	0	0.0	0	0.0	972	6.6
6	4,584	14.4	33	1.7	8,835	12.1
7	37,492	16.9	845	14.2	66,857	15.0
8	141,038	20.0	6,424	14.8	246,913	17.7
9	184,196	25.9	17,667	20.4	357,311	22.0
10	167,946	31.9	21,274	25.0	336,883	26.6
11	228,194	38.7	35,113	28.4	443,237	31.8
12	124,492	47.4	12,920	34.2	251,244	37.9
13	81,283	53.1	8,591	41.9	159,974	43.8
14	67,181	58.6	8,531	50.0	126,829	49.7
15	52,010	62.0	6,524	54.6	90,569	54.3
16	20,890	71.1	3,480	57.5	46,164	58.6
17	15,783	70.1	2,836	61.7	30,975	61.4
18	7,549	71.5	3,182	64.5	20,005	62.8
19	5,208	87.9	1,859	85.5	12,703	73.9
20	1,755	84.2	572	81.7	7,233	69.3
21+	4,693	127.4	4,769	90.3	18,609	100.9
Total	1,144,293	38.6	134,620	35.7	2,225,576	33.0
	Av Len 117.0, Av Age 10.9		Av Len 114.8, Av Age 12.1		Av Len 111.7, Av Age 11.1	
	#Oto's 6,627, #Aged 6,627		#Oto's 1,662, #Aged 1,662		#Oto's 16,771, #Aged 16,765	

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The Commission publishes three serial publications — Annual Reports, Scientific Reports, and Technical Reports — and also prepares and distributes regulation pamphlets and information bulletins. Items produced during 1988 by the Commission and staff are shown below. A list of all Commission publications is shown on the following pages. Commission materials are available upon request free of charge.

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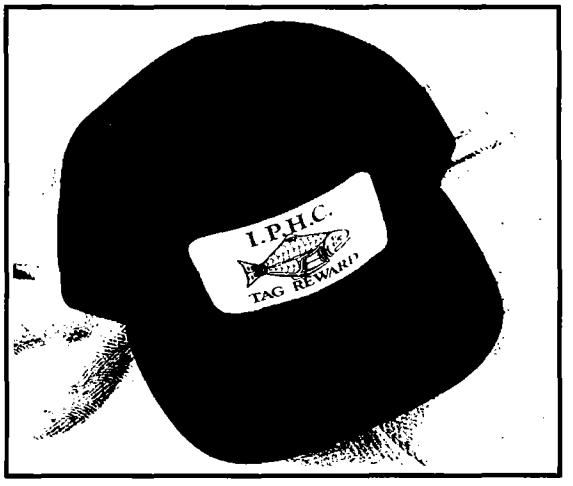
TAGGED HALIBUT

The INTERNATIONAL PACIFIC HALIBUT COMMISSION attaches plastic tags to the cheek on the dark side of the halibut. Fishermen should return all tags, even those from halibut below legal size or those caught in trawls.



REWARD

$5.00 will be paid for the return of each tag.
OR
A "Hat" will be paid for the return of each tag.

WHEN YOU CATCH A TAGGED HALIBUT:

1. Record tag numbers, date, location and depth in your log book.
2. Leave the tag on the fish.
3. Mark the fish with a gangion around tail.

WHEN YOU LAND A TAGGED HALIBUT:

1. Report fish to a Commission Representative or Government officer
   or
2. Forward tags to address below and enclose recovery information (see above), your name, address, boat name, gear, length of fish, and, if possible, earstones.

FINDER WILL BE ADVISED OF MIGRATION AND GROWTH OF THE FISH.

International Pacific Halibut Commission
P.O. Box 95009
Seattle, Washington 98145-2009