INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report
1997

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

Commissioners

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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.

On the Cover: A view from the F/V Sand Island

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 industry; specifically the Conference Board and the Processor Advisory Group. 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 numbers of that series have 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 dividing the dressed weight by 0.75.

The IPHC can now be visited on the Internet. Our Homepage address is:

http://www.iphc.washington.edu

The following abbreviations are used throughout this report:

IPHC	International Pacific Halibut Commission
NMFS	National Marine Fisheries Service (United States)
DFO	Department of Fisheries and Oceans (Canada)
NPFMC	North Pacific Fishery Management Council
PFMC	Pacific Fishery Management Council
ADF&G	Alaska Department of Fish and Game
WDFW	Washington Department of Fish and Wildlife
ODFW	Oregon Department of Fish and Wildlife
IFQ	Individual Fishing Quota
IVQ	Individual Vessel Quota

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ACTIVITIES OF THE COMMISSION: DANCING TO THE RHYTHM OF THE DEEP

Stewardship of the world's benthic treasures is not so much a matter of satisfying demands as obeying commands: "The always wind-obeying deep," as Shakespeare called it, issues its silent, mysterious dictums and we - responsible, cautious, insatiable - must obey. For seventy-four years, the International Pacific Halibut Commission has studied and celebrated the great Pacific halibut, *Hippoglossus stenolepis*, and we have tried with all our science and some soul to obey the canon set before us by the fish themselves: to learn, to listen, to set limits upon ourselves and our appetites so that this species can flourish, and in flourishing can teach us something new about the wonders of the world we inhabit.

The International Pacific Halibut Commission is a six-member board, with three Canadian and three U.S. delegates, that meets several times a year to set catch limits, write fishing regulations, oversee biological research, and design programs and policies to protect the resource and further the fisheries.

In January 1997, the Commission held its seventy-third annual meeting in Victoria, British Columbia, chaired by Dr. Richard Beamish of Canada's Department of Fisheries and Oceans (DFO). Mr. Steven Pennoyer from the U.S. National Marine Fisheries Service (NMFS) served as vice-chair. This year was also the last year under the leadership of Executive Director Donald McCaughran, who retired in early 1998 after serving the Commission well for 20 years. Late in the year, the Commission reins were handed to Dr. Bruce Leaman, formerly of DFO.

CATCH LIMITS AND OTHER REGULATIONS

As stewards of the Pacific halibut resource, the Commission sets conservative catch limits every year, which are in turn adopted by the various fishery management agencies that oversee all harvests within the halibut range. Commercial catch limits for 1997 are shown in the table at the right.

Area	Catch limit (pounds)
2A	374,235
2B	12,500,000
2C	10,000,000
3A	25,000,000
3B	9,000,000
4A	2,940,000
4B	3,480,000
4C	1,160,000
4D	1,160,000
4E	260,000
Total	**65,874,200**

The Commission again adopted the Area 2A catch sharing plan, as specified by the Pacific Fishery Management Council. The Catch Sharing Plan allocates each of the fisheries in Area 2A its own catch limits: Commercial (144,235 pounds); Treaty Indian directed fishery (230,000 pounds); the Treaty Indian ceremonial and subsistence fishery (15,000 pounds); sport fishing north of the Columbia River (166,530 pounds); sport fishing south of the Columbia River (144,235 pounds).

Much of the discussion during the Annual Meeting focused on proposed regulatory changes and their implications. The changes that affected fishing and research activities of 1997 are discussed in the body of this Annual Report.

Licensing: For the commercial halibut fisheries off Alaska, the IPHC decided to discontinue licensing of commercial vessels, since the Commercial Fisheries Entry Commission already has a system in place.

Combination trips: Vessels are allowed to combine Area 4 IFQ trips with Area 3 or 2C, provided fish are kept separate in the hold and an observer is aboard.

OTHER CONCERNS RAISED AT THE ANNUAL MEETING

Those who have attended an IPHC Annual Meeting know what a lively and vigorous interchange it can foment. Here are some of the topics discussed during the public session of the 1997 Annual Meeting:

Seabirds and fishing activities: Mr. Thorn Smith from the North Pacific Fishing Vessel Owner's Association and Mr. Mark Lundsten, owner of the *F/V Masonic*, made presentations regarding the capture of short-tailed albatross in the halibut fishery. Following a review of the new regulations for the groundfish fishery off Alaska, Mr. Smith noted several ways to deal with the problem and encouraged fishers to experiment with different methods. Mr. Lundsten talked about his experience with seabird interactions. It was pointed out that the NMFS is responsible for monitoring the short-tailed albatross take and will administer closures based on the Endangered Species Act.

Among the other topics raised at the public session were weight-at-age discrepancies of the fish and the ramifications of the smaller weight-at-age seen in the population recently; leaving unharvested fish on the grounds; local depletion; accountability of removals; chalky condition in halibut; early life history studies; allocations to sport interests; and observer coverage in the halibut fishery.

SINGING THE BYCATCH BLUES

Bycatch of halibut and other species remains a deep and constant concern within north Pacific fisheries. At the 1997 Annual Meeting, much discussion focused on halibut bycatch reduction in each country.

Off the U.S. West Coast, all trawlers were sent a video describing methods of reducing halibut bycatch mortalities, and trawlers participate in a voluntary observer program and fill out logbooks to assist with bycatch estimates.

In Canada, the trawl fleet began an Individual Bycatch Quota program, allocating a certain amount of halibut bycatch to each groundfish trawler, giving each individual an incentive to reduce bycatch as much as possible. In 1997, only one vessel exceeded the cap and was removed from the area. Bycatch was low this year also because the Pacific cod fishery was closed. As that fishery catch limit increases, so will bycatch, although the total bycatch mortality should still fall below the goal of one million pounds.

In Alaska, attempts to establish a Vessel Incentive Program are continuing. Many of the bycatch reduction methods were developed when halibut stocks were declining. Since that is no longer the case, there is increasing pressure to raise halibut bycatch caps. The reauthorization of the Magnuson Act will allow managers to move towards new methods of handling bycatch, such as vessel bycatch accounts. The industry does support a vessel bycatch account system, but opinions on how to implement it vary considerably, since it is seen as an allocation of groundfish.

THE MOST COMPLEX STOCK ASSESSMENT IN THE WORLD

One of the topics of greatest interest to the Commission members was the new stock assessment, which reflects far higher halibut stocks than previously thought, and the staff-proposed catch limits that result from the new assessment. There are significant uncertainties attached to the assessment - these are discussed in detail later on in this report - that influence our interpretation of the assessment.

At this Annual Meeting, Dr. McCaughran said that of all the stock assessment models that fishery managers have to work with, the halibut assessment model that IPHC scientists use is the most complex in the world. As a rule, the staff is conservative in all areas when recommending catch limits. However, in areas where confidence in the assessment was high, the catch limit recommendation was closer to the CEY, and in areas with low confidence, such as Area 4, the staff recommendations were more conservative.

THE FIVE-YEAR RESEARCH PLAN

Since the reanalysis of the stock assessment last year, the assessments and resulting catch limits are undergoing a dramatic change. Participants in the annual meeting expressed concern about the accuracy of information upon which the changes are based, and that adequate care is being taken to compensate for possible errors or misinterpretations. The IPHC staff will conduct a complete set of surveys each year for the next five years that will provide information on relative distribution among areas needed for the assessment.

The five-year plan includes five years of extensive stock assessment surveys in all areas, as well as other biological research, that will give us a comprehensive view of stocks, changes, and other biological data over an intense span of time. During the current five year period, the staff will present progress reports of research projects in the autumn of each year in a public meeting. The Commission also reaffirmed that advisory groups would be asked to suggest new research projects, and to comment on ongoing projects during each Annual Meeting.

BANK ACCOUNTS

During the administrative session, Mr. Pennoyer informed the Commission members that the U.S. is unwilling to change the 50/50 funding formula by which each country supports the IPHC. For several years, Canada has asked for a reconsideration of the formula, in light of the fact that a greater percentage of Pacific halibut is harvested in U.S. waters than in Canada. Negotiations between the two countries will continue.

HIGHLIGHTS FROM THE NOVEMBER INTERIM MEETING

Research ex-vessel price: For survey vessels in 1997, the research ex-vessel price was about $2.00 per pound in Alaska and $2.40 in Canada.

High-grading: High-grading is the practice of releasing halibut of less desireable sizes (lower price) in order to increase the overall value of the catch. High-grading can cause mortality of released fish and create problems in interpreting the abundance of halibut in each size class. High-grading is legal in Canada, but illegal in the U.S. There has not been much change in the size composition within the past five years, which would indicate that high-grading is not a wide-spread problem. However, because size composition of the catch can vary widely depending on the relative size of year classes recruiting to the fishery, size information does not alone indicate how much high-grading is taking place.

New stock assessments: This year, we have six times the amount of data to work with than in previous years. This is a luxury, but it also takes far more time to analyze and interpret. For that reason, there were delays in producing the stock assessment for 1998. During 1997, the assessment underwent a peer review and a report was presented to the Commission regarding the panel's findings.

The following actions were taken at the Interim Meeting:

1) The Commission agreed to bring the high-grading discussion to the 1998 Annual Meeting;

2) The staff was to make copies of the peer review of the stock

assessment model available to the public and send staff comments back to the peer review panel;

3) The Area 4 assessment model, sport charter license issue, and sublegal halibut discards on survey vessel issues will be discussed at the 1998 Annual Meeting, and the 1998 Interim Meeting will be scheduled for the week preceding the North Pacific Fishery Management Council meeting;

4) A report on a migration effects model being developed by the staff will be presented to the Commission in 1998;

5) A report will be presented in 1998 which considers two different estimates of halibut mortality rates (one by IPHC and one by NMFS).

Hot topics for 1997

- Stock assessments: Are they accurate? How can we manage in the face of uncertainties?
- Chalky condition in halibut: Is it preventable?
- Sport fishing: How do we treat sport fisheries and commercial fisheries equitably in our regulations?
- Local depletion: Are some fishing spots getting hit harder than they should?

Director's Report: Message From Dr. Leaman

The major feature of 1997 for the Commission and the resource has been change. Changes in the assessment methodology, changes in our understanding of halibut, changes in the quotas, and tremendous change in halibut bycatch mortality in Canada. There has also been a change in the face on this page that you have become accustomed to over the past 20 years. Don McCaughran has retired and will continue to work on projects of his choosing and, of course, the odd round of golf. I came on staff with the Commission in October, 1997 after 21 years as a scientist with the Canadian Department of Fisheries and Oceans, including 12 years as the Canadian Scientific Advisor to the Commission. Don and I had the opportunity for several months of overlap, which was invaluable for me.

What are my objectives for the Commission? The foremost objective that any resource management agency should achieve is to produce scientifically sound recommendations for management. This sounds deceptively simple, yet is anything but, as we have seen only too clearly for several world fisheries in recent years. It is not just building the best possible analytic model. That has and is being done by the Commission staff on a continuing basis. It is ensuring that the necessary research is conducted so that we can reduce the number of assumptions that must be made in assessment models. This research involves everything from the basic biology of the fish, to behaviour of the fishing gear and the fleet, to the influence of the environment and the ecosystem on halibut population dynamics. The Commission has been at this task for a long time and we still have much to learn. This learning is an ongoing process not only because the ecosystem is complex and dynamic, but also because the halibut population changes in concert with changes in the environment and the ecosystem. Maintaining the Commission's record of scientific excellence is therefore my highest priority.

It is also one of my major objectives to make sure that the Commission is an active part of the fishing and fishery management community. The Commission's port samplers are one of our strongest assets and they help ensure that your concerns and advice get to us. However, I won't just be sitting at my desk in Seattle, either. You will see me on the docks and in the plants on a regular basis. I will be there to question, listen, and learn, as well as to share the results of our research with you. The Commission must work constructively with the fishery management agencies of the two countries. This does not mean that the health of the halibut resource should be sacrificed for that of another species. It does mean that the Commission and its staff should work jointly with these agencies to achieve common goals. In that vein, the staff will continue its efforts to reduce halibut bycatch mortality in non-target fisheries, through both our research and through stimulation of agencies to develop more effective bycatch reduction programs.

In 1997 there were large changes in the stock assessment. These changes were made so that we would account for changing halibut growth rates and the correct distribution of bycatch mortality impacts by IPHC area. The net result of the changes in the assessment was that recruitment is no longer believed to be sharply declining and the stock is larger than assumed previously. Catch rates on our standardized setline surveys also confirmed that halibut biomass is at a high level.

The Commission funded an external review of the assessment model by a panel of international experts during 1997. This panel endorsed the Commission's approach but also indicated areas where it believed caution was required. The Commission needs additional experience with the new assessment model and the quotas assigned for 1997 were at the low end of the range of recommendations supplied by the assessment. Nonetheless, the overall catch limit increased substantially, from 48.66 million pounds in 1996 to 66.2 million pounds in 1997. We believe that the stock is healthy and that this level of removals maintains the Commission's prudent approach to management. We also know that this belief needs constant verification and that is our primary task for the future.

One of the major concerns facing the Commission and me is the continued funding of our operations. The Commission's budget was reduced by $67,000 by the two governments in 1995 and has been frozen since. While governments are faced with the difficult task of deficit reduction, inflationary effects have created a continuing decline in our effective budget. The implementation of IQ programs in the two countries has also extended the fishing season and increased our port sampling costs. The Commission needs to access external sources of funds or draw revenue from the resource, just to fund our basic fishery monitoring activities. Funding our research programs means an additional increment on this basic requirement. The Commission will therefore have to expend more effort in trying to acquire external funds for needed research. This represents a considerable challenge for the future of the Commission.

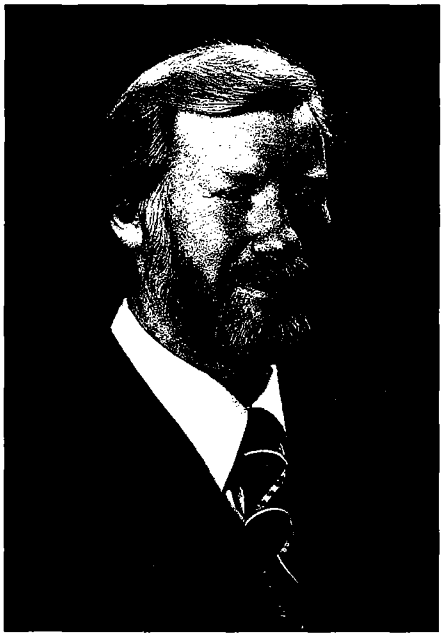
Bruce M. Leaman
Director

Bruce

Director McCaughran Retires

Dr. Donald A. McCaughran came to work for the International Pacific Halibut Commission as the Director in 1978, replacing Mr. Bernard Skud. Dr. McCaughran claimed his position at a time of unprecedented low abundance of halibut stocks and a dramatically changing international fisheries scene.

In 1976, the U.S. and Canada extended fishery jurisdiction to 200 miles, and negotiated a new halibut treaty in 1979 to bring the halibut fishery into compliance. Dr. McCaughran helped smooth the transition from complete access of any fisherman to all waters of either country to allocation of specific quotas to each country. Under his leadership, the Commission adopted a principle of setting quotas in all areas based on the biomass in the areas. This policy reduced the opportunity for political influence on quotas.



Dr. McCaughran felt strongly that one of his most important jobs was finding the best scientists available, and giving them the freedom to do their jobs. He acted as a buffer to outside influence on the scientists, and often stated "you do the best analyses you can, and let me worry about the consequences."

In the 1980s, Dr. McCaughran facilitated a new way of looking at the stock assessment. Commission scientists were among the first in North America to apply age-structured models to fishery management. Instead of using catch per unit of effort as the primary indicator of stock health, a system of using catch and age data was instituted. The model evolved as fishery science improved, and became more realistic, more data intensive, and more complex. In the early 1990s, The staff noted discrepancies in the model results. Dr. McCaughran encouraged the IPHC staff to address the discrepancies, and an improved stock assessment model was presented to the Commission in 1996. His practices helped to preserve the reputation of the IPHC as one of the most successful fishery management agencies in the world. At this time, halibut abundance is at record high levels after over 100 years of commercial fishing.

Dr. McCaughran completed his last full year as Director in 1997, and retired in January 1998. In his retirement, he plans to continue teaching classes at the University of Washington on a periodic basis, and spending time golfing, birding, and working on a statistics text book at his Arizona home. The commissioners and staff would like to thank him for his outstanding service and leadership for the past 20 years.

YIELDS OF DREAMS: THE 1997 COMMERCIAL FISHERY

"I must go down to the seas again, to the lonely sea and the sky,
And all I ask is a tall ship and a star to steer her by,
And the wheel's kick and the wind's song and the white sail's shaking
And a grey mist on the sea's face and a grey dawn breaking...."
- John Masefield 1878 - 1967
"Sea Fever"

It was a remarkable year in the Pacific halibut fishery. Those who steered their ships through the gray mists and the gray dawns breaking came home with more than poetry in their pockets. For halibut harvesters, the "sea fever" that seizes the soul rewarded the treasury as well this year. Commercial harvesters landed more than 65 million pounds of halibut in 1997, 138 percent of the 47 million pounds landed in 1996. (This total does not count sport, personal use, and other uses.) The dramatic hike in catch limits followed from incorporating new knowledge of halibut growth and changes in how we account for the impacts of halibut bycatch. This revealed that there were actually a lot more fish in the sea than previously estimated. Though Pacific halibut stocks continue a natural downward trend due to lower recruitment in recent years, the overall abundance is far higher than was formerly assumed.

After several years of declining catch limits, fishers reaped a bounty indeed in 1997, harvesting 65 million pounds in the commercial fisheries alone.

"THE WORLD OF WATERS WIDE:" MAPPING IPHC AREAS

Stewards of the Pacific halibut stock draw lines around regulatory areas so that we can better manage the fishery to meet the specific needs of each area.

Figure 1 shows the ten regulatory areas within the Pacific halibut fishing grounds. These boundary lines have remained the same since 1990. The Southeastern flats in the Bering Sea, excluding Bristol Bay, remained closed to all halibut fishing in 1997. In cartographer's terms, the ten regulatory areas are as follows:

Area 2A - all waters off the coast of the states 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.
Area 4A - all waters west of Area 3B and the Bering Sea closed area that are south of 56°20'N. and east of 172°00'W.

Area 4B - all waters in the Gulf of Alaska and the Bering Sea west of Area 4A and south of 56°20'N.

Area 4C - all waters in the Bering Sea north of Area 4A and the closed area that 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 and 4B, north and west of Area 4C, and west of longitude 168°00'W.

Area 4E - all waters in the Bering Sea north and east of the closed area, east of Areas 4C and 4D, and south of 65°34'N.

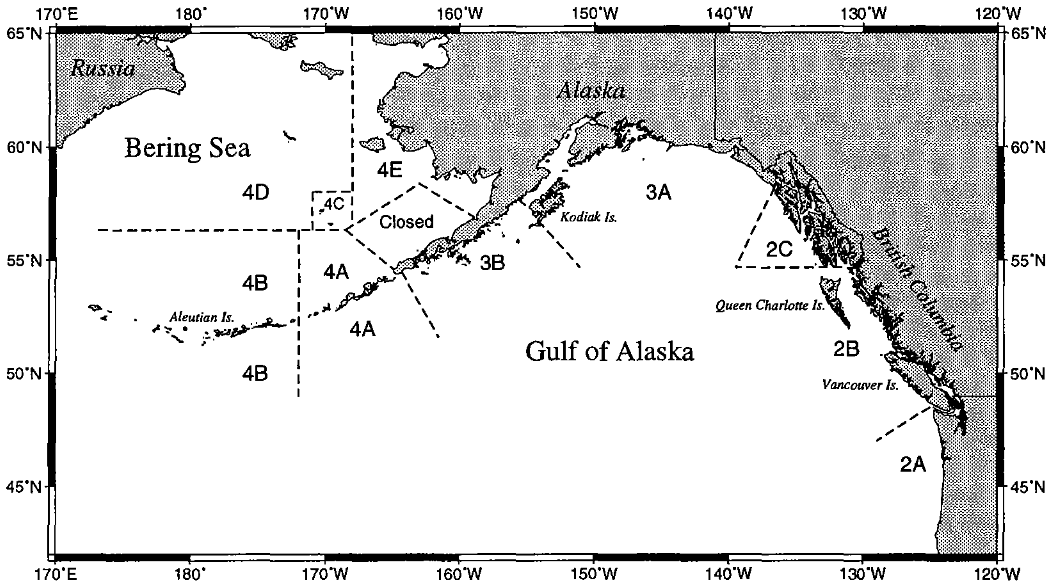


Figure 1. IPHC regulatory areas in 1997.

A FEW STRONG INSTINCTS AND A FEW PLAIN RULES: REGULATIONS FOR 1997

The most momentous regulatory change for the year came in the form of increased catch limits that reflected the change in estimated halibut abundance.

Each year at its Annual Meeting, the Commission adopts regulations that will apply to the halibut fisheries for the year ahead. The 1997 Annual Meeting was held in January in Victoria, British Columbia, where the most momentous regulatory change for the year came in the form of increased catch limits that reflected the change in estimated halibut abundance. A few minor regulatory changes helped ease fishers' reporting requirements and made accurate landing data a little easier to come by.

To help improve landing data by regulatory area, the 1996 regulations were changed to require fishers to identify each halibut by regulatory area of capture when vessels fished in more than one regulatory area on a single fishing trip in Areas 2C, 3A and 3B. In 1997, the regulations were expanded to allow vessels to fish in Area 4 and then in Areas 3A, 3B, or 2C during the same trip. The fish still needed to be identified by the area of capture, and NMFS-certified observer requirements still applied. Also, Area 4 clearance procedures were still in effect.

Also in 1997, the requirement to keep a halibut fishing log separate from other fishing records on board the vessels was lifted.

Also in 1997, the requirement to keep a halibut fishing log separate from other fishing records on board the vessels was lifted. This change allowed skippers to maintain one log if fishing for sablefish and halibut during the same trip, and also allowed skippers to use the NMFS groundfish catcher vessel logbook.

The IPHC did not issue its own Alaska commercial licenses in 1997, since the Alaska Commercial Fisheries Entry Commission licenses Alaskan vessels. In British Columbia and areas southward, there were no changes to licensing procedures.

Catch limits in the Bering Sea areas (Area 4) are set to reflect a catch sharing plan implemented by the North Pacific Fishery Management Council (NPFMC), rather than according to biological allowance. The Commission adopted the catch sharing plan as requested by the NPFMC, but in the future will recommend catch limits based on biological data.

NO BOUNDARIES TO OUR BOUNTY: HIGH CATCHES COASTWIDE

With the exception of catches off the U.S. west coast, the lion's share of the commercial Pacific halibut catch occurred over 245 days, from March 15 to November 15. More than 30 percent of the coastwide catch occurred in Area 3A, those tumultuous waters of the eastern Gulf of Alaska. However, the biggest increase in the catch limit came in Area 3B, the western Gulf, where the catch was nearly tripled over 1996 catches (see Appendix I for specific figures).

Area 2A: Spreading the wealth

Area 2A was managed to provide a total allowable catch of 700,000 pounds for all user groups. Each year, the Pacific Fishery Management Council (PFMC) recommends a halibut allocation between the user groups, and the IPHC adopts the recommendations. This year the sport fishery was allocated 310,765 pounds, and the treaty Indian fishery was allocated 245,000 pounds; 15,000 pounds for subsistence and ceremonial use, with the remaining 230,000 pounds for a commercial fishery. The non-treaty commercial catch limit was 144,235 pounds: 122,600 pounds allocated to the directed fishery, and 21,635 pounds earmarked as incidental catch in the salmon troll fishery. The directed commercial fishery is restricted to waters south of Point Chehalis, Washington (46°53'18"N. latitude) under regulations established by the NMFS.

This year the IPHC issued 428 licenses for the directed commercial fishery - 25 more than in 1996 - and 139 licenses for the sport charter fishery, which remained fairly consistent with last year. The number of licenses issued for the incidental commercial catch of halibut during the salmon troll fishery more than doubled from 1996, leaping to 275 in 1997.

The incidental commercial halibut catch during the May and June salmon troll fishery slid below the catch limit by 10 percent (2,200 pounds), which is the closest the incidental catch has been to the catch limit since this allocation started in 1995. The allowable incidental catch ratio was one halibut per ten chinook, plus an extra one halibut regardless of ratio, but the total number of incidental halibut landed could not exceed twenty. In 1996, the ratio of halibut to chinook had been one to fifteen. The new, decreased ratio and apparent increased interest in this fishery boosted the total number of pounds landed to 19,000 pounds. The remaining pounds (at the time of the fishery it was estimated to be 4,000 pounds) were rolled into the directed commercial halibut fishery at the end of the June troll fishery. If commercial catch had been under that catch limit at the end of July, some amount would have rolled back into the troll fishery then. However, the entire commercial catch limit was taken in one July opening, so there was no incidental commercial halibut fishery later in the year.

This year the IPHC issued 428 licenses for the directed commercial fishery - 25 more than in 1996 - and 139 licenses for the sport charter fishery in Area 2A.

The directed commercial fishery consisted of one 10-hour fishing period with fishing period limits by vessel size (Appendix II - Table 1). Stormy weather during the fishery probably lowered these catches, but with the high interest in this fishery this year, the final landings still exceeded the catch limit by 25,000 pounds, and as a result the overall Area 2A commercial catch exceeded the catch limit.

The directed commercial fishery consisted of one 10-hour fishing period with fishing period limits, and still exceeded the catch limit by 25,000 pounds.

The treaty Indian catch of 228,000 pounds slipped in just below the 230,000-pound limit. This catch was taken in an unrestricted and a restricted fishery. The unrestricted longline fishery consisted of three openings over six days with a catch of 201,000 pounds. The restricted fishery, with a trip limit of 500 pounds, closed earlier than usual on March 27, with a catch of 27,000 pounds.

Area 2C: The Metlakatla fishery

In the gemstone-still waters of the southeast Alaska archipelago, a small but important fishery takes place each year. The Metlakatla Indian community conducts a commercial halibut fishery within the Annette Island Reserve that is managed separately from the quota fisheries in surrounding waters. This year, the Metlakatla fishery was divided into nineteen 48-hour fishing periods scheduled between May 2 and September 28, producing a total catch of 88,490 pounds (Appendix II - Table 2).

Though the Metlakatla fishery enjoyed five more openings in 1997 than in the previous year, the total catch was lower and the number of participating vessels decreased from 39 in 1996 to 32 in 1997. The Metlakatla landings are included in the total Area 2C catch.

Modulations in management: The Quota Share Fisheries

Individual quotas have lengthened the fishing year: the intense, short openings that characterized the derby fishery have elongated into an eight-month halibut fishing season.

It has been a decade of change for the halibut fisheries north of Juan de Fuca. The fishery management philosophy altered dramatically a few years ago, when British Columbia, and later Alaska, separately switched from the derby system to an individual quota system. The transition has brought a multitude of predicted and unforeseen changes to the halibut fisheries in both regions.

One of the biggest changes is the length of fishing season: the intense, short openings that characterized the derby fishery have elongated into an eight-month halibut fishing season, allowing harvesters to schedule halibut fishing around market demands, weather, and other fisheries. From British Columbia to the Bering Sea, all quota share fisheries were open from March 15 to November 15.

In an individual quota fishery, quota share holders or vessels are allocated a predetermined amount of the total halibut catch each year. Because it is difficult to catch a precise amount to the very pound, an underage/overage program was established that enables fishers to roll up to 10% of unused poundage into the next year's fishery, or subtracts amounts of 10% of overharvests from the next year's catch. The underage/overage program has helped harvesters reduce the risk of trying to hit their target poundage without exceeding it.

This was the seventh year of individual quota fishing for British Columbia (Area 2B) vessels, and the third in waters off Alaska. Though there are some similarities between the two quota programs, there are major differences also.

This was the seventh year of quota fishing for British Columbia vessels, and the third in waters off Alaska.

The Area 2B catch and the fleet

The Individual Vessel Quota (IVQ) program in British Columbia assigns each vessel a predetermined poundage of halibut, as calculated by the Canadian DFO, based on the catch limit approved by IPHC. This year the Area 2B catch limit was 12.5 million pounds, plus an additional 81,000 pounds carried over from 1996. This year landings totaled just 1 percent less than the catch limit, coming in with a catch of 12,420,000 pounds.

Since quota shares became transferable in the British Columbia IVQ program in 1993, the fleet has gradually diminished in number. At the start of the IVQ program, 435 vessels with "L" licenses were issued quota shares. In 1996, 279 vessels landed halibut; this year 285 participated, and approximately half of the catch (6.2 million pounds) was transferred among vessels through lease or sale. It is important to note that because of the vessel quota restrictions, the number of vessels will probably not drop below 218.

In 1996, DFO issued some native tribes "F" licenses, instead of "L" licenses, to be fished as part of a Native Communal commercial fishing program. The catch from these licenses in 1997 was 231,289 pounds, compared with 64,726 pounds in 1996. This poundage is included in the IVQ landings.

Target of largess off Alaska

Where British Columbia's IVQ program assigns quota shares to vessels, the Individual Fishing Quota (IFQ) fishery in waters off Alaska assigns quota shares to individuals. Here, the NMFS allocates quota share recipients a predetermined poundage of halibut catch by regulatory area, known as their IFQ.

The total Alaskan catch limit leapt from 37.5 million pounds in 1996 to 52.4 million pounds in 1997. The largest increase came to Area 3B, where catches jumped from 3.66 million pounds last year to 9.07 million pounds in 1997. Even at these large numbers, the 1997 catch hit closer to the target catch limit than it has since the IFQ program began. In each regulatory area, catches came in under the limits by 2 to 8 percent. This is an improvement over previous years, especially in some of the Bering Sea areas where underages ran as high as 12 percent in 1996 and 27 percent in 1995. This increased accuracy probably reflects changes in the IFQ regulations, consolidation of IFQs within the fleet, and more experience among skippers in adjusting to an eight-month IFQ fishery.

The total Alaskan catch limit leapt from 37.5 million pounds in 1996 to 52.4 million pounds in 1997.

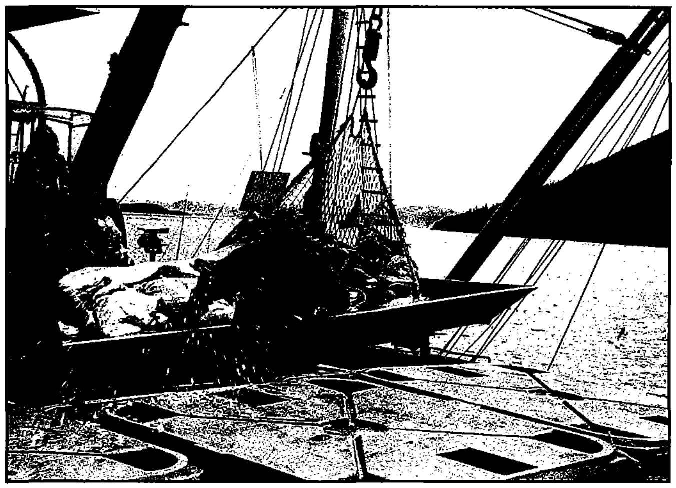
As in British Columbia, this year's bonanza catch was shared among a smaller fleet. The IFQ program in Alaska has brought consolidation to the fleet, from approximately 3,400 vessels participating in the open access fishery in 1993 and 1994, to just over 2,200 vessels in 1995, when the quota fishery began. A certain decrease is expected because a number of individuals who received initial quota shares no longer fished halibut, or found it advantageous to sell their shares for economic reasons. The Alaska fleet has diminished only slightly since 1995.

THE HARMONICS OF HARVESTING: LANDING PATTERNS IN QUOTA FISHERIES

Still only about 10 percent of Alaska's halibut are landed in ports south - about the same proportion as before IFQs.

How have the two quota share programs altered landing patterns for the halibut fleets? In some cases the changes have been minor; elsewhere they have been more dramatic.

Far fewer Canadian halibut are landed in Washington state under the quota program than before it started. The Washington ports of Bellingham, Blaine, Seattle, and Anacortes have varied in importance to the Canadian fleet over the years, but for the two years prior to the IVQ fishery, landings to Washington ports represented 9 to 19 percent of the catch. For the last two years (1996 and 1997) Washington ports received less than 1 percent of the Canadian catch.



Before the IFQ program began in Alaska, there was concern that more of the fish caught in Alaska would be landed in southern ports. This has not happened; still only about 10 percent of Alaska's halibut are landed in ports south - about the same proportion as before IFQs. During the short one- and two-day seasons of the open access Alaskan fishery, vessels fished in only one regulatory area during an opening. Now IFQ holders who own quota share in several areas can catch halibut from more than one area in one trip. Logbooks show that in some areas vessels are fishing closer to the regulatory area boundaries than they used to in the pulse fishery. In Area 3B in particular, vessels have increased pressure close to the Area 3A/3B boundary line, in statistical area 290. Some 46 percent of the Area 3B catch came from statistical area 290 in 1997, a significant increase since the quota system began. Catches from this same statistical area ranged from 19 percent to 27 percent from 1991 to 1994. User groups now are concerned about local depletion, since the commercial fleet now competes with the sport fleet in the area for eight months of the year, rather than just a few days.

One advantage of the quota share fisheries is that halibut landings are spread out over eight months. May and June were the busiest months for landings from Areas 2C and 3A, while June and July were the hottest halibut months in the Bering Sea. The 1997 season got off to a similar start as 1996, with only 5 percent of landings occurring in March.

Kodiak was once again the leading U.S. landing port, receiving 16 percent of the coastwide halibut catch, totaling 11 million pounds. Dutch Harbor, Homer, and Seward were the next busiest ports. Though other ports received more halibut than Sitka did, it saw the most vessel landings: 1,100 throughout the season. Kodiak was a close second in vessel landings at around one thousand vessels.

Kodiak was once again the leading U.S. landing port, receiving 16 percent of the coastwide halibut catch, totaling 11 million pounds.

In British Columbia, most of the landings came in May this year, a change from previous years, when March would see the heaviest landings. Inclement weather may have kept the fleet off the halibut grounds in the first few weeks of the 1997 season.

Once again, the top three halibut ports in Canada were Prince Rupert, Port Hardy, and Vancouver - holding steady as the top three since the quota program began. Prince Rupert received the largest Canadian poundage and the most landings, though the port received fewer U.S. landings in 1997 (226,000 pounds), than the 700,000 pounds processed in 1996.

INFINITESIMALS OF PLEASURE: HALIBUT SPORT FISHERY ON THE RISE

The happiness of life, said Samuel Taylor Coleridge, is made up of minute fractions: "the countless infinitesimals of pleasure...." To anglers bent on harvesting the mighty *Hippoglossus*, happiness is measured in immensities - sometimes hundreds of pounds. Sport fishing for halibut is an increasingly popular pastime.

It takes a year to compile and analyze sport catch figures, so each year of data lags behind the current fishery by a year.

At the IPHC, we manage the sport fisheries for halibut a little bit differently in each region, according to the needs and limitations of the community and of the stocks themselves.

Sport fishing data comes from a multitude of sources. The Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) conduct creel census estimates during the season and telephone surveys at the end of the season to supply sport fishing data for Area 2A. For British Columbia, we estimate sport catches by using catch data collected in previous years, and weight averages from surrounding areas, although a new estimation procedure was being developed by DFO during 1997. In Alaska, the Alaska Department of Fish and Game (ADF&G) provides harvest estimates for Areas 2C, 3, and 4. They obtain their estimates from postal surveys and port sampling, but it takes a year to compile and analyze these figures, so each year of data lags behind the current fishery by a year. (For sport fishing figures see Appendix III.)

AREA 2A: MORE FISH, BIGGER FISH

In Area 2A, along the Washington and Oregon coasts, the sport catch is part of the annual Catch Sharing Plan established by the PFMC and adopted by the Commission. The sport fisheries along this fairly populated coastline are divided into several sub-areas, each assigned its own catch limit and other restrictions. Sport fishers harvested 354,872 pounds of halibut from Area 2A in 1997, 14 percent over the catch limit of 310,765 pounds.

Sport fishers harvested 354,872 pounds of halibut from Area 2A in 1997.

In Washington inside waters, anglers landed 86,733 pounds, nearly double the 46,628 pound catch limit. The halibut were heftier this year, too: average weight of landed halibut increased from 20.7 pounds in 1996 to 24.7 pounds this year, even higher than the recent high of 23.0 pounds in 1993. Along Washington's north coast, the fishery closed just over 2,200 pounds above the 96,088 pound quota. Here, the average weight of sport-caught halibut ended a three-year decline this year, hovering right around 16.4 pounds, nearly identical to the 16.2 pounds in 1996. The Washington south coast fishery, centered principally out of Westport, was only 77 pounds over quota. The average weight of halibut fell again to 14.8 pounds from 17.7 pounds in 1996 in the all-depth fishery. The Columbia River area came in well under its catch limit for the third straight year, yielding only about 21 percent of its quota. All of the Columbia River catch is taken by the Washington fleet, primarily from Ilwaco. Pacific halibut caught in this area averaged 22.5 pounds, similar to the 22.9 pound average in 1996.

Along the Oregon coast, fishery managers and user groups alike struggle with the challenges of managing small quotas and restricted openings. Some harvests exceeded the quota and some fell under, but the statewide catch almost matched the overall quota nevertheless. On the central coast, where sport catches fell 22 percent below the catch limit in 1996, this year's harvest topped an even larger quota by 27 percent. The restricted 30-fathom fishery once again fell below the quota by a significant percentage. In southern Oregon, anglers landed slightly less than the quota, and only one-third of the catch limit was taken in the restricted 30-fathom fishery.

The average weight of Oregon's sport-caught halibut ranged from 20.4 pounds in the early season Oregon central coast fishery to 33.8 pounds in the Oregon south coast 30-fathom restricted season fishery. In 1996, the overall average weight for the Oregon sport halibut fishery was 20.8 pounds.

In 1996, the overall average weight per fish for the Oregon sport halibut fishery was 20.8 pounds.

AREA 2B: A BIG LEAP IN INTEREST

Historically, there has not been heavy interest in sport fishing for halibut in British Columbia. For primarily that reason, along with budget limitations at Canada's DFO, current methods for assessing sport catches in this area are far from comprehensive. However, interest in sport fishing for halibut is increasing in this region, and the need for a more scientifically based estimating procedure grows accordingly. Until such a method is in place, however, we continue to estimate sport harvesters' activities in British Columbia by using the data we do have available. We take the average catch in numbers from the DFO Tidal Diary Program during 1987 through 1992. We then expand the harvest from numbers of halibut into pounds by multiplying the average weight from ADF&G creel surveys for those same years in Ketchikan for northern British Columbia waters, and the WDFW average weight for 1987-1992 from the Neah Bay sampling program for southern British Columbia waters.

Interest in sport fishing for halibut is increasing in this region, and the need for a more scientifically based estimating procedure grows accordingly.

In 1997, Washington anglers caught 10,752 halibut off Swiftsure Bank in Canadian waters and landed them in Neah Bay, an increase of about 30 percent from last year's harvest. Applying an average weight of 14.8 pounds, a figure derived from nearly 800 length frequencies measured in the

Canadian landings, we estimate the harvest at 158,915 pounds for 1997, about a 33 percent increase over the 1996 harvest.

AREA 2C: LOWEST CATCH SINCE '92

In Area 2C, covering Alaska's southeastern archipelago, the sport harvest declined slightly, about 12 percent, bringing in only 73,568 fish.

This year, the Commission received 1996 estimates of Alaska's sport catches of halibut, revealing a fairly consistent statewide harvest over the past three years. In Area 2C, covering Alaska's southeastern archipelago, the sport harvest declined slightly again (about 12 percent), as it has in previous years, bringing in only 73,568 fish, the lowest harvest since 1992. Average weight ranged from a high of 32.8 pounds in the Petersburg-Wrangell region to a low of 14.8 pounds in Craig. The only area which increased its harvest numbers was the Haines-Skagway region with an 18 percent rise.

AREA 3A: THE HEART OF HALIBUT COUNTRY

By far the greatest proportion of sport halibut are caught in the Gulf of Alaska and Prince William Sound. Here the 1996 harvest, when measured in pounds, increased only 7 percent from 1995. Actual numbers of halibut landed increased by 10 percent, but this gain was offset by a decrease in average weight from 19.3 pounds in 1995 to 18.8 pounds in 1996. In this region the heaviest average weight came from Valdez, averaging 31.5 pounds, and the lightest average weight was in Seward, averaging 15.6 pounds. The 1988 and 1987 year classes (fish ages 8 and 9) continued to dominate the fishery in 1996, making up about 40 percent of the catch in numbers for most ports.

More anglers are heading to Deep Creek, some 40 minutes closer to Anchorage than Homer.

On the Kenai Peninsula, we saw a continuation of trends that began in the early 1990s. In the lower Cook Inlet area, where Homer is the major port, more halibut are landed each year. Local wisdom tells us that sport fishers account for their catch in sampling areas near Homer even though they often land their catch elsewhere on the Kenai Peninsula. Otherwise, Homer has had a fairly stable harvest since the late 1980s.

More anglers are heading to Deep Creek, some 40 minutes closer to Anchorage than Homer, where charter operators offer combination trips for halibut and king salmon, shorter boat rides to fishing grounds, and more half-day charters. This developing fishery draws a number of likely Homer-bound fishers into the central Cook Inlet area.

AREA 3B AND 4: BEST-KEPT SECRET

With sport fishing so hot near the urban centers, few anglers head out to Western Alaska in search of halibut. Local fishers are likely too busy catching commercial and subsistence harvests, or live too far from prime halibut grounds, to generate a large sport fishery in these sparsely populated areas. In Area 3B, the catch is quite small - 22,000 pounds in 1996 - and is concentrated at Sand Point and Popof Strait.

Small though it is, the sport catch in the Bering Sea and Aleutian Island region increased by over 27 percent in numbers of fish for 1996. Most of this catch is taken in Dutch Harbor, the largest community in this region. Dutch Harbor recently has produced several large halibut, with a few dandies in the 400 pound range.

As IPHC biologists have talked with local charter operators and read sport fish publications, we have learned that the average weight of sport-caught halibut is increasing in Western Alaska. Therefore, we have substituted the average 20.3 pounds, provided by the military's Morale, Welfare and Recreation Activity on Adak Island, with average weights obtained from ADF&G sport fish sampling on Kodiak Island in estimating Area 3B and 4 harvests for 1995 and 1996.

HARVESTS VISIBLE AND INVISIBLE: WASTE IN THE FISHERIES

Responsible living demands thankfulness for such abundance. Responsible fishery management demands an accurate accounting of the Pacific halibut that are killed and not used, for a host of reasons, so that we include those numbers in the annual removals.

Waste happens in a number of different ways in the commercial Pacific halibut fisheries. We measure wastage in two primary categories; estimating the total pounds of legal sized halibut that are killed by lost and abandoned gear, and also estimating the mortality of sublegal halibut (smaller than 32 inches or 81.3 cm) that are killed because of commercial halibut fishing. In 1997, we began using those two wastage estimates a little differently, so waste from lost or abandoned gear is included in the stock assessment, and losses of sublegal halibut are accounted for when we set the exploitation rate. (Prior to 1997, estimates of discarded sublegal halibut were deducted when we figured the setline CEY.)

Waste from lost or abandoned gear has diminished markedly since 1994, the last year of the open access fishery in Alaska.

WASTE FROM LOST OR ABANDONED GEAR

Every year, halibut are killed by lost or abandoned gear in the commercial fisheries. This kind of waste has diminished markedly in most areas since 1994, the last year of the chaotic open-access fishery off Alaska.

When circumstances require a vessel to abandon gear, skippers are required to keep track of lost gear and report it in logbook interviews and mailed-in fishing logs. By extrapolating the information we do get according to activity in different fisheries, standardizing our data to compensate for the fleet's considerable variation in length of skates, hook size and hook spacing, we can estimate the total amount of wastage of halibut from lost or abandoned gear.

Of course, sometimes the data we receive simply cannot be standardized. For example, the IFQ fishery in Alaska allows mixed halibut and sablefish trips, as well as trips targeting on sablefish where halibut are landed incidentally. Sablefish gear is considered a non-standard halibut gear that fishes differently, and therefore is not included in the calculation.

To estimate wastage, we determine the ratio of effective skates lost to effective skates hauled, and then multiply that ratio by the total catch. For calculating purposes, we use fixed hook gear in Alaska and snap gear in Areas 2B and 2A. The Area 2A catch includes the non-treaty directed commercial and treaty commercial catch.

In 1997, the ratio of effective skates lost to skates hauled (by area) were: Area 2A = .014; Area 2B = .003; Area 2C = .004; Area 3A = .003; Area 3B = .006; and Area 4 = .009.

Loss ratios in Areas 2C and 3A, southeast Alaska and the eastern Gulf of Alaska, are now lower and closer to the ratio in the Canadian IVQ fishery, bringing the wastage estimates down for these areas in 1997. This decrease may be a result of many factors: smaller fleet size, improved fishing factors, fishing during better weather - all results of the quota fishery. The effective skate ratios remained the same in Areas 2B and 3B, but the catch increased bringing a slight increase in the wastage this year. The effective skate ratio of lost to hauled gear in the Bering Sea decreased in 1997, but is still higher than it was in 1995.

Waste can also occur in the quota fisheries, when harvesters set more gear than is required to catch their quota. The amount of halibut that is discarded because the quota share limit has been reached is recorded as part of the logbook data. At this point, waste from setting too much gear and discarding the caught halibut is not included in the total annual wastage calculation, but there are plans to begin including it in the wastage figures for the 1999 stock assessment.

THE GENTLE RETURNS: DISCARDS OF SMALL HALIBUT

Every member of a family knows it is not always possible to hide the ice cream from the youngsters. In the underwater world, a morsel of squid on a hook is a great treat for young and old alike, and so we find ourselves calculating losses to the halibut resource when small halibut (smaller than legal size) are taken on commercial gear. Regulations require the fishing crew to throw the youngsters (fish less than 32 inches or 81.3 cm in length) back, allowing the majority to survive, grow and reproduce. Of course, a certain portion of these small halibut will die. We estimate how many undersized halibut are killed each year by using the ratio of sublegal to legal halibut caught during our setline surveys. In 1997 those ratios, by area, were: Area 2A =.16; 2B =.17; 2C =.09; 3A =.17; 3B =.18; Area 4 =.12.

We estimate that 16 percent of all sublegal halibut that are discarded at sea in the quota fisheries will die.

For the past three years, since the IFQ program began in Alaska, the discard mortality rate has been 16 percent for all areas. In other words, we estimate that 16 percent of all sublegal halibut that are discarded at sea will die. Observations of various fisheries confirm that this mortality rate is fairly accurate. Previous to the IFQ program in Alaska, discard mortalities were estimated at 25 percent in the Alaska fisheries, a figure gleaned from observations during Gulf of Alaska sablefish harvests from 1992 to 1993.

Even at the lower mortality rate, losses of sublegal halibut increased this year, from a coastwide total of 899,000 pounds in 1996 to 1,584,000 pounds. The increase is partly attributable to higher catch limits this year. Another factor was that in Area 4, the ratio of smaller halibut to large halibut increased markedly, from .05 in 1996 to .09 in 1997. In Area 2C, sublegal mortalities remained the same even though the catch limit increased, but the ratio of sublegal to legal halibut decreased slightly in 1997, which helped keep sublegal mortalities lower.

HALIBUT THAT FEED OTHER HUNGERS: PERSONAL USE

In calculating how much halibut is taken each year in the commercial, sport and treaty Indian fisheries, and as bycatch and waste, there remains the sticky question of how to estimate and categorize all those fish that are caught for other reasons: sanctioned Indian food fish in Canada, subsistence harvests in Alaska, and illegally retained catch in other fisheries for food fish.

These removals go into the "personal use" category here at the IPHC, though estimating the actual take is naturally difficult, because there is no accurate way to count it.

REDEFINING PERSONAL USE IN ALASKA

This year the NPFMC, state agencies, and the IPHC are working together to redefine personal use to accommodate subsistence harvests.

Before the IFQ program, take-home fish the crew kept for their own consumption counted for a major portion of the defined personal use take in Alaska. Under IFQs, however, take-home fish is included in a person's quota. These days the personal use category covers only halibut harvested outside the commercial and sport fisheries, and in Alaska that brings us into the uncertain territory of subsistence use, a topic of increasing political heat in Alaska.

This year the NPFMC, state agencies, and the IPHC are working together to redefine personal use to accommodate subsistence harvests; to answer the question of authorization of personal use under the Halibut Act, and to respond to requests by Alaska Natives to legally retain subsistence fish. Subsistence issues - who gets to harvest what resources, and where and in some cases how - have sparked numerous meetings in the past year or so, and will continue to into the next few years.

After the questions of how subsistence halibut harvests might be handled and accounted for within the overall scheme of halibut management and resource management in Alaska, the estimates for personal use halibut harvests will be updated. In the meantime, we continue to use the best information available, which are data from 1993. In that year, personal use removals of halibut were estimated at about 228,000 pounds.

FOOD FISH IN BRITISH COLUMBIA

In the IVQ fishery, as in the Alaskan quota fishery, all take-home fish from commercial trips is monitored and weighed at the time of the offload by the port monitors, and is included as part of the vessel's quota.

The primary defined source of unreported personal use halibut in British Columbia is the Indian food fishery. The DFO estimates that the take classified as the Indian food fishery totaled 300,000 pounds in 1997.

Currently, IPHC receives some logbook and landing data for the Indian food fishery from DFO, but those figures do not account for the entire 300,000 pounds.

COUNTING ALONG THE COAST

In Area 2A, Washington, Oregon, and California, the entire catch limit is allocated by the PFMC to commercial incidental and directed catch, sport catch, and treaty Indian catch. The treaty Indian personal use catch is included in the catch sharing plan; these harvests totaled 15,000 pounds in 1997.

State regulations require that the personal use fish from the halibut fisheries throughout Area 2A be recorded on fish tickets. The personal use removals from the directed commercial fishery have been included in the commercial catch, as it is in the quota share fisheries. Therefore, any known personal use fish that are taken in Area 2A already are fully accounted for.

TUMULTUOUS, TEEMING SWEETNESS: HALIBUT STOCKS IN 1997

Over the years we have developed comprehensive assessment models that are among the most accurate anywhere; yet, as in all the sciences, a level of uncertainty restrains us.

One of the biggest challenges in halibut management in this decade is also our most profound blessing: Hundreds of millions of halibut live just off our shores, lurking in the unknowable deep. The science of halibut population assessment is both sophisticated and chancy: over the years we have developed comprehensive assessment models that are among the most accurate anywhere; yet, as in all the sciences, a level of uncertainty restrains us.

Accurate population assessment requires compiling many forms of data that include numbers and poundage of fish from surveys and bycatch observation, growth of individual fish, commercial catch-at-age, catch-per-unit-of-effort (CPUE), and other kinds of information. This information together will provide a reasonably certain snapshot of the current halibut population, as well as a landscape view of how the current population estimate fits with estimates in surrounding years.

In other words, it's a complex process. We began using a new assessment procedure in 1996 that accounts for changes in individual halibut growth that likely would result in changes in fishing selectivity. We also added data about area-specific mortalities of legal-sized bycatch, which overlays another complexity but will help make the assessment more accurate.

In 1997 the population assessment procedure was reviewed by a panel of three outside scientists who believed the procedures used are innovative and sound but who also recommended caution due to the complexity of the model. They made other suggestions, some of which have been incorporated into the current assessment; one was to outline more clearly the assumptions reflecting the level of uncertainty present in this assessment. This year we examine two assumptions concerning how survey selectivity is believed to operate.

THE SCIENCE OF UNCERTAINTY

The trouble with dropping hooks in the water to compile a population assessment, is that you can never be quite sure what questions that hook is asking, or what questions the hooked halibut are answering. To ensure an accurate assessment from a survey requires a complete understanding of survey selectivity - in other words, what factors cause fish to get caught, and what factors cause a hook to rise up empty. Surveys are designed to provide a consistent mechanism for taking observations over time, so that the survey data reflect changes in population density and not merely gear configurations or fishing methods. However, the behavior of fish themselves influences the likelihood that they will be caught at different sizes and life stages.

Because these uncertainties cannot be resolved at present, we conducted two different studies each in Areas 2A, 2B, 2C and 3A, the areas for which both commercial catch data and long-term survey results are available. One approach assumed that survey selectivity *at age* remained constant while size at age decreased, and the other assumed that survey selectivity *at length* stayed constant. These two approaches resulted in two dramatically different population assessments, with the differences between them increasing for the most recent four to five years, especially in Area 3A, where the decrease in individual size at age has been greatest. The constant-age-selectivity estimates show the lower population estimates; the constant-length-selectivity give the more optimistic estimates. If the analysis assumes constant size-specific selectivity were correct, it would indicate that the abundance of smaller, newly-recruited halibut is much larger than the other analysis indicates.

What factors cause fish to get caught in a survey, and what factors cause a hook to rise up empty?

The two survey approaches resulted in two dramatically different population assessments, with the differences increasing for the most recent four to five years.

It seems likely that the truth lies somewhere between the two extremes. Until these uncertainties can be resolved, we believe halibut biomass estimates are best viewed as bounded by these two sets of estimates. Our conservative management policy calls for setting a 20 percent exploitation rate. In other words, total removals from the halibut population will not exceed 20 percent of our best estimate of the total exploitable halibut biomass, and in this case our best estimate of biomass will fall somewhere in the range between the two extremes described above.

The grace of increase

One way to measure the abundance of the stocks is by measuring how easy halibut are to catch. CPUE is a broad indicator of stock abundance, and this year the CPUE data looked encouraging. In the commercial fishery, CPUE increased 22 percent in Area 2A, 10 percent in Area 2B, 17 percent in Area 2C, and 13 percent in Area 3B over 1996 levels. CPUE decreased 1 percent in Area 3A and 5 percent in Area 4, but this small decrease did not dampen the overall effect: Coastwide, CPUE increased about ten percent this year, keeping steady a trend that began in 1994.

Coastwide, CPUE increased about ten percent this year, keeping steady a trend that began in 1994.

The commercial CPUE differed from CPUE measured during the Commission's setline survey. The 1997 survey showed a 10 percent decline for the combined Area 2A-2B, a 20 percent increase for Area 2C, and a 32 percent increase for Area 3A, the latter rebounding from a significant drop in the previous year. Because survey statistics represent only a fraction of the annual removals of halibut, they tend to exaggerate the year-to-year variation. The difference between survey CPUE data and the commercial fleet's CPUE was even greater this year, because the commercial fishing quotas were so much higher than usual.

No matter how you look at it, the news is good for Pacific halibut stocks this year. Evidence from both survey and commercial CPUE indicates that the estimated biomass remains high in all areas. Within this view, there are variations worth investigating further. For example, in area 3A (the eastern Gulf) we have two views of the overall abundance and stock trends for the future. The assessment assuming constant selectivity at age shows a sharp drop in both total biomass and eight-year-old abundance (the age at which halibut recruit into the fishery). In contrast, the assessment assuming constant selectivity at size shows that both biomass and eight-year-old abundance is holding stable. It will be several years before we will be able to tell which of these two estimates is closest to being correct.

When surveyed in the 1997 Bering Sea NMFS trawl survey, the 1987 year class, now ten-year-olds, appeared to be the strongest year class in abundance in recent history.

Certain inconsistencies also arose between our assessments in Area 3A and 3B. By one method, using relative abundance from research surveys, results indicate that Area 3B exploitable biomass is roughly 30 percent of that estimated for Area 3A. By another method, the Area 3B exploitable biomass should be about 60 percent of that shown for Area 3A. At this point, no merging of the data has yielded an estimate that is consistent with all available information. We continue to exercise caution in our biomass estimates while wrestling with these issues.

The 1987 year class, which appeared as eight-year-old recruits in 1995, continues to give a strong showing coast-wide. Generally, we are seeing most of the eight-year-olds' strength moving south into Area 2A, for reasons that are not yet known. Perhaps this year class is showing greater southward migration, or perhaps environmental conditions are causing greater survivorship in the south.

The 1987 year class was ten years old in 1997. When surveyed in the 1997 Bering Sea NMFS trawl survey, these ten-year-olds appeared to be the strongest year class in abundance in recent history. However, these halibut remain relatively small for their age. Year classes that come after 1987 appear not to be as strong in number.

Elsewhere, halibut are getting bigger (that is, weight at age is increasing), especially for Areas 2C, 3A, and 3B. Figure 2 shows how average weight at age (in this case, for 12-year-old fish) plummeted in the late 1980s and now, except in Area 4, is on a small upswing. It is still not clear what causes such increases and decreases, but as individuals gain in weight, the population biomass increases proportionately.

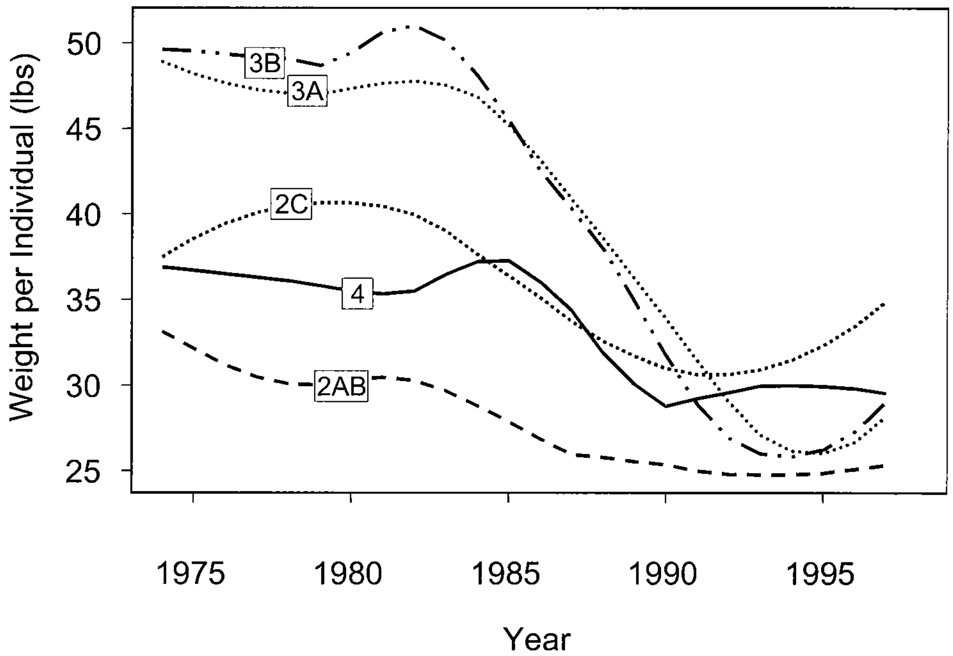


Figure 2. Trends in halibut weight at Age 12.

Setting catch limits in western waters

The Commission sets catch limits as a proportion of the biomass in each area. But what about an area for which we are uncertain about the biomass? Here we move with caution. In Area 4, covering the Aleutian Islands and Bering Sea, our data is the weakest in the entire region, so our biomass estimates are most uncertain. Yet Area 4 is home to a significant portion of the total halibut resource. In previous years, we have pooled data with commercial catch information, and have averaged out data from neighboring regions, to compile a statistical estimate of biomass out in the northwestern frontier of halibut habitat. But a historical foundation of biologically-based estimates of biomass in Area 4 we do not yet have.

In Area 4, covering the Aleutian Islands and Bering Sea, our data is the weakest in the entire region, so our biomass estimates are most uncertain.

A couple of years ago, we at the IPHC developed a biologically-based procedure for subdividing the halibut biomass among the subareas of Area 4, and announced plans to use that procedure to set catch limits for those areas in 1996. Basically, it involved combining the area of fishing grounds (mapped and measured by IPHC) with commercial CPUE in each of the subareas to calculate relative biomass. At the time, this was the best information we had to work with. This procedure was not entirely satisfactory because it did not address the fundamental question: how accurate was our estimate of the Area 4 exploitable biomass? In the end, the NPFMC asked us to postpone any changes for a year so that the Catch Sharing Plan could be modified to accommodate the new assessment. They adopted a Catch Sharing Plan that continued the historical catch proportions in 4C, 4D, and 4E.

Fish caught in any of the subareas 4C, 4D, or 4E could likely have been caught in the other areas at a different time of year.

Throughout 1997, we studied the distribution of halibut throughout Area 4. Legal-sized halibut generally spawn in winter along the upper continental slope in water from 150 to 300 fathoms. Fish in the Bering Sea move up on to the outer continental shelf in spring, and disperse onto the Bering Sea flats in summer. Most commercial halibut fishing in the Bering Sea occurs during July and August, after the halibut have fully migrated out of the deep water and have redistributed along the edge and across the shelf. The largest removals occur during the summer from a small region of Area 4D along the edge of the continental shelf. For some areas in the Bering Sea where local fisheries occur, halibut are available for only short periods of time, depending on the migratory pattern. Thus, fish caught in any of the subareas 4C, 4D, or 4E could likely have been caught in the other areas at a different time of year. The large-scale mixing suggests that halibut in the eastern Bering Sea are a single biological unit, and that local depletion is not likely at the current scale of fishing.

Delicate dance in the western Gulf

For some reason, the stock assessment model produces a biomass estimate for Area 3B that is inconsistent with other biological information.

In contrast to Area 4, our historical information for Area 3B is fairly extensive, and includes a satisfactory supply of logbook data for calculating CPUE and biological data for size and age distributions. However, we do lack a long sequence of longline surveys for Area 3B. For some reason, the stock assessment model produces a biomass estimate for this area that is inconsistent with other biological information. For example, the geographical area of the fishing grounds and the CPUE data in Area 3B are nearly as large as in Area 3A. The 1995 and 1997 IPHC longline surveys showed that the Area 3B estimated relative biomass is about two-thirds as large as in Area 3A. The swept-area trawl surveys conducted by National Marine Fisheries Service showed a similar relationship. Yet the stock assessment model estimates the Area 3B biomass to be about one quarter the size of the 3A biomass. The mixed signals from the biological data and from the model show that further investigation is needed.

Our surveys provide us with fishery-independent data to assess the relative abundance of halibut in Areas 4 and 3B compared to other areas, and to estimate the halibut biomass within Area 4. Because we have good estimates of absolute biomass in other areas, we can use this to derive estimates of biomass in Areas 4 and 3B.

THE BEAUTIFUL CHANGES: GROWTH TRENDS WE HAVE SEEN

We watch changing trends in the growth and development of halibut with interest. In recent years we have seen dramatic changes not only in the abundance of halibut but in the biological development of the fish themselves. We have watched individual growth decrease dramatically in waters off Alaska for the past 15 to 20 years, but have seen very little similar change in British Columbia. We have watched the average size of halibut at sexual maturity fluctuate, while the age at sexual maturity has remained remarkably stable. And in those 15 to 20 years, recruitment (that is, the fish that become eligible for harvest by reaching 32 inches or 81.3 cm in length) has increased dramatically coastwide, except for the central Gulf of Alaska, where recent recruitment has been low.

One question we ask periodically is, should the 32-inch size limit be changed? The Commission first adopted that limit in 1973, when halibut growth rates were highest, in an effort to increase sustainable yields. We reevaluated it in 1991, after halibut growth rates had declined, and found it to be adequate to achieve the goal of optimum sustainability. Growth rates have continued to decline since then while the age of maturation remains stable, suggesting that a decrease in the size limit might bring about some increases in yield.

In recent years we have seen dramatic changes not only in the abundance of halibut but in the biological development of the fish themselves.

When we look at optimal size limits, we must consider several factors. Because egg production is proportional to body weight, and the age of maturity has not changed, the reduction in individual growth implies that the average reproductive contribution made by each recruit is now substantially smaller than it used to be. In other words, the smaller females are producing proportionately fewer offspring than the larger females of years ago once did. Harvest rates had to be adjusted down to compensate for this effect. In addition, new information about sustained high levels of recruitment at high levels of spawning biomass has changed our views about the relationship between spawning biomass and subsequent recruitment, also prompting a reduction in the harvest rate.

How the size limit affects yield and spawning biomass

Average length at maturity has decreased dramatically from 125 to 90 cm in Area 3A, and from 110 to 100 cm in Area 2B since the 1980s.

We have been studying growth patterns of halibut by calculating yield and spawning biomass for recruits at the current size limit of 32 inches (81.3 cm), and also for smaller fish of 24 inches (60 cm). We used data from recent surveys, contrasted against 1980 survey data, to draft a maturity schedule for halibut that reflects individuals' growth and maturity patterns. From the information available to us, we try to determine what impact the 32-inch size limit has on yields in the fisheries.

One thing our maturity schedules tell us is the length at which 50 percent of the females in the halibut population of each area have reached sexual maturity. Average length at maturity has decreased dramatically from 125 to 90 cm in Area 3A, and from 110 to 100 cm in Area 2B since the 1980s. Meanwhile, the age at which sexual maturity is reached has remained constant, around 11 to 12 years, in both areas.

It is difficult to evaluate yields that would result if the size limit were changed. One unknown factor is how commercial selectivity - the likelihood of a halibut being caught in the commercial fishery - might change if the size limit were reduced. For example, fishing grounds that were abandoned when the current size limit was imposed because they were filled with high densities of sublegal halibut, may be fished again if the limit is lowered. Our data shows that in Area 3A, few fish smaller than 80 centimeter get caught under current regulations. As a result, yield per recruit and spawning biomass per recruit would be little affected by a change in size limit when the commercial selectivity was assumed to be fixed. However, fish tend to get caught when they are smaller in Area 2B, so a drop in the size limit would result in some yield gains here, accompanied by a small decrease in spawning biomass per recruit. Yield per recruit rose somewhat higher under the assumption that selectivity by commercial gear would shift toward smaller sizes if the size limit changed.

Dropping the legal size limit could cause a major loss of spawning biomass per recruit....

However, those increases in yield would not come without a tradeoff: dropping the legal size limit would cause a major loss of spawning biomass per recruit if the commercial selectivity shifts toward smaller sizes. In Area 3A, the spawning biomass per recruit would drop to 51 percent of its present level; in Area 2B, it would drop to 66 percent its present level. Thus, catch limits would have to be adjusted down to compensate for the reproductive losses, and most of the potential gains in yields would be lost. Thus, our results show that the current size limit of 32 inches is appropriate, and that any potential gains derived from lowering the size limit would be small compared to the potential reproductive losses.

The art of the evanescent

In recent years, halibut have grown more slowly, have been smaller at a certain age, and have recruited into the fishery at a younger age.

In recent years, halibut have grown more slowly, have been smaller at a certain age, and have recruited into the fishery at an older age. However, since these growth changes were not included in our assessment we estimated a drastic decline in recruitment of eight-year-olds during the late 1980s and 1990s, subsequent to a period of increasing spawning biomass during the early 1980s. Opposite trends in the number of eight-year-olds and parental biomass gave support to the hypothesis that recruitment might actually become weaker, instead of stronger, if the spawning biomass were allowed to increase.

However, estimates produced by the new assessment model show a very different relationship between spawning biomass and subsequent recruitment in recent years. Instead of declining, the new assessment model shows recruitments for the last ten years either fluctuating without a clear trend, if selectivity is assumed to be a function of age, or actually increasing, if selectivity is assumed to be a function of size. In either case, historical trends indicate that the environment has played a major role in driving variation in recruitment, at least within the range of stock levels observed.

Recruitment levels estimated for 1985-1996 (year-class 1977 and later) under the most conservative assumption (age-dependent selectivity) are generally about twice the average recruitment level estimated for the preceding 40 years. The timing of the increase in recruitment coincides with major changes in the North Pacific climate - changes that have affected productivity of other fish stocks.

Historical trends indicate that the environment has played a major role in driving variation in recruitment.

Because it is impossible to predict future recruitment trends, we have considered various possible stock-recruitment relationships for evaluating alternate harvest limits. In all relationships explored, a great deal of recruitment variability is caused by the environment itself.

For example: we might explore how stocks are affected by gradual changes in environmental effects, with environmental conditions similar from one year to the next but changing gradually over time. Recruitment would be expected to vary dramatically from year to year though.

In another model, we paint a very different scenario, characterized by more abrupt climate changes. Here, average recruitment increases in proportion to reproductive biomass until a carrying capacity is reached, and is constant thereafter; but carrying capacity is affected by environmental conditions that shift between two very different climate regimes every twenty to thirty years.

Both models predict that recruitment will decrease gradually as spawning biomass decreases.

What does this kind of model-building tell us? Both models predict that recruitment will decrease gradually as spawning biomass decreases to levels lower than the historical minimum. How much they will decrease is extremely uncertain.

We asked the computer model to simulate future stock trajectories for the next two hundred years under a range of harvest rates, factoring in the new, slower growth schedules. While the two models gave us two different ideal exploitation rates, both sets of results show that keeping harvest levels between 20 percent and 30 percent of the exploitable biomass yielded the best long-term sustainability. The model predicted that the long-term average yields for a 20-percent harvest rate ranged from 50 to 60 million pounds per year. These yields correspond to total removals, not just to commercial catch, and do not include Area 4. They are only about 54-64 percent of our most conservative estimated CEY rate for 1997 - a rate that is clearly not sustainable.

We asked the computer model to simulate future stock trajectories for the next two hundred years under a range of harvest rates....

Although it is impossible to predict future yields, dependent as they are on future environmental conditions, our results indicate that harvest rates ranging from 20 to 25 percent may achieve close-to-maximum yields under a range of variables, and still maintain historical levels of abundance.

READING THE LANGUAGE OF THE SEA

How do you ask a halibut its age? You scrutinize its otolith - the tiny ear bone that indicates by rings the age of the fish, the same way a tree's rings reveal the number and relative hardship of each of its years.

This year, we collected more than 15,000 otoliths from the commercial catch. Overall, the average age of the samples taken from Areas

2B, 2C, 3B, and 4 decreased slightly from 1996. The mean age increased in Area 2A by 0.7 years, and in 3A by 0.2 years. Coastwide, the average age of halibut increased by 0.2 years in 1997.

Halibut size is measured in fork length - the length of a straight line from the tip of the lower jaw to the middle of the tail. Average fork length of sampled halibut also decreased in Areas 2B, 2C, and 3B in 1997, but increased in Areas 2A, 3A, and 4. Average fork length was largest in Area 4C.

The 1987 year class accounted for the largest proportion of the overall commercial catch in 1997.

The 1987 year class (10-year-olds) accounted for the largest proportion (in numbers) of the overall commercial catch (21.4 percent) in 1997, as it did in 1996. The next most abundant year classes were 1986 and 1985, (11- and 12-year-olds) accounting for 11.6 percent and 10.7 percent of the catch, respectively.

When broken down by regulatory area, the 1987 year class (ten-year-olds) was the most abundant year class in Areas 2, 3B, and 4, while the 1985 and 1984 year classes (12- and 13-year-olds) were the most abundant year classes in Area 3A. Area 4C had the highest percentage (41.6 percent) of ten-year-olds in the 1997 commercial catch.

The oldest of the halibut harvested in the 1997 market samples were determined to be 42 years old; the youngest were six. There were three 42-year-olds and fifty-two six-year-olds. All three 42-year-olds came from Area 4B, which had the highest percentage of fish over 26 years old (5 percent) as well as the highest average age (14.7 years). These figures were derived from samples processed and aged before November 30, 1997.

What the edge reveals

The halibut otolith is a flattened, spade-shaped bone, roughly the size of a thumbnail and about the same thickness as a poker chip. Each growth season is marked with a narrow translucent ring, or annulus, separated by a wider band of opaque white that signifies the summer growth period. Pure as a poem, the otolith encodes the life history of the fish; like poetry, the otolith is a rich and concise language indeed.

More than half of our commercial otolith samples are collected from March through June, and often the translucent or winter zone has not yet been deposited, or is still in the process of forming on the otolith edge. This creates a problem, for we must decide whether the edge growth on a particular otolith is new (from the current spring or summer) or from the previous summer. As a rule, IPHC readers include the edge in the annulus count if the edge growth is greater than half the width of the previous opaque (summer) zone in fish older than ten years, or almost the same width as the previous opaque zone in fish younger than ten years. The edge is not counted in younger fish unless it is about the same width as the previous year's growth, because young halibut start their growth season earlier in the year than older fish do, and may already have close to half the previous year's width of new growth by late May or early June.

This year, IPHC readers noted that many fish were showing their age rather early; otoliths collected in March and April already had new growth. There were also cases of early annulus formation in samples collected in late August and later.

In 1997, we requested both U.S. and Canadian fishery observer programs to have observers collect halibut otoliths from March through June. These otoliths are to be used in edge growth or *marginal increment* analysis, which we hope will give us a better understanding of timing and deposition of annuli, and will improve the accuracy of our halibut-aging data.

EXUBERANT INTERMINGLING: BYCATCH AS A FACT OF LIFE

"All organisms are dependent upon the varied activities of other organisms for the supplies of essential stuffs," writes biologist Paul N. Burkholder. "No single species could persist if it were alone on the planet. Life is necessarily a cooperative venture." Halibut surely are not alone in their world, either: they are awash in an exuberant confusion of biota, from the microscopic to the mighty, inextricably woven into a network of life so tangled and abundant no single species can be imagined separately. As a symphony of life, the intertangled biomass is a source of delight and wonder, but for the commercial fisher it can be a source of aggravation as well. No net comes up clean of incidental catch; no hook attracts only its intended prey.

An estimated 13.2 million pounds of halibut were killed as bycatch in 1997, a 9 percent reduction from 1996.

The incidental catch of Pacific halibut by fisheries targeting on other species is one of the most contentious issues in the groundfish fisheries today. Regulations require that halibut caught as bycatch be returned to the sea with no additional injury; still, a significant portion of those halibut that are caught incidentally and discarded at sea die. At-sea observers on board commercial fishing boats monitor halibut bycatch and estimate bycatch mortalities. Their reports, and other information compiled by the IPHC staff, show that an estimated 13.2 million pounds of halibut were killed when taken as bycatch in 1997 - a substantial figure but still a 9 percent reduction from 1996.

In U.S. waters, the NMFS oversees an observer program covering the groundfish fishery off Alaska, and provides bycatch estimates. To monitor bycatches in the Canadian trawl fishery, the DFO instituted individual bycatch quotas in 1996, allocating a certain portion of halibut bycatch to each groundfish trawler. Observer information is lacking for the Area 2A domestic trawl and hook-&-line fisheries, though bycatch levels can be estimated from commercial fishery logbooks, results from gear experiments, and the triennial NMFS trawl surveys of the area. We also estimate levels of bycatch mortality in crab pot and shrimp trawl fisheries off Alaska, using bycatch rates observed on research surveys.

ESTIMATING THEIR VULNERABILITY

For each fishery in each area, we try to estimate discard mortality rates accurately to determine the fraction of the bycatch that dies. For Area 2A, the domestic groundfish trawl and shrimp trawls are assumed to have a 50 percent mortality rate (in other words, 50 percent of the halibut caught as bycatch and discarded are assumed to die in the process), whereas the unobserved hook-and-line fishery for sablefish is at 25 percent. The midwater whiting fishery is assumed to have a 75 percent rate, since large hauls like those typical of the whiting trawl fishery tend to cause high halibut mortalities, although the total number of halibut caught by such midwater trawl fisheries is low. The rate for the Canadian trawl fishery in Area 2B is 40 percent. Mortality rates are 50 percent for the state-managed scallop fisheries off Alaska.

The groundfish fisheries off Alaska are managed by NMFS using a schedule of discard mortality rates ranging from 10 percent to 79 percent. As observer data comes in at the end of each fishing year, the assumed mortality rates are replaced with actual mortality rates as tallied by on-board observers.

Preliminary bycatch mortality estimates for 1997 total 13.2 million pounds, 9 percent lower than 1996.

Halibut bycatch mortality was relatively small until the 1960s, but it increased rapidly as the foreign trawl fleets flocked to the North American coast after the bountiful groundfish. As the historical bycatch graph in Figure 3 shows, the total bycatch mortality (excluding the Japanese directed fishery in the eastern and western Bering Sea) peaked in 1965 at about 21 million pounds. Bycatch mortalities declined during the 1960s, but rose again to about 20 million pounds in the early 1970s. During the late 1970s and early 1980s, it dropped to roughly 13 million pounds. By 1985, bycatch mortality had declined to 7.2 million pounds, the lowest level since the IPHC began monitoring bycatch nearly 25 years earlier. But as the U.S. groundfish fishery off Alaska boomed in the late 1980s, mortalities again skyrocketed, peaking at 20.3 million pounds in 1992. Since then, bycatch mortality has declined; preliminary estimates for 1997 total 13.2 million pounds, 9 percent lower than 1996 and 35 percent lower than 1992. Most of the decrease is attributed to the introduction of IFQs in the Alaskan sablefish fishery and Individual Vessel Bycatch Quotas in the Canadian trawl fishery.

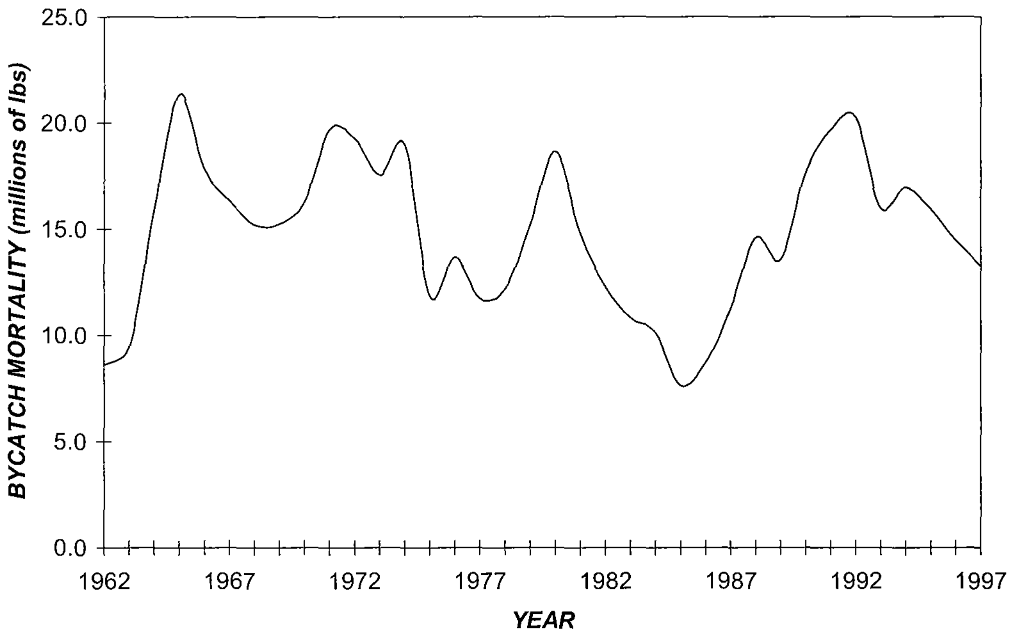
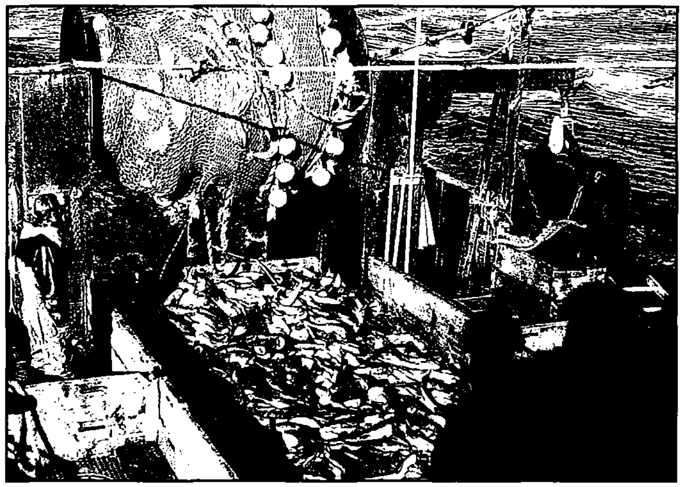


Figure 3. Pacific halibut bycatch mortality (millions of pounds, net weight) from 1962 to 1997.

Bycatch mortality in Area 2 was estimated at 1.28 million pounds in 1997, showing little change from 1996. In the second year of the Individual Vessel Bycatch Quota program for the trawl fishery in Canada, halibut bycatch levels remain quite low. This is likely to increase some as DFO reopens the trawl fishery for cod in 1998.

Bycatch for the U.S. west coast fisheries in Area 2A has been estimated in 1987, 1992, and 1995, with intervening years filled in by carrying forward the previous estimate. Consequently, the 1995 estimate is used for 1996 and 1997. Bycatch estimates increased in 1995 as bycatch rates hiked up due to increases in overall halibut abundance.

The southeast Alaska fleet has eliminated most of the halibut bycatch in Area 2C waters with the introduction of IFQs in 1995. Most halibut and sablefish are caught in mixed target trips, thereby allowing much of what used to be bycatch to be retained by those vessels that hold halibut quota.



Estimated bycatch mortality in Area 3 dropped from 4.7 million pounds in 1996 to 4.2 million pounds this year. Bycatch mortalities decreased in the trawl fisheries, but increased in the hook-and-line cod fishery, especially in Area 3A. Mortalities in Area 3A are estimated at 64 percent of the overall Area 3 total.

In 1996 British Columbia began a bycatch quota system, alloting a specific quota of halibut to each groundfish trawler and thereby significantly reducing halibut mortalities.

Bycatch mortalities also decreased in Area 4 by 800,000 pounds, to an estimated 7.7 million pounds. Again, mortalities in the trawl fisheries decreased, this time by 11 percent from 1996. The cod and pollock fisheries achieved halibut mortality rates below the bycatch allotment, and excesses in the yellowfin sole and rock sole fisheries were not large enough to make up the difference. Non-IFQ hook-and-line bycatch mortality declined just 4 percent, although the cod fishery reached its catch limit at about the same time as it reached its bycatch limit. Bycatch mortality declined in the pot fishery for cod, although it remains at the same relative low level seen in 1995 and 1996.

STRONG STEPS IN CANADA

Canada has taken strong steps to decrease halibut bycatch mortalities in recent years. More than 90 percent of the trawl fleet carries on-board observers; in 1996 observers monitored 1,095 trips and observed 21,312 tows. In addition, all groundfish landings are attended by port monitors, and in 1996 a bycatch quota system began, alloting a specific quota of halibut to each groundfish trawler and thereby significantly reducing halibut mortalities.

The highest halibut bycatches in the 1996 trawl fishery occurred in Queen Charlotte Sound and Hecate Strait; the lowest off the west coast of the Queen Charlotte Islands. Most halibut bycatch was caught at depths between 10 and 200 fathoms. Catches dropped off sharply at depths deeper than 300 fathoms. Generally, bycatches remain at steady levels throughout the year, with the highest catches occurring during February, May-September, and November.

A look at the congregation of fishes shows that the tows that caught halibut often brought up sharks, skates, ratfish, and flatfish also - particularly the ubiquitous dogfish and arrowtooth flounder. Rockfish species were relatively rare in the mix. Off the west coast of Vancouver Island, arrowtooth flounder, dogfish, and Dover sole most commonly accompanied halibut as bycatch in tows. Off the west coast of the Queen Charlotte Islands, the species mix included arrowtooth flounder, Pacific cod, and dogfish. In Hecate Strait bycatches most commonly included flatfish species, dogfish, and gadoids along with halibut. In Queen Charlotte Sound arrowtooth flounder, lingcod, and dogfish were most commonly associated with halibut.

STATISTICS STATESIDE

This year for the first time we were able to bring together information from all the management agencies active in Area 2A, including IPHC, NMFS, ODFW, and WDFW. A thorough review of available data resulted in several products, most importantly an agreed upon approach for estimating bycatch and estimates that reflect changes in halibut abundance and trawl fishery effort. This is the first time in recent history that there has been agreement among the different agencies on a total bycatch amount for Area 2A.

The combined groundfish and shrimp trawl bycatch mortality rose from 390,000 pounds in 1987 to 427,700 pounds in 1992, and to 598,400 pounds in 1995.

Halibut bycatch off the U.S. west coast occurs in three principle fisheries: groundfish bottom trawl, shrimp trawl, and hook-and-line fishing for sablefish. We estimate that the combined groundfish and shrimp trawl bycatch mortality rose from 390,000 pounds (net weight) in 1987 to 427,700 pounds in 1992, and to 598,400 pounds in 1995. There are some variables that skew these numbers slightly - for example, we believe these figures underestimate the actual amount of bycatch in the shrimp fishery - but they indicate an overall trend.

The sablefish hook-and-line fishery causes only about 4 percent of the halibut bycatch mortality in Area 2A. We only have estimates for 1994, when halibut bycatches totaled 64,000 pounds (net weight); at 25 percent mortality, 16,000 pounds of halibut were killed in this fishery.

Foreign fleets targeting Pacific whiting caught 3,000 pounds of halibut bycatch in 1977, about 1,000 pounds in 1980 and mere traces through 1988, when foreign fishing was phased out. Joint ventures targeting Pacific whiting kept halibut bycatches down below 2,000 pounds per year between 1982 and 1991. Domestic whiting catcher/processors recorded 1,000 pounds of halibut bycatch in 1991, and only 500 pounds in 1992.

Starting in 1998, we hope to replace bycatch information generated from research data with real-world information gained on the fishing grounds from the Oregon Voluntary Observer Program. Trawling effort is expected to be lower in 1998 in response to recent reductions in the allowable catch and harvest guidelines set by the PFMC. So in the future we expect bycatch figures for this area to be lower, and more accurate as well.

THE GREAT OCEAN OF TRUTH: SCIENTIFIC INVESTIGATIONS

In 1955, Sir Isaac Newton wrote, in his memoirs, "I seem to have been like a boy playing on the seashore, diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." The power of the undiscovered draws us forward still, and drives us onward through the methodical practice of every discipline available to us: the exercise of creative thought, the daily rituals of work, the mindful pursuit of biological investigation. It is, in the end, our curiosity that propels us. Curiosity may play mortician to felines, but to humans it gives us life, and gives life to our pursuits.

CRUISE OF DISCOVERY: THE 1997 SETLINE GRID SURVEY

Throughout the history of the Commission, a number of commercial halibut boats have helped the IPHC conduct setline surveys throughout the Pacific halibut range, from California to the Aleutian Islands. This year, 15 vessels participated, five Canadian and ten U.S., fishing 1,130 stations from Cape Blanco, California in Area 2A to the island of Attu at the western end of the Aleutian islands in Area 4B. In all, 6,200 skates of gear were fished, harvesting 1,306,060 pounds of halibut. All vessels used longline gear configured with 18-foot spacing and #3 circle hooks baited with chum salmon. At each station, 9,000 feet of gear was set, either as five 1,800 foot skates or six 1,500 foot skates. The first vessel began fishing on May 29th in Oregon, and the last longline came aboard in the Fairweather region September 12th, culminating over 1,100 staff vessel days.

Area	# of stations completed	Survey CPUE (lbs/skate)	Halibut sold (lbs)	Average $$/lb
2A	77	49	44,120	2.39
2B	158	131	95,641	2.40
2C	96	390	166,447	2.21
3A	273	331	411,948	2.02
3B	181	414	323,815	1.90
4A	119	245	133,066	1.91
4B	79	281	105,262	1.92
4C	64	57	17,618	1.82
4D	68	113	37,926	1.88

The purpose of the standardized grid survey is to collect data for stock assessment: CPUE, size, age, and sex composition, and the species composition of the catch.

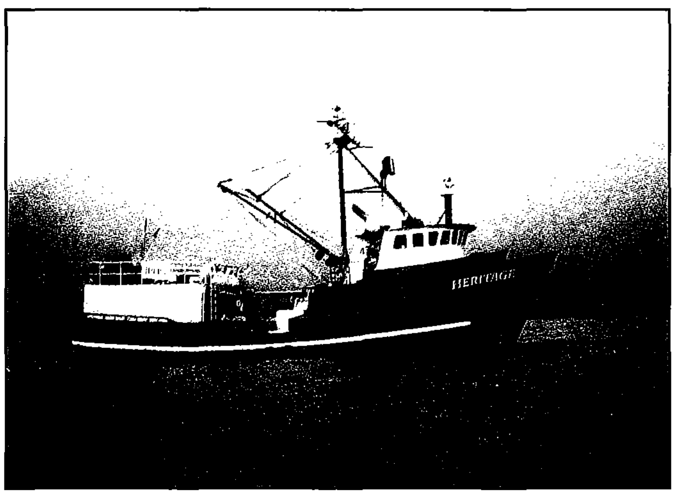
The purpose of the standardized grid survey is to collect fishery independent data for stock assessment, namely, CPUE, the size, age, and sex composition of halibut, and the species composition of the catch. This information is used to study growth and distribution of halibut, relative abundance of other species, sexual maturity, and the rate of bait attacks on the gear, and other aspects of the fishery. In addition, in 1997, the scope of the surveys was enlarged to attempt to access the biomass distributions within all the IPHC regulatory areas.

The surveys have changed over the years. In 1997, the stations were laid out in triangles with a station in the center. The grid was designed to cover all major fishing grounds for halibut. In Area 4, the design was based on the current layout for Area 3. We did not survey the area above 75 fathoms in Area 4D, nor any of Area 4E. Additionally, stations in the Aleutian Islands (Areas 4A and 4B) were placed using a grid pattern, where fishable grounds were available. For logistical reasons Bowers Bank was not included as part of the survey.

Thanks to the vessels

The *F/V Anita M* was chartered to complete the Area 2A, Oregon and Washington region surveys. She is a steel 63-foot, seine-style boat out of Delta, B.C. with a six-man crew (including captain). The *F/V Anita M* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Risky Business* was chartered to complete the Area 2B, Vancouver region survey. She is a steel 56-foot, seine-style boat out of Kodiak, Alaska with a four-man crew (including captain). The *F/V Risky Business* used 1800-foot skates of tub gear and had accommodations for two IPHC staff.



The *F/V Cape Ball* was chartered for the Area 2B, Goose Island region survey. She is a wooden 65-foot, seine-style boat out of Richmond, B.C. with a five-man crew (including captain). The *F/V Cape Ball* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

Aboard the *F/V Bold Pursuit*, we completed the Area 2B, Graham region survey. She is an aluminum 73-foot, seine-style boat out of Comox, B.C. with a five-man crew (including captain). *The F/V Bold Pursuit* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Ocean Viking* was chartered to complete the Area 2C, Craig region survey. She is a wooden 57-foot, seine-style boat out of Pender Harbor, B.C. with a four man crew (including captain). The *F/V Ocean Viking* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Dorothy Jean* completed the Area 2C, Sitka region survey. She is a fiberglass 62-foot, seine-style boat out of Petersburg, Alaska, with a five-man crew (including captain). The *F/V Dorothy Jean* used 1800-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Kristiana* was chartered to complete the Area 3A, Fairweather, and St. Elias region surveys. She is a wooden 69-foot, seine-style boat out of Seattle, Washington, with a five-man crew (including captain). The *F/V Kristiana* used 1800-foot skates of conventional gear and had accommodations for two IPHC staff. Due to mechanical problems, the vessel was only able to finish the St. Elias and part of the Fairweather region. The missed stations in the Fairweather region were later completed by the *F/V Norska*.

The *F/V Aleutian* was chartered for the Area 3A, Middleton region survey. She is a wooden 68-foot, schooner-style boat out of Seattle, Washington, with a five-man crew (including captain). The *F/V Aleutian* used 1500-foot skates of conventional gear and had accommodations for three IPHC staff.

The *F/V Lualda* conducted all of the Area 3A, Portlock region survey. She is a wooden 63-foot, seine-style boat out of Seattle, Washington with a five-man crew (including captain). The *F/V Lualda* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Judi B* was chartered to complete the Area 3A, Albatross, Area 3B, Chirikof, and Area 4B, West Aleutian region surveys. She is a steel 94-foot, seine-style boat out of Homer, Alaska, with a six-man crew (including captain). The *F/V Judi B* used 1500-foot skates of conventional gear and had accommodations for three IPHC staff. Due to concerns about commercial fishery closures the vessel requested, and was granted, release from the Chirikof and part of the West Aleutian region surveys. Those stations were instead completed by the *F/V Elizabeth F*, *F/V Norska*, and *F/V Heritage*.

The *F/V Elizabeth F* was chartered to complete the Area 3B, Chignik region survey. She is a steel 90-foot, combination-style boat out of Kodiak, Alaska with a six-man crew (including captain). The *F/V Elizabeth F* used 1800-foot skates of tub gear and had accommodations for two IPHC staff.

The *F/V Cape Cross* was chartered to complete the Area 3B, Sanak region survey. She is a steel 63-foot, schooner-style boat out of Seattle, Washington with a five-man crew (including captain). The *F/V Cape Cross* used 1800-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Norksa* completed the Area 4A, Unalaska, Area 4C, Pribilof region, and part of Area 4B surveys. She is a steel 72-foot, whaleback-style boat out of Newport, Oregon, with a five-man crew (including captain). The *F/V Norska* used 1800-foot skates of tub gear and had accommodations for two IPHC staff.

The *F/V Northern Prince* handled the Area 4A, Misty Moon region survey. She is a steel 60-foot, seine-style boat out of Seattle, Washington with a five-man crew (including captain). The *F/V Northern Prince* used 1500-foot skates of conventional gear and had accommodations for two IPHC staff.

The *F/V Heritage* was chartered to complete the Area 4D, 4D Edge region survey. She is a steel 68-foot, whaleback-style boat out of Seattle, Washington with a five-man crew (including captain). The *F/V Heritage* used 1800-foot skates of tub gear and had accommodations for two IPHC staff.

Answers the sea gives back: Survey results

The highest CPUE was 1,912 pounds per standard skate, from an Area 4B station.

These surveys provide CPUE data for each station that was fished. The highest CPUE calculated from the 1997 grid survey was 1,912 pounds per standard skate from an Area 4B station.

In comparing survey stations to the commercial CPUE for 1997 alone, it is interesting to note that the survey CPUE ranges from 26 percent of commercial CPUE (Area 2A) to 156 percent of commercial CPUE (Area 2C). Our survey is not intended to estimate the commercial CPUE in any area. Comparing trends in the ratio of survey to commercial CPUE over time is a better indicator of survey reliability than comparing ratios between areas during any given year.

We have completed the first year of a five-year program to survey the entire distribution of Pacific halibut each year.

This kind of detailed glimpse of the halibut distribution throughout its range is extremely helpful for accomplishing a number of our halibut management goals. With 1997 behind us, we have completed the first of a five-year program to survey the entire distribution of Pacific halibut each year. This first year of data gives us a significant amount of information, so that we may alter the survey design to improve the usefulness of its results.

ALONG THE CHAIN OF INQUIRY: SURVEY IN THE ALEUTIAN ISLANDS

Every three years, the NMFS conducts a trawl survey along the great northern arc of the Aleutian Islands region. This was one of the survey years, and the IPHC sent along a biologist to participate. This geographically unique region is one of the most fascinating on earth, and holds a multitude of mysteries below its fog-shrouded shores. Our objective on this survey was to sample every halibut caught on one of the two survey trawlers and document length, gender, maturity, otolith information, and prior hooking injuries of all the halibut caught.

The survey began on June 10 in the Fox Islands region, and concluded at Stalemate Bank, west of Attu Island, on August 10. The two chartered trawlers, *F/V Vesteraalen* and *F/V Dominator,* each fished three trips, staying within close proximity to each other throughout the survey so that both vessels would be sampling throughout the survey range.

Depths range from 30 to 500 meters. Equipment was attached to the trawl net to record data about each tow; a ScanMar recorded net height and width while fishing; a microbathythermograph recorded temperature and depth; and a tilt sensor was used to detect when the footrope hit bottom. The survey has been conducted the same way since 1991, except that this year 15-minute tows were performed instead of the 30-minute tows in previous surveys.

Following each tow, the codend was brought aboard and weighed. If the total weight was over about 1500 kilograms, the scientific crew subsampled for all species except halibut (which was sampled at 100 percent). All tows were given an effectiveness rating based on how the codend fished.

Trawl gear selects for smaller fish than longline gear does; trawl surveys are the only source of juvenile halibut information consistently available.

What we looked for

All halibut caught by the *F/V Vesteraalen* were sampled. Trawl gear selects for smaller fish than longline gear does; and trawl surveys are the only source of juvenile halibut information available on a consistent basis.

Otoliths (earbones) are collected from each fish brought aboard. As explained earlier, the age of the fish can be estimated by counting the rings on the earbone under a dissecting microscope.

Each halibut is examined to see whether it is male or female, and where it is on the maturation scale. Females are classified into one of four stages of maturity: immature, ripening, ripe/spawning, and spent/resting. Males have only two maturity stages: immature and mature. Immature for both genders means that the fish will not participate in the upcoming spawning season. The other stages represent various phases of the spawning process, and fish in those categories are considered mature enough that they may participate in the upcoming spawning season.

We also check for injuries to the mouth or jaw caused from longline gear, to collect information for a special IPHC project. The objective, as we shall see later, is to assess the types of hooking injuries a fish might sustain and still survive.

The survey fished 425 stations, of which the *Vesteraalen* towed 246. Number of tows per day varied from four to seven. There were 90 hauls made on the first trip, 85 on the second, and 71 on the third. A total of 866 halibut were caught and sampled; 520 halibut on the first trip, 234 on the second, and 112 on trip three. Of those, 315 were female, 548 were male, and three were not sexed. Most (86 percent) of the females were immature, 13 percent were ripening, 1 percent were spent/resting, and there were no halibut actively spawning. Of the males, 78 percent were immature and 22 percent were considered mature.

Prior hooking injuries were found on only 7.5 percent of the fish; the rest showed no evidence of interactions with hooks.

Prior hooking injuries were found on only 65 (7.5 percent) of the fish; the rest showed no evidence of interactions with hooks.

ROCKING IN THE CRADLE OF THE BERING SEA

The Bering Sea is commonly known as a nursery ground for young Pacific halibut; here the young fish feed to their hearts' content on the bountiful nutrients that swarm about them, distributed by upwelling and the great froth and bounce of the far-north waters.

According to the swept-area estimates, halibut biomass on the eastern Bering Sea shelf remained near the same high level observed in recent years. The total biomass as measured by the trawl survey is now about twice the levels seen in the mid-1980s. How long will this last? There is no indication of any strong year-class following the 1987 year-class, which is so ubiquitously present in current stocks.

The total biomass as measured by the trawl survey is now about twice the levels seen in the mid-1980s.

This we know from the NMFS systematic trawl survey of a standard area of the eastern Bering Sea shelf extending northward to about 61°N latitude. These are major nursery grounds for juvenile halibut in the summer season, when the survey is carried out. NMFS has surveyed the area every year since 1979, and every third year adds the northern shelf and slope to the survey area. Stations are set on a 20-nautical mile (37 kilometers) grid in depths from 30 to 200 fathoms. Abundance is estimated by expanding the survey catch from the area swept by the trawl to the total survey area, assuming the trawl catches everything between the wings and nothing outside that path. This estimate may be biased high or low, but over a long period should provide a good index of relative abundance in the survey area during the summer, when both juvenile and adult halibut are mostly within the depth range covered by the survey. In winter, halibut move into deeper water, so a series of winter surveys might show different trends.

In winter halibut move into deeper water, so a series of winter surveys might show quite different trends.

Total survey biomass increased slowly from about 50,000 metric tons (110 million pounds, round weight) in 1980 to about 100,000 metric tons (220 million pounds, round weight) in 1992 (see Figure 4). In 1993 the

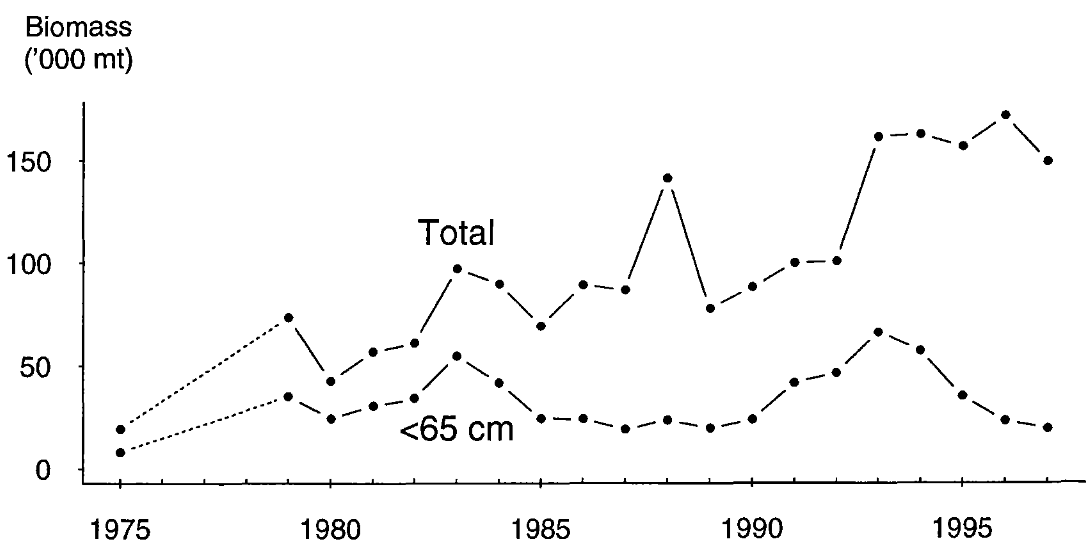


Figure 4. Halibut biomass in the Bering Sea estimated by the NMFS trawl survey.

estimate jumped to 160,000 metric tons (353 million pounds, round weight), and has remained at about that level since. This recent increase is not due to sampling variability; the estimate of the total biomass has a coefficient of variation of only about 10 percent. (Note: the biomass estimates are in round weight units instead of the IPHC standard of net weight units because the majority of fish being dealt with are juveniles. A conversion to net weight in this case would be less accurate than round weight.)

A BLOW TO THE SENSES: PRIOR HOOK INJURIES AMONG HALIBUT

The coast-wide comprehensive longline survey program provided a unique opportunity to gather information showing geographical differences among components of the population. One of the problems that has been noticed more frequently by halibut sport fishers recently is the presence of hook injuries from previous captures. Though groundfish longline fishers in Alaska are required to release all halibut using Careful Release techniques, we began to be concerned that halibut were being inflicted with worse damage than believed. The comprehensive surveys provided a means of examining trends in hook injuries - where they are inflicted and how seriously - across the entire range of halibut in the north Pacific Ocean and Bering Sea.

The comprehensive surveys allow us to examine trends in hook injuries - where they are inflicted and how seriously - across the entire range of halibut in the north Pacific.

We defined prior hook injuries as injuries that occurred as a halibut was released from a previous capture by hook-and-line gear. During the survey, all sampled halibut were examined for the presence of a prior hook injury. The fish may have been hooked recently, in which case the injury should be easily noticed, or it may have happened some time ago, thereby allowing the injury to heal. In either case, some difficulty was expected, as fresh injuries may be mistakenly attributed to the current capture, whereas old injuries may have been sufficiently healed so as to actually mask or hide the damage.

Although there were some differences among areas, the injury rate was significantly higher for the Bering Sea edge than for any other area.

The following criteria were used to determine a prior injury: (1) the injury is obvious, and may be healed; (2) the skin is damaged and may be torn; (3) the upper or lower jaw bone may be broken or even missing; (4) injuries may occur on either the left or right side of the head; and (5) the injury was not caused during the capture by the survey vessel.

From the 15 survey vessels fishing in 20 areas, more than 75,000 fish were examined, almost 92 percent of the total number of halibut caught in the 1997 cruise. Coastwide, 6 percent of the fish examined showed evidence of injury. Although there were some differences among areas, the injury rate was significantly higher for the Bering Sea edge than for any other area: 16 percent versus 4 to 7 percent.

Area	No. of fish examined	Prior hooking injuries	
		number	%
2A	1,178	59	5%
2B	5,524	228	4%
2C	7,349	397	5%
3A	25,055	1,434	6%
3B	22,112	1,011	5%
Aleutians	8,204	599	7%
Bering Sea	5,918	933	16%
Total	**75,340**	**4,661**	**6%**

The fraction of previously injured sublegal halibut (smaller than 81 centimeters) also varied by area, but as with the overall injury rate, injuries to sublegals were highest in the Bering Sea. Sublegal rates were also relatively high in Areas 2B and 2A, but this is probably because there are more small fish in those areas (relative to 2C-3A), not because fish are being released with a higher injury rate.

To a large degree, the injuries appeared in areas where the longline groundfish fisheries operate. In particular, the Bering Sea longline fishery for Pacific cod is highly concentrated along the Bering Sea edge. Here bycatch is high, according to observer data. Much of the effort in the IFQ sablefish fishery is spent in the Aleutians and the eastern part of Area 3A.

This first year of injury data has yielded information on geographic and size-related differences. As a time series is developed, we expect to be able to examine annual changes as it might relate to changes in regulations or management policy.

PACIFIC HALIBUT, SEA MONKEYS AND TED KOPPEL'S HAIR

The New Chaos theory, which focuses on the interconnectedness of seemingly unrelated events, is sprouting up everywhere. An April, 1998 article in *Discover* magazine tells us: "Over the past decade mathematicians have realized that the weather, the stock market, Ted Koppel's hair, and other complicated phenomena are exquisitely sensitive to seemingly innocuous events. The collapse of the sea monkey fisheries off the coast of Brunei, for example, can have repercussions on Wall Street. Similarly, the weather in Los Angeles can be affected by a thunderstorm in Azerbaijan...." Under the circumstances, our models for predicting the future health and well-being of the Pacific halibut communities would seem incomplete without an inquiry into the environmental changes that might affect the population.

This year we began the Climate Change and Halibut Biology project, a three year study of interdecadal changes (that is, changes over several decades) in growth and recruitment of Pacific halibut, and the relationship of those biological variables to north Pacific climate variability. The first year of the project was focused simply on *describing* north Pacific climate variability - not a simple task in itself. This involved assembling an ocean-bottom properties database and forming collaborations with other researchers around the Pacific Rim who are investigating the influence of climate on marine organisms.

This year we began a three year study of changes in halibut growth and recruitment, and the relationship of those biological variables to changes in the north Pacific climate.

An extensive analysis of climate records has uncovered a recurring mode of climate variability that fluctuates over a period of several decades. Termed the *Pacific Decadal Oscillation*, or PDO, this recurring climate change repeats a spatial pattern similar to the El Niño Southern Oscillation (ENSO), but follows a much different temporal pattern. During the 20th century, the PDO has alternated between warm and cool phases every twenty to thirty years. The ENSO appears every three to five years with episodes lasting 12 to 18 months. The PDO also tends to have a stronger physical impact on the north Pacific than ENSO, whose effects generally diminish with latitude.

The PDO has attracted much attention recently as the possible climate force behind many of the ecosystem changes observed in the north Pacific since the mid 1970s. The transition from one phase of the PDO to another is termed a regime shift. A very strong regime shift occurred in the winter of 1976-77, following regime shifts earlier this century in 1924-25 and 1946-47.

The Pacific Decadal Oscillation has attracted much attention as the possible climate force behind many of the ecosystem changes in the north Pacific since the mid 1970s.

Along with the mid 1970s regime shift came dramatic changes in the growth and recruitment of Pacific halibut. Compared to the 20-year period before the regime shift, halibut growth slowed while recruitment for many consecutive year classes was very strong. Another regime shift may have transpired in the 1990s as well, but not enough time has passed to accurately evaluate the physical and biological evidence.

Mapping the mysteries of the ocean bottom

This year, we have built an environmental database of the ocean bottom along the Alaskan continental shelf and upper slope to help us understand and explain the observed changes in halibut biology. Virtually all climate analyses focus on variability that occurs where the ocean and atmosphere interface. The relevance of ocean surface climate change to halibut depends on the similarity of the water property trends at the surface and on the bottom where halibut reside. Given our knowledge of physical oceanography, it is unlikely that processes at the sea bottom can be deduced from data about the ocean's surface. However, while we have a long-term (1854-present), high quality database of surface observations, no compilation of conditions at the ocean bottom has been created until now.

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Data for this ocean properties database were assembled from several sources, including the National Oceanic Data Center, NMFS, Japanese Meteorological Agency, U.S. Foreign Observer Program, University of Alaska, and IPHC longline surveys. At present, the database contains 107,000 records and has the following boundary conditions:

To illustrate the temporal and spatial distribution of data, we plotted changes in temperature and salinity for each decade, from the 1940s through the 1990s. Most of these data were compiled in the months May through September. For the study of halibut, this is actually the best time, since these are the months during which most growth takes place. The amount of usable data varies substantially by decade and variable (i.e. temperature, salinity, dissolved oxygen, and nutrients). The temperature data is the most promising; we now anticipate that annual indices of ocean bottom temperatures by IPHC area from 1960-present can be constructed. For salinity, we may not be able to do better than 5-year averages. Figure 5 shows the long-term average temperature and salinity, between May and September, between 1961 and 1995. It is interesting to see the varying conditions to which halibut have adapted over time. We might assume that sustained departures from these average conditions are stimulating agents of change in halibut biology.

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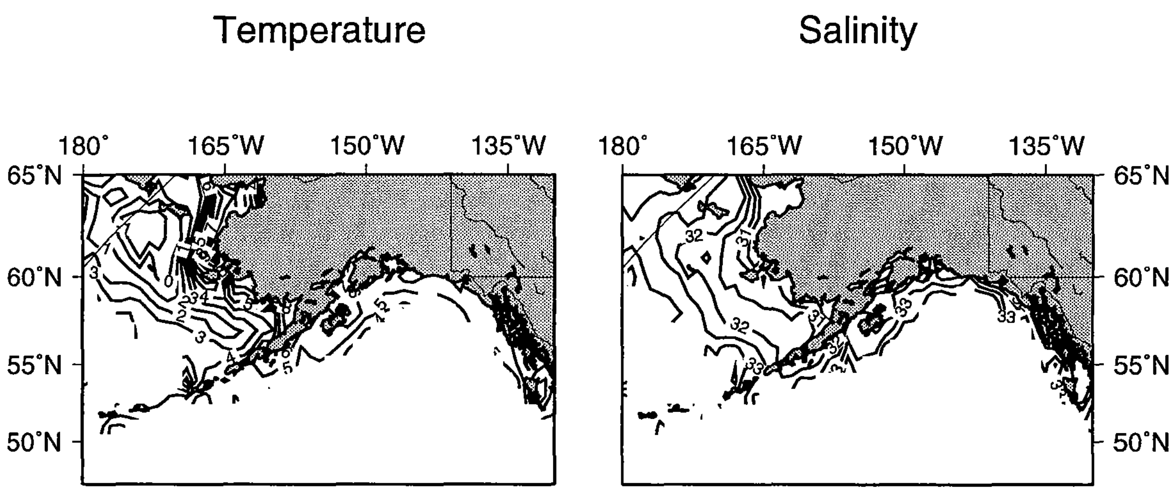


Figure 5. The long term average temperature and salinity between May and September, 1961-1995.

Initial analyses of the database are encouraging. To check on the effect, if any, of the 1976-77 regime shift, we compared the five-year averages for the periods before and after the winter of 1976-77. Bottom temperatures increased over the entire shelf west of Kodiak by as much as 2 degrees Celsius. In the Bering Sea, this is a dramatic jump, particularly in the central shelf where long-term ambient bottom temperatures are 2-3 degrees Celsius. Salinity, on the other hand, showed very little response to the regime shift.

A similar comparison was made between the five-year periods on either side of the winter of 1989-90. An increasing number of reports suggest that a climate shift occurred in 1989-90 that was different in nature than the

1976-77 event. The PDO index does show a change in character beginning in 1990: rather than being strongly positive or negative as has been its history, it has hovered around the zero mark for the last several years. Ocean bottom temperatures in the Bering Sea cooled by as much as 3 degrees Celsius in the five years after 1990. This cooling trend is unlike changes that occurred at the surface, where the heating trend that began in the mid 70s has continued unabated. Partly in response to a sequence of El Niño events in the 1990s, surface waters of the northeast Pacific warmed by 1-2 degrees Celsius, while surface waters of the Bering Sea showed no significant change.

Ocean bottom temperatures in the Bering Sea cooled by as much as 3 degrees Celsius in the five years after 1990. In contrast, a heating trend at the surface that began in the mid 70s has continued unabated.

Vis á visionary:
Working collaborations in the climate change study

One of the intentions of our climate change project was to develop working collaborations by which we could "piggyback" with other research agencies and groups who also are investigating the influence of climate on marine resources. Several important collaborations were initiated this year. One of the largest is an investigation currently led by University of Washington professor Ed Miles. It is called "An Integrated Assessment of the Dynamics of Climate Variability, Impacts, and Policy Response Strategies for the Pacific Northwest." This 3-year project, funded by the National Oceanic and Atmospheric Administration (NOAA), is being run jointly by the University of Washington School of Marine Affairs and the Joint Institute for the Study of the Atmosphere and Oceans. The IPHC is now actively participating in weekly meetings and strategy sessions.

Within the Pacific International Council for the Exploration of the Sea (PICES) organization there is an initiative termed the CCCC (Climate Change and Carrying Capacity) program. This year, IPHC joined the regional experiment sub-task team charged with organizing regional comparative experiments to study climate and fish. A set of recommendations and directives were developed at the PICES 1997 Annual Meeting in Pusan, South Korea.

By May of 1997, it had become obvious that a major ENSO event had begun in the equatorial-Pacific. Subsequently, the highly-valued Bristol Bay sockeye salmon had its poorest return year since the mid-1970s. These two events spurred a research group to gather, headed by IPHC staff. The group began meeting every three weeks to discuss general issues related to climate and fisheries. The first inquiry: an investigation into the possibility of a climatic regime shift in the winters of 1989-90 or 1994-95. We continue to collect and analyze data, hoping to improve our understanding in this area.

By May of 1997, it had become obvious that a major El Niño event had begun in the equatorial-Pacific. Subsequently, the highly-valued Bristol Bay sockeye salmon had its poorest return year since the mid-1970s.

Additionally, the IPHC joined a NOAA team in creating a project to gather non-digitized hydrographic data from institutions around the Pacific Rim. This project calls for rescuing historical water column properties data and constructing a water properties database to publish on the world wide web. The project has attracted enthusiastic cooperation within NOAA, at both the Pacific Marine Environmental Lab and the Alaska Fisheries Science Center. We envision that a coupled program between ourselves and these two research centers will draw upon the talents and resources of oceanographers and fisheries scientists, resulting in a database that provides access to data in a format that has practical utility for both research disciplines. This database will result in an expansion of the ocean properties database.

Two other papers were produced during research on climate and fisheries within this project. One presents a detailed view on how climatic processes affect Pacific salmon productivity. A second presents a theoretical model of climate-driven bottom-up control of ecosystem productivity.

See climate changes on the Web

The World Wide Web is fast becoming an interactive communication medium for research projects worldwide. This project has used the WWW to concentrate and disseminate data, papers, and assorted information on decadal-scale climate variability and fisheries. The three main web sites that have been developed are located at:

http://www.iphc.washington.edu/PAGES/IPHC/Staff/hare/html/decadal/decadal.html

http://www.iphc.washington.edu/PAGES/IPHC/Staff/hare/html/1997ENSO/1997ENSO.html

http://www.iphc.washington.edu/PAGES/IPHC/Staff/hare/html/decadal/post1977/post1977.html

The first site contains contents and links to meetings, institutions, people, manuscripts and references dealing with decadal scale climate variability. The second site concentrates on the 1997-8 ENSO event and the third site concentrates information on the possible 1995 regime shift. All three sites are maintained on a regular basis, receive considerable outside contributions and all receive a large number of daily hits.

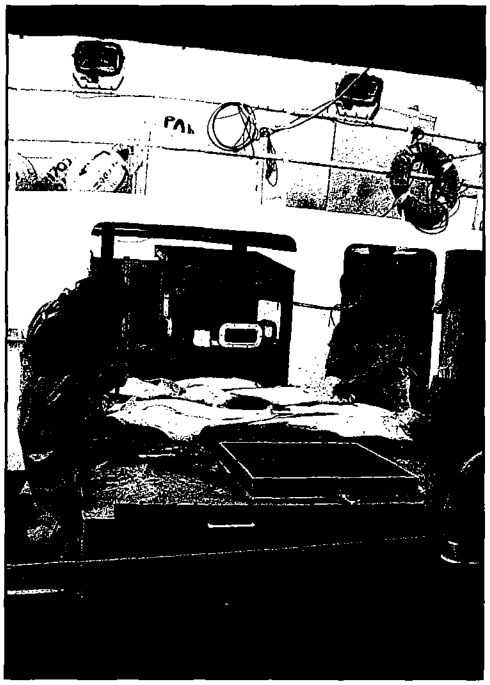
THE GRAND RONDELÉ OF RIDDLES: WHAT CAUSES CHALKY CONDITION?

During the mid 1960s, IPHC staff looked into the mysterious phenomenon known as chalky condition in halibut. What causes it? How prevalent is it? Is it preventable? Does it occur throughout the halibut range, or in specific areas? Can any patterns be traced that might shed light on this condition?

The studies found that the chalky condition in halibut seems to result from a biochemical activity in the halibut flesh associated with a lowering of the pH levels in the flesh. Chalky condition has been related to warm temperatures, and to stress or exhaustion before death of the fish. Chalky halibut has an opaque appearance which may make it less marketable in the retail case, and when cooked may taste drier or more fibrous.

During the 1997 Annual Meeting, the Processor Advisory Group (PAG) raised concerns about chalky halibut and asked the Commission to devote some staff time to renewing our investigations of the phenomenon.

We worked with the PAG to design a study with three goals: 1) to determine the incidence of chalky halibut during the 1997 season, 2) to investigate the cause of chalky halibut, and 3) to study methods to detect, avoid and/or reduce the occurrence of chalky halibut for the future. For 1997, we focused efforts on conducting industry-wide surveys to more fully document the occurrence of chalky halibut, both over time and area, and on continuing to research the available literature to develop a physiological description of the chalky condition.



Can any patterns be traced that might shed light on chalky condition?

Chalk it up to experience

An initial survey questionnaire was sent out early in 1997 to all segments of the industry, including fishers, fish buyers and processors, fish brokers, and retail users. The questionnaire asked respondents whether they had even seen chalky halibut in the past, and for an estimate of chalky halibut encountered during the previous year. We also asked them to participate in our study by returning report forms to us each time they encountered chalky halibut. We also invited them to contribute suggestions for research not covered in the survey questions.

We also asked industry members to participate in our study by reporting each time they encountered chalky halibut.

Along with the questionnaire, we sent a report form on which each respondent could document occurrences of chalky halibut during 1997. Respondents were asked to fill one out for each observed occurrence of chalky halibut during 1997, and mail or fax them to the IPHC office before the end of the year.

Near the end of the 1997 fishing season we sent out a second questionnaire to summarize 1997 experiences with chalky halibut. This survey was very similar in format to the one mailed out at the start of the year requesting a summary of 1996 experiences.

In the return mail: 1996 Results

- Two respondents were fishers, 15 were buyers or processors, one was a broker, one was a cold storage facility.
- 16 respondents indicated IPHC area: two from Areas 2A or 2B, seven from 2C, 15 from 3A, eight from 3B, and four from Areas 4 (Some respondents operated in more than one area.)

- 17 had seen chalky fish before, 14 in 1996, and it is "an issue" for 11 of the respondents.
- 14 saw chalky fish in 1996. Range: 0.0 percent to 6.3 percent of fish handled. Overall volume less than 29,000 pounds - out of 7.7 million, about 0.4 percent.
- Five respondents identified chalky halibut at time of delivery, 12 during later processing in the plant, and 10 by later claims from buyers.

Comments indicate that chalky fish is seldom recognized at the buying plant when fish are shipped whole, either fresh or frozen.

Comments indicate that chalky fish is seldom recognized at the buying plant when fish are shipped whole, either fresh or frozen. While some chalky fish are identified during fletching operations at the buying plant, most chalky fish are identified by later claims.

The second survey, chalky halibut in 1997

Fifteen companies responded to the second survey.

- Eleven respondents identified themselves as buyers or processors, one as a broker, one as a cold storage, and two as retail sellers.
- Fourteen of the respondents indicated IPHC area: one from Area 2A: two from Area 2B, six from Area 2C, eight from Area 3A, five from Area 3B, and five from Area 4 (totals more than 14, since some respondents have activity in more than one area).
- Eight had seen chalky fish before 1997, nine in 1996, and it was "an issue" for six of the respondents. It was "not an issue" for five of the respondents.
- 14 indicated amount of chalky fish seen in 1996, ranging from 0.0 percent to 2.4 percent of fish handled, overall about 124,000 pounds out of almost 17 million pounds, about 0.75 percent, overall.
- There was some trend for higher proportions of chalky fish in the more southern areas. Overall, chalky fish proportion in Area 2 ran about 1.0 percent, while chalky fish in Area 3 ran about 0.5 percent.
- One respondent identified chalky halibut at time of delivery, four during later processing in the plant, and six by later claims from buyers.
- Six of the respondents said the chalky condition either required a price reduction to the buyer, or removal of the chalky fish from the paid delivery.

Querying for clues

The general trends shown in the 1996 survey appear to continue. The 0.5-percent incidence in the U.S. is comparable to that estimated from the previous survey, while the 1.0 percent in Canada is new information. Some amount of chalky halibut has shown up in all IPHC areas, for all months of the fishery, with reports from Area 2C both early and late in the year, and reports from Area 3A during the middle of the season. Anecdotal reports suggest that chalkiness may increase into the middle of the summer and taper off during the fall.

Most of the chalky fish reported was recognized through claims by subsequent buyers, and it is possible that a large proportion of chalky fish goes unreported. It is also possible that some chalky fish goes purposely unreported, in an effort to diminish perception of the problem. We have no way of determining whether either of these biases in fact exist, and, if so, the degree to which they might effect our results.

Some amount of chalky halibut has shown up in all IPHC areas, for all months of the fishery.

Chalky halibut has occurred in the directed halibut fishery for at least 30 years. Research directed at this problem dates back to the late 1960s, when a series of field projects established a link between acidity buildup caused by capture stress and the post mortem development of the chalky condition. Our current surveys have demonstrated that the occurrence of chalky halibut is widespread but at a low level over the range of the fishery, both in terms of area and timing. While our surveys represent about 8 million pounds in 1996 and 17 million pounds in 1997, out of landings of around 60 million pounds in both years, it may not be accurate to directly extrapolate percentages from those subsamples up to the total landings for each year. Where such extrapolations are made, they should be viewed cautiously.

Current surveys show that the occurrence of chalky halibut is widespread but at a low level over the range of the fishery, both in terms of area and timing.

What causes chalkiness?

Various reasons have been suggested for the onset of chalkiness. In general, it appears that a fish that dies in a state of exhaustion will have a high degree of lactic acid, a byproduct of exhaustion, in the muscle tissue. This exhaustion could be caused by intense exercise without a recovery period prior to or during the capture process, recent feeding, or possibly by temperature or air exposure while lying on deck prior to dressing. While a reading of the literature suggests that proper handling of setline halibut can reduce the development of chalkiness, in no case is there any indication that fish handling can stop or reverse the development of chalkiness once the fish dies in an exhausted state.

Overall, the incidence of chalkiness appears to be on the order of about a half to one percent, with some trend to higher chalkiness during hotter months. It is possible that either higher water temperatures, or higher air temperatures during capture either increase capture stress or in some way accelerate the chalky process. A most unfortunate part of this problem is the timing of the onset of the chalky condition. Halibut are not chalky when they are killed. The early studies demonstrated that chalkiness developed in iced product 3 to 7 days after death, and the condition could develop after thawing at a much later date in fish which were frozen. While it may not be possible to eliminate chalky halibut from our fishery, a method to determine the tendency for chalkiness at dock delivery would be most advantageous.

How much does it affect the halibut fishery?

If the overall incidence of chalkiness is one-half to one percent of total landings that could represent 300,000 to 600,000 pounds of chalky fish being sent to market. It is possible that increased diligence by fishers can reduce the occurrence of chalky fish. For the most part, fishers now are very aware of procedures to maximize quality of landed product, and our studies have not yet suggested any changes in these procedures which would minimize chalkiness. One possible exception could be to encourage fishers to stun the fish on landing, to reduce a continuation of stress between capture and dressing. Many fishers do this now.

It is possible that chalkiness is a fact of the fishery, even when fish are handled as well as possible.

There is only the weakest pattern in area and time of chalky fish occurrence, the suggestion that chalkiness is more common during hot months, or that it occurs in the more southern and eastern areas. While it would be possible for the IPHC to conduct field investigations of factors associated with chalkiness, no practical design has been suggested by our recent investigations. We received no reports of chalkiness in more than 1 million pounds of fish delivered by our 1997 setline surveys, which represented short and long soak times, shallow and deep sets, deliveries from throughout the halibut's range and from June through August. In few cases, the magnitude of the catch at an individual station resulted in fish languishing, sometimes unstunned, for one or two hours before dressing. It is possible that chalkiness is a fact of the fishery, even when fish are handled as well as possible.

THE BUDDING BIOTA: EARLY LIFE HISTORY OF HALIBUT

All biological inquiries eventually seek the source of life: what is the essence of this life form? Through what permutations and metamorphoses does it venture, on its way to becoming itself? A sincere study of halibut biology necessarily takes us traversing into its life history, where we can witness its spawning, hatching, transforming from possibility into being, from potential into protean.

This year our healthy brood stock produced good eggs and larvae, but a water system failed at the laboratory ....

The Commission has funded a halibut Early Life History project for several years. In 1997 the Commission voted to continue for one more year, with future work contingent on successful rearing of halibut larvae during the year. This year our healthy brood stock produced good eggs and larvae. Larvae were well on the way to metamorphosis when a water system failure at the laboratory killed all the halibut larvae, along with salmon and herring larvae that were part of other projects.

The Early Life History project is one of three proposed for environmental investigations by the IPHC Staff. New information has recently demonstrated that changes in the environment significantly affect abundance and growth of fish populations. Environmental conditions act upon maternal effects, and directly influence eggs and larvae. Variations in initial larval size, growth rates, larval period duration, and sizes at transition between larval and juvenile stages will affect survival. Presence or absence of maternal effects could have significant implications for the halibut resource. Long-term environmental changes do appear related to halibut production, but we seek to know exactly how, and in what ways. Does the environment act on female fitness/progeny fitness and directly on larval/juvenile survival? Knowledge of the biology of Pacific halibut early life history is considered important for the continued effective management of this valuable species.

Knowledge of the biology of Pacific halibut early life history is considered important for the continued effective management of this valuable species.

Nursing a healthy brood

Our experiences tell us that it takes at least three years to establish a healthy halibut broodstock. A long delay between capture and effective spawning is a common phenomenon for many marine fishes, as we have seen in research on other species. After three years of collection and selection, we have established a healthy Pacific halibut broodstock of more than 40 adult fish.

We can now produce large numbers of feeding larvae. The major requirements for producing feeding larvae are cold water temperature (about 5° Celsius); total darkness; and slow water exchange. In 1997, spawning began around February 24 and continued to May 3. The earliest spawning produced the best survival. Approximately 2,000 of 6,000 larvae survived to first feeding stage when held in the right conditions. Almost 100 percent mortality occurred for larvae held in sub-optimum conditions. Most of the feeding larvae were used for experiments. Over 300 larvae had been feeding and growing well for over 30 days by early June, when the water supply system to the lab broke down.

After three years of collection and selection, we have established a healthy Pacific halibut broodstock of more than 40 adult fish.

Knowledge is never lost

Before the system crash that killed all the larvae, we gained some important information:

1. The time from hatching to first feeding was reduced when the larvae were maintained at a temperature of either 9° C or 11° C, as compared with 5° C to 6° C. A further increase in temperature to 13° C, however, proved fatal.
2. Rotifers (*Brachionus plicatilis*) were the preferred first food. Halibut larvae that were offered rotifers, brine shrimp (*Artemia* sp. nauplii), and wild copepods, either alone on in the presence of phytoplankton (*Tetraselmus* sp.) preferred the rotifers.

3. We hypothesize that broodstock may not produce enough thyroid hormones, and thereby reduce survival of the delicate eggs and larvae. Addition of two thyroid hormones appeared to improve larval survival rates. Neither of the hormones caused abnormalities in developing embryos or in larvae from hatching to age 30 days.
4. There was no observed advantage of providing live food animals (*Artemia* sp. nauplii) in the presence of algae (green water technique) as compared with providing live food in the absence of algae (clear water technique).

We are confident that we can raise halibut larvae past the metamorphosis stage in 1998.

We are confident that we can raise halibut larvae past the metamorphosis stage in 1998. Larvae were only two weeks from metamorphosis and growing well in 1997 when the water supply failed. We will improve the rearing facility with a new filtration system installed by the Marrowstone Lab, and by adding a vertical water current, after first feeding but before metamorphosis, a change that has increased rearing success in Norway. We propose conducting the following three experiments in 1998:

Experiment 1: Variations in halibut larval incubation temperatures.
Experiment 2: Temperature effects on halibut larval otolith formation
Experiment 3: Photoperiod effects on broodstock

THE ROAD MORE TRAVELED BY: TAGGING STUDIES

Through our tagging programs, we can chart the travels and travails of halibut between the time they are tagged and when they are finally harvested and the tags returned.

"The great affair is to move," wrote Robert Louis Stevenson, "I travel for travel's sake." Through our tagging programs, we can chart the travels and travails of halibut - at least a few of them each year - between the time they are tagged and released and when they are finally harvested and the tags returned.

		Recovery Area							
		2A	2B	2C	3A	3B	4	Unk.	Total
Release Area	2A	2	6	1	-	-	-	-	9
	2B	-	19	-	1	-	-	1	21
	2C	-	2	25	-	-	1	1	29
	3A	1	2	-	189	6	-	2	200
	3B	-	4	3	20	25	-	3	55
	4	-	3	-	1	2	4	1	11
	Total	**3**	**36**	**29**	**211**	**33**	**5**	**8**	**325**

This year, 373 halibut were tagged and released, all of them in the sport fishery. The Homer Derby Association released 75 fish tagged with an orange wire tag in Cook Inlet. In addition, volunteer charter boat operators were able to catch, tag, and release 298 halibut with a plastic-tipped dart tag. Many of these fish made very interesting journeys from their point of release.

Tag recoveries in 1997 dropped slightly from numbers seen in 1996. There were 325 tags redeemed this year, compared to 416 recoveries in 1995. Kodiak saw the most recoveries with 157 tags turned into the IPHC port sampler. By far the largest numbers of tags are recovered in Area 3A, where the most recent tag experiments took place. The majority of the 1997 tag recoveries were from the 1993-94 Longline Mortality Study, many of which were recovered close to their release site.

Three fish tagged in the Bering Sea in 1985 traveled south; one was recovered off the Queen Charlotte Islands and two were caught off the north end of Vancouver Island.

Consistent with the southerly migration theory, a number of tagged fish moved from their Alaskan area of release south into B.C. and Washington. Three fish tagged in the Bering Sea in 1985 traveled south; one was recovered off the Queen Charlotte Islands and two were caught off the north end of Vancouver Island. One of the 1995 Homer Derby fish was recovered this year off of Newport, Oregon. Some northerly migration was verified when three fish released in 1989 off Oregon were recovered this fall off northern Vancouver Island.

Recovery rates from the most recent experiments vary from 2 to 47 percent. The highest recovery rates, of course, occur in the older experiments where fish have been available for capture the longest. Nearly half the tagged fish released in the 1988 Sitka Spot experiment have now been recovered. The 1989 Central Oregon study, with 614 recoveries, has a recovery rate of 29 percent. The longline mortality experiments in 1993 and 1994 have recovery rates of 6 and 7 percent, respectively. The most recent project was the 1995 Trawl Mortality experiment aboard the *F/V Forum Star*. The recovery rate for this experiment is only 2 percent so far.

Those Pelagic Pilgrims: The sport tagging program

Generally, halibut migrate southward from the nursery grounds of the Gulf of Alaska into other areas. Sometimes they travel quite far, even circulating back northward again. We gain a glimpse, though it is the barest glimpse, of halibut's migratory patterns by tagging and releasing fish through various programs, and collecting information from those tags when the fish are ultimately harvested.

When the IPHC receives information from a sport-tag recovery, recapture data is forwarded to the charter operator who in turn informs the client.

Tagging programs are an important tool we use to promote conservation in recreational fisheries. Large billfish, for instance, are tagged, rather than harvested by recreational fishers, to learn more about migration patterns. Several years ago, some charter and lodge operators approached the Commission about starting a voluntary tagging program for sport charter boats to promote catch and release halibut fishing. Some operators acted out of concern that removing large females from the spawning population would adversely affect the halibut stock. Others were motivated to reduce potential recreational and commercial conflicts by slowing down the harvest rate of recreationally caught halibut.

Such programs benefit the IPHC in important ways, particularly the ability to track the movements of fish released over an extended time period. As both the United States and Canada conducted commercial IFQ or IVQ fisheries in 1995, fishers pushed for extended seasons to market their catch.

By the end of 1997 we had received sport-tag release information from only 50 participants.

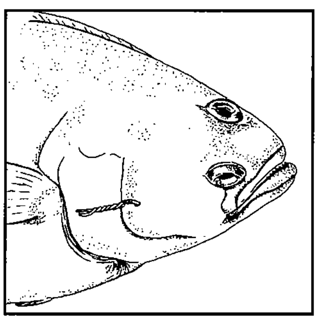
Tag releases from the sport fishery may shed some light on home range data and seasonal movements to and from spawning grounds, particularly from releases and captures early and late in the season.

After reviewing a pilot program started in 1993, we began the program in 1994. Sport charter boat operators pay for a portion of the cost of tags, tagging needles, and pennants. Tag buttons and certificates were provided with the tags. Additional costs of data entry, data summaries, and rewards were considered minimal at that time. Each charter operator is sent a tagging kit consisting of tags, an applicator needle, a log form to record release information about the fish, and a tagging certificate and pin for the client who landed the fish. Skippers are also offered an optional tagging pennant to fly from their vessel on days they tag halibut.

Since 1993, 112 charter operators have ordered tagging kits, which included nearly 6,450 tags. By the end of 1997 we had received sport-tag release information from only 50 participants. Seventeen participants notified us that they received tagging kits from us but did not release any tagged fish. The disposition of over 1,800 tags remains unknown from recipients who have not responded to our requests for information. Three operators released tags in more than one regulatory area, all in 1994. Area 2C sport charter boat operators have released the vast majority of tagged fish since the program's inception. Sitka continues as the most active of all ports.

TAGGED HALIBUT

The INTERNATIONAL PACIFIC HALIBUT COMMISSION attaches plastic-coated wire tags to the cheek on the dark side of the halibut, as in the diagram below. Fishermen should retain all tagged halibut, regardless of gear type used, time of year caught, or size of the halibut.



REWARD

$5.00 or a baseball cap with tag reward logo will be paid for the return of each tag.

The IPHC also pays a reward for the return of Halibut Sport Tags:

1. A plastic-tipped dart tag inserted into the back just below the dorsal fin.
2. A metal-tipped tag inserted into the flesh behind the head.

WHEN YOU CATCH A TAGGED HALIBUT:

1. Record tag numbers, date, location and depth .
2. Leave the tag on the fish until landed.
3. If possible, mark the fish with a gangion or flagging tape around the 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, fish length, and, if possible, the ear bones. Tags should be completely removed from the fish. Plastic-tipped and metal-tipped tags may need to be cut out of the fish.

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

International Pacific Halibut Commission
P.O. Box 95009
Seattle, WA 98145-2009
Phone: (206) 634-1838

APPENDICES

The tables in Appendix I provide catch information for the 1997 commercial and tribal fisheries. The areas specified are the IPHC regulatory areas, depicted in Figure 1 of this report. Appendix II shows the fishing period limits used during the 1997 seasons, and Appendix III shows the current sport fishing statistics.

All of the weights used are dressed (eviscerated), head off. Round weight can be calculated by dividing the dressed weight by a factor of 0.75.

APPENDIX I

Table 1. Commercial catch of Pacific halibut by regulatory area (thousands of pounds) for 1993-1997.

Table 2. The total landings (thousands of pounds) of commercial catch, including research, of Pacific halibut from the IPHC regulatory areas in Alaska and British Columbia by month for 1997.

Table 3. Fishing periods, number of fishing days, catch limits, commercial, research, and total catch (thousands of pounds) by regulatory area for the 1997 Pacific halibut commercial fishery.

Table 4. Number of vessels and catch (thousands of pounds) of Pacific halibut by vessel length class in the 1997 commercial fishery. Information shown for Area 2A does not include the treaty Indian commercial fishery.

Table 5. Commercial landings (including research trips) of Pacific halibut by port and country for 1997 (thousands of pounds).

Table 6. Commercial halibut fishery catch (thousands of pounds) in 1997 by country, statistical area, and regulatory area.

APPENDIX II.

Table 1. The fishing period limits (pounds) used in the directed commercial fishery in Area 2A.

Table 2. Metlakatla community fishing periods, number of vessels, and catch (pounds) in 1997.

APPENDIX III.

APPENDIX I.

Table 1. Commercial catch of Pacific halibut by regulatory area (thousands of pounds) for 1993-1997.

REGULATORY AREA	1993	1994	1995	1996	1997
2A	504	370	297	295	413
2B	10,628	9,911	9,625	9,557	12,420
2C	11,290	10,379	7,761	8,860	9,920
3A	22,738	24,844	18,342	19,696	24,628
3B	7,855	3,860	3,122	3,662	9,072
4A	2,561	1,803	1,617	1,694	2,907
4B	1,962	2,017	1,680	2,075	3,318
4C	831	715	668	680	1,117
4D	836[1]	711[1]	643	703	1,152
4E	64	120	127	120	251
Total	**59,269**	**54,730**	**43,882**	**47,342**	**65,198**

Table 2. The total landings (thousands of pounds) of commercial catch, including research, of Pacific halibut from the IPHC regulatory areas in Alaska and British Columbia by month for 1997.

Area	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
2B	671	1,619	2,185	2,077	1,778	791	1,260	1,328	711	12,420
2C	1,001	1,529	2,082	1,636	661	992	1,225	604	190	9,920
3A	1,812	2,951	4,343	3,494	1,943	3,130	2,771	3,018	1,166	24,628
3B	45	506	1,834	1,179	1,200	1,675	1,125	1,356	152	9,072
4A	0	35	598	692	440	768	201	155	18	2,907
4B	0	6	138	809	870	750	485	211	49	3,318
4C	0	0	0	448	541	106	14	8	0	1,117
4D	0	0	14	421	251	231	184	51	0	1,152
4E	0	0	21	162	68	0	0	0	0	251
Alaskan Total	2,858	5,027	9,030	8,841	5,974	7,652	6,005	5,403	1,575	52,365
Grand Total	**3,529**	**6,646**	**11,215**	**10,918**	**7,752**	**8,443**	**7,265**	**6,731**	**2,286**	**64,785**

APPENDIX I.

Table 3. Fishing periods, number of fishing days, catch limits, commercial, research, and total catch (thousands of pounds) by regulatory area for the 1997 Pacific halibut commercial fishery.

Area	Fishing Period	No. of Days	Catch Limit	Commercial Catch	Reasearch Catch	Total Catch
2A treaty Indian	3/15 - 3/27	directed incidental	195.5 34.5 230.0	201 27 228	-	228
2A incidental	5/01 - 6/30	61	21.6[1]	19	-	19
2A directed	7/08[2]	10 hrs	122.6 (126.6)[1]	148	18	166
2B	3/15 - 11/15	245	12,500[3]	12,322	98	12,420
2C	3/15 - 11/15	245	10,000[5]	9,753	166	9,920
3A	3/15 - 11/15	245	25,000[5]	24,235	393	24,628
3B	3/15 - 11/15	245	9,000[5]	8,729	343	9,072
4A	3/15 - 11/15	245	2,940[5]	2,785	122	2,907
4B	3/15 - 11/15	245	3,480[5]	3,213	105	3,318
4C	3/15 - 11/15	245	1,160[5]	1,101	16	1,117
4D	3/15 - 11/15	245	1,160[5]	1,116	37	1,152
4E	3/15 - 11/15	245	260[5]	251	-	251
TOTAL			**65,874**	**63,899**	**1,299**	**65,198**

1 4,000 pounds carried over from the incidental to directed commercial catch limit at time of fishery, due to troll catch estimate of 17,600.
2 Fishing period limits by vessel class.
3 An additional 81,000 pounds available as carryover from 1996.
4 Includes 88,000 pounds taken by Metlakatla Indians during additional fishing within reservation waters.
5 Additional carryover in 000's of pounds from the underage program were:2C=271; 3A=446; 3B=76; 4A=45; 4B=84; 4C=21; 4D=19.

APPENDIX I.

Table 4. Number of vessels and catch (thousands of pounds) of Pacific halibut by vessel length class in the 1997 commercial fishery. Information shown for Area 2A does not include the treaty Indian commercial fishery.

Overall Vessel Length	Area 2A Directed commercial		Area 2A Incidental commercial	
	No. of Vessels	Catch (000's lbs)	No. of Vessels	Catch (000's lbs)
Unk. Length	5	4	1	NA
<26 ft.	11	2	8	0.7
26 to 30 ft.	4	1	9	0.9
31 to 35 ft.	10	8	20	2.6
36 to 40 ft.	37	27	44	7.6
41 to 45 ft.	24	26	30	4.3
46 to 50 ft.	17	26	13	2.5
51 to 55 ft.	14	17	6	0.6
56+ ft.	17	55	1	NA
Total	**139**	**166**	**132**	**19.3**

Overall Vessel Length	Area 2B		Alaska	
	No. of Vessels	Catch (000's lbs)	No. of Vessels*	Catch (000's lbs)*
Unk. Length	1	NA	89	179
<26 ft.	0	0	338	849
26 to 30 ft.	3	NA	199	1,124
31 to 35 ft.	25	580	314	3,653
36 to 40 ft.	67	1,744	338	3,893
41 to 45 ft.	88	3,216	265	4,569
46 to 50 ft.	33	2,069	201	5,332
51 to 55 ft.	32	2,140	92	3,112
56+ ft.	36	2,493	344	29,654
Total	**285**	**12,420**	**2,180**	**52,365**

***preliminary**

APPENDIX I.

Table 5. **Commercial landings (including research trips) of Pacific halibut by port and country for 1997 (thousands of pounds).**

Ports	Canada	United States	Total
California & Oregon	10[1]	287	297
Seattle		1,214	1,214
Bellingham	90	2,480	2,570
Misc. Washington	2[1]	285	287
Vancouver	2,933		2,933
Port Hardy	3,342		3,342
Misc. Southern B.C.	877	10[1]	887
Prince Rupert	5,035	226	5,261
Misc. Northern B.C.	195		195
Ketchikan, Craig, & Metlakatla	7[1]	1,308	1,315
Petersburg, Kake		3,084	3,084
Juneau		1,560	1,560
Sitka		3,565	3,565
Hoonah, Excursion, & Pelican		2,380	2,380
Misc. Southeast Alaska		1,357	1,357
Cordova		1,217	1,217
Seward		4,890	4,890
Homer		5,258	5,258
Kenai		192	192
Kodiak		10,582	10,582
Chignik, King Cove, & Sand Point		2,103	2,103
Misc. Central Alaska		2,616	2,616
Akutan & Dutch Harbor		6,199	6,199
Misc. Bering Sea		1,894	1,894
Totals	**12,491**	**52,707**	**65,198**

[1] IPHC research vessels landed fish in these ports, but not exclusively in these ports.

APPENDIX I.

Table 6. Commercial halibut fishery catch (thousands of pounds) in 1997 by country, statistical area, and regulatory area.

Country	Statistical Area	Catch	Regulatory Area	Catch
United States	00-03	171		
	04	8	2A	413
	05	234		
Canada	06	246		
	07	58		
	08	787		
	09-O	207		
	09-I	647		
	10-O	1,145	2B	12,420
	10-I	1,379		
	11-O	221		
	11-I	1,603		
	12-O	135		
	12-I	305		
	13-O	665		
	13-O	5,022		
United States	14-O	86		
	14-I	605		
	15-O	353		
	15-I	1,401		
	16-O	1,564	2C	9,920
	16-I	2,408		
	17-O	900		
	17-I	739		
	18S-O	831		
	18S-I	1,033		
	18W	2,074		
	19	1,257		
	20	1,330		
	21	1,231		
	22	1,053		
	23	1,091	3A	24,628
	24	3,545		
	25	1,909		
	26	3,303		
	27	3,365		
	28	4,470		
	29	4,182		
	30	989		
	31	928	3B	9,072
	32	1,529		
	33	815		
	34	629		
	35	428		
	36	583		
	37	22		
	38	77		
	39	16	4	8,746
	40	76		
	41	303		
	42+	736		
	Bering Sea	6,505		

APPENDIX II.

Table 1. The fishing period limits (pounds) used in the directed commercial fishery in Area 2A.

VESSEL CLASS		FISHING PERIOD
LTR	**FT**	**July 8**
A	0-25	335
B	26-30	420
C	31-35	670
D	36-40	1,850
E	42-45	1,990
F	46-50	2,385
G	51-55	2,660
H	56+	4,000

Table 2. Metlakatla community fishing periods, number of vessels, and catch (pounds) in 1997.

Fishing Period Dates	Number of Vessels	Catch
May 2 - 4	11	3,768
May 16 - 18	12	4,620
May 30 - June 1	14	5, 201
June 7 - 9	8	6,916
June 14 - 16	8	3,445
June 20 - 22	5	4,039
June 27 - 29	11	7,733
July 4 - 6	3	2,445
July 11 - 13	6	4,198
July 18 - 20	7	3,826
Aug 1 - 3	13	9,199
Aug 8 - 10	7	7,281
Aug 15 - 17	9	9,911
Aug 22 - 24	5	2,097
Aug 29 - 31	9	6,373
Sept 5 - 7	7	3,872
Sept 12 - 14	8	3,122
Sept 19 - 21	1	NA
Sept 26 - 28	1	NA
19 Fishing Periods		**88,490**

APPENDIX III.

Table 1. Fishing dates, opportunity, size limits, and bag limits for the 1997 Pacific halibut sport fishery.

Area	Fishing Dates	Days open	Size Limit	Bag Limit
2A				
WA Inside Waters[1]	5/22-8/10	59	No	1
WA North Coast[2]	5/1-8/1	67	No	1
WA South Coast (all depths)[3]	5/1-5/17	17	No	1
WA South Coast (near shore)	5/18-9/20	3	No	1
Columbia River[4]	5/1-9/30	153	Yes	1
OR Central Coast (all depths)[5]	5/8-5/10, 5/15-5/17 5/23-5/24	8	Yes	2
OR Central Coast (< 30 fathoms)[6]	5/25-7/31 8/2-8/8	75	Yes	2
OR South Coast (all depths)[7]	5/8-5/17	6	Yes	2
OR South Coast (< 30 fathoms)[8]	5/18-7/31 8/2-8/8	68	Yes	2
OR Coast[9]	8/1	1	Yes	2
California[10]	5/1-9/30	153	Yes	1
2B, 2C, 3, and 4	2/1-12/31	334	No	2

[1] East of Bonilla-Tatoosh Line, closed Tuesday and Wednesday
[2] Bonilla-Tatoosh Line to Queets River, closed Sunday and Monday
[3] Queets River to Leadbetter Point, open 7 days per week
[4] Leadbetter Point to Cape Falcon, open 7 days per week, minimum size limit of 32 inches
[5] Cape Falcon to Siuslaw River, closed Sunday through Wednesday, minimum size limit of 32 inches for the first fish, and 50 inches for the second fish
[6] Cape Falcon to Siuslaw River, inside 30-fathoms, open 7days per week, minimum size limits same as for all depth fishery
[7] Siuslaw River to California/Oregon border, same open days and minimum size limits as in OR Central Coast fishery (all depths)
[8] Siuslaw River to California/Oregon border, same open days and minimum size limits as in OR Central Coast fishery (< 30 fathoms)
[9] Cape Falcon to California/Oregon border, same minimum size limits apply
[10] Open 7 days per week, minimum size limit of 32 inches

APPENDIX III.

Table 2. 1997 harvest allocations and estimates of sport catch (pounds) by sub-area within Regulatory Area 2A.

Sub Area	Allocation	Catch Estimate
WA Inside Waters	46,628	86,733
WA North Coast	96,088	98,330
WA South Coast (all depths)	19,483	20,324
WA South Coast (near shore)	1,000[1]	236
Columbia River	6,215	1,326
OR Central Coast (all depths)	86,703	110,806
OR Central Coast (<30 fathoms)	8,925	4,428
OR South Coast (all depths)	8,077	7,295
OR South Coast (<30 fathoms)	2,019	676
OR Coast	31,877[2]	20,968
California	3,750	3,750
Total	**310,765**	**354,872**

[1] The Washington South Coast all depth fishery was restricted to fishing in near shore waters when the harvest was projected to be within 1,000 pounds of the overall quota. After closure of the all depth fishery 1,932 pounds remained to be harvested.

[2] After accounting for underages and overages in previous openings from Cape Falcon to the California border, about 14,000 pounds remained to be harvested.

Table 3. Harvest by sport fishers (thousands of pounds) by area, 1992-1996.

Area	1992	1993	1994	1995	1996
2A	250	246	186	236	229
2B	579	657	657	657	657
2C	1,668	1,811	2,001	1,759	1,534
3A	3,899	5,265	4,487	4,488	4,822
3B	-	-	-	20	22
4	40	72	51	50	71
Total	**6,436**	**8,051**	**7,382**	**7,210**	**7,335**

PUBLICATIONS

The IPHC publishes three serial publications - Annual Reports, Scientific reports , and Technical reports - and also prepares and distributes regulation pamphlets and information bulletins. Items produced during 1997 by the Commission and staff are shown below and a list of all Commission publications is shown on the following pages. In addition, a listing of articles published by the Commission staff in outside journals is available on our website (see Preface).

CALENDAR YEAR 1997

Clark, W. G., G. St-Pierre, and E. S. Brown. 1997. Estimates of halibut abundance from NMFS trawl surveys. Int. Pac. Halibut Comm. Tech. Rpt. 37: 49 p.

Coughenower, D. and C. Blood. 1997. Flatout facts about halibut. Alaska Sea Grant College Program, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences.

Francis, R.C. and S.R. Hare. 1997. Regime scale climate forcing of salmon populations in the Northeast Pacific - some new thoughts and findings. [*In*] Emmett, R. L. and M. H. Schiewe [eds]. Estuarine and ocean survival of Northeastern Pacific salmon: Proceedings of the workshop. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-29: 113-128.

Hoag, S. H., G. St-Pierre, and J. E. Forsberg. 1997. Bottom area estimates of habitat for Pacific halibut. Int. Pac. Halibut Comm. Tech. Rpt. 36: 28 p.

International Pacific Halibut Commission. 1997. Annual Report, 1996, 64 p.

______. 1997. Pacific halibut fishery regulations 1997. 17 p.

Kaimmer, S. and R. Trumble. 1997. Survival of Pacific halibut released from longlines. [*In*] Fisheries Bycatch: Consequences and Management: Proceedings of the Symposium on the consequences and management of Fisheries Bycatch, August 27-28, 1996, Dearborn, Michigan. Alaska Sea Grant College Program Rep. No. 97-02, University of Alaska Fairbanks: 101-106.

Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bull. Amer. Meteor. Soc. 78: 1069-1079.

Schmitt, C. C. and G. St-Pierre. 1997. Evaluation of two methods to determine maturity of Pacific halibut. Int. Pac. Halibut Comm. Tech. Rpt. 35: 24 p.

COMMISSION PUBLICATIONS 1930-1997

Reports

1. Report of the International Fisheries Commission appointed under the Northern Pacific Halibut Treaty. John Pease Babcock, William A. Found, Miller Freeman, and Henry O' Malley. 31 p. (1931).[Out of print]
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8. Biological statistics of the Pacific halibut fishery, Effects of changes in intensity upon total yield and yield per unit of gear. William F. Thompson and F. Heward Bell. 49 p. (1934). [Out of print]
9. Life history of the Pacific halibut - Distribution and early life history. William F. Thompson and Richard Van Cleve. 184 p. (1936). [Out of print]
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Scientific Reports

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Technical Reports

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Annual Report 1977. 39 p. (1978).
Annual Report 1978. 40 p. (1979).[Out of print]
Annual Report 1979. 43 p. (1980).
Annual Report 1980. 49 p. (1981).[Out of print]
Annual Report 1981. 48 p. (1982).
Annual Report 1982. 56 p. (1983).[Out of print]
Annual Report 1983. 59 p. (1984).
Annual Report 1984. 63 p. (1985).[Out of print]
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Annual Report 1989. 39 p. (1990).
Annual Report 1990. 52 p. (1991).
Annual Report 1991. 57 p. (1992).[Out of print]
Annual Report 1992. 57 p. (1993).
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Annual Report 1995. 64 p. (1996).
Annual Report 1996. 64 p. (1997).