

**REPORT OF THE
INTERNATIONAL
PACIFIC HALIBUT COMMISSION**

**APPOINTED UNDER THE CONVENTION BETWEEN CANADA AND THE
UNITED STATES OF AMERICA FOR THE PRESERVATION OF THE
NORTHERN PACIFIC HALIBUT FISHERY**

NUMBER 32

**REGULATION AND INVESTIGATION
OF THE PACIFIC HALIBUT
FISHERY IN 1961**

COMMISSIONERS:

WILLIAM A. BATES

HAROLD E. CROWTHER

HAROLD S. HELLAND

MATTIAS MADSEN

RICHARD NELSON

WILLIAM M. SPRULES

SEATTLE, WASHINGTON

1962



FOREWORD

The terms of the 1953 Convention between the United States and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea provide that the International Pacific Halibut Commission, formerly designated the International Fisheries Commission, shall publish a report of its activities and investigations from time to time.

The present report, the thirty-second published by the Commission, is the fifteenth in a series of annual reports that was begun in 1947 to provide a summary of the Commission's activities and the more significant results of its investigations during the year. Those desiring additional background information are referred to earlier reports.



REGULATION AND INVESTIGATION OF THE PACIFIC
HALIBUT FISHERY IN 1961

by

INTERNATIONAL PACIFIC HALIBUT COMMISSION

CONTENTS

	<i>Page</i>
Introduction	7
Activities of the Commission	7
The Regulations in 1961	8
Statistics of the Fishery	10
Landing by Regulatory Areas	10
Landings by Port	11
Catch Per Unit Fishing Effort	12
Length of Fishing Seasons	12
Composition of the Catches	14
Growth Studies	17
Tagging Experiments	18
Studies of Halibut Below Commercial Size	20
Trawl Survey	22



INTRODUCTION

The International Pacific Halibut Commission, previously named the International Fisheries Commission, has been responsible for the investigation and management of the Pacific halibut fishery under four successive treaties between Canada and the United States signed in 1923, 1930, 1937 and 1953.

The responsibilities of the Commission under the 1923 treaty were largely restricted to investigation of the halibut and the fishery for the purpose of recommending measures for its rehabilitation and development. Under succeeding treaties the functions of the Commission were expanded to include the regulation of the fishery.

The most recent treaty, 1953, specifies that the Commission is responsible for developing the stocks of Pacific halibut to levels which will permit maximum sustained yield and for maintaining the stocks at those levels. It also requires the Commission to support its regulatory activities by scientific investigations. The foregoing biological objectives are substantially the same as some of the objectives of the International Convention for the High Seas Fisheries of the North Pacific Ocean, signed in 1953 by Canada, Japan and the United States.

Since management of the fishery began in 1932 under authority provided by the 1930 convention, the size of the halibut population of the eastern Pacific has been more than trebled. The permitted annual catch presently averages over 70 million pounds, much above the 44 million pounds produced by the partially overfished stocks in 1931. Without regulation the Pacific halibut catches would now be at an annual level well below the latter. Over the past 30 years this would have entailed a loss of yield worth at least \$100,000,000 to the fishermen during the period. This loss would be more than trebled if given in terms of combined gross national products of the two countries. In either case, the gain represents a very high and continuing return on the \$3,000,000 that the two Governments have appropriated to the Commission for the investigation and management of the fishery during the past 35 years.

ACTIVITIES OF THE COMMISSION

During 1961 the Commission continued the regulation of the fishery and the program of statistical and biological observations upon which regulation depends.

Members of the Commission from Canada in 1961 were: Dr. William M. Sprules, Ottawa, Ontario, Chairman; Mr. Harold S. Helland, Prince Rupert, British Columbia; and Mr. Richard Nelson, Vancouver, British Columbia. United States members were: Mr. Andrew W. Anderson, Washington, D.C., Vice-Chairman until his resignation in October; Mr. Harold E. Crowther, Washington, D.C., who succeeded Mr. Anderson; Mr. Mattias Madsen, Seattle, Washington; and Mr. William A. Bates, Ketchikan, Alaska.

The Commission held its regular annual meeting from February 7 to 9 inclusive in Prince Rupert, British Columbia. The meeting was the first annual meeting to be held elsewhere on the Pacific coast than at Seattle, the seat of the Commission.

During the meeting the Commission examined the results of regulations and investigations in 1960, considered and approved the research program for 1961, dealt with administrative and budgetary matters, conferred with industry representatives regarding regulation of the fishery, and adopted regulations for 1961.

A joint open meeting was held on February 7 with all branches of the halibut industry to review events in the fishery and the results of investigations in 1960, and to discuss these and the suggestions that had been received regarding the regulation of the fishery in 1961. On February 9 the Commission met with the Conference Board consisting of representatives of the fishermen's and vessel owners' organizations in Washington, British Columbia and Alaska. At the fourth and last session of the annual meeting on February 9 the Commission considered all regulatory proposals in the light of conditions within the stocks and in the industry and adopted regulations for 1961. A summary of the regulations which were being recommended to the two Governments was released the same day for the information of the industry and the public.

During the fishing season the Commission determined the dates upon which it deemed the area catch limits would be attained, announced these dates in advance and closed the areas accordingly.

An annual report upon the investigation and regulation of the Pacific halibut fishery in 1960 was published during the year. Also, two methodological reports by G. Morris Southward, "Photographing Halibut Otoliths for Measuring Growth Zones", and "A Method of Calculating Body Lengths from Otolith Measurements for Pacific Halibut and Its Application to Portlock-Albatross Grounds Data between 1935 and 1957", were accepted by the Fisheries Research Board of Canada for publication in its Journal. Several other scientific reports were advanced to the publishable stage.

THE REGULATIONS IN 1961

The Pacific Halibut Fishery Regulations adopted by the Commission for 1961 were approved by the President of the United States on March 29 and by the Governor General of Canada on March 30 and became effective on the latter date.

There were several significant changes in the regulations from those in 1960. Area 3B was divided into two parts—Area 3B North and Area 3B South—with different opening dates of April 10th and April 25th respectively. The second season in Areas 1B and 2 was eliminated. The catch limit in Area 2 was increased from 26,500,000 to 28,000,000 pounds and that in Area 3A from 30,000,000 to 33,000,000 pounds.

The five regulatory areas in 1961, shown in Figure 1, were the same as in 1960 except for the division of Area 3B. They were as follows: Area 1A—the waters off northern California and southern Oregon, south of Heceta Head, Oregon; Area 1B—the waters off Oregon and Washington between Area 1A and Willapa Bay, Washington; Area 2—the waters off Washington, British Columbia and Southeastern Alaska between Willapa Bay and Cape Spencer, Alaska; Area 3A—the waters off Alaska between Cape Spencer and Kupreanof Point, near the Shumagin Islands, Alaska; Area 3B South—the waters south of the Alaska Peninsula and Aleutian Islands between Kupreanof Point and Cape Sagak, Umnak Island; and Area 3B North—the waters of Bering Sea and around the Aleutian Islands west of Cape Sagak.

Catch limits in Area 2 and Area 3 were increased to 28,000,000 and 33,000,000 pounds respectively, as noted above. Fishing in other areas was again controlled by length of season as the amounts of removals were too small to be effectively administered by the catch-limit method.

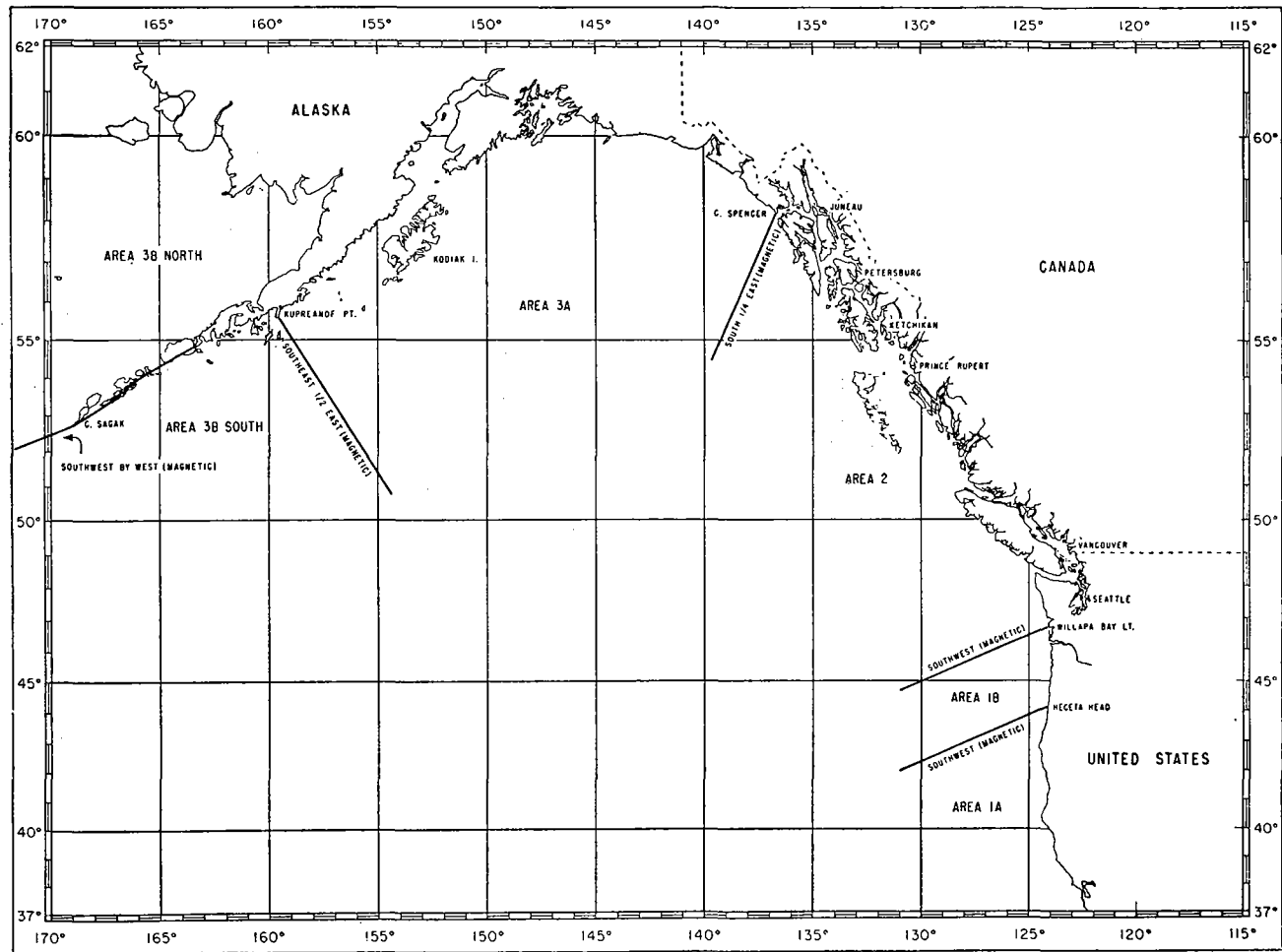


Figure 1. Pacific Coast of North America showing regulatory areas defined by the International Pacific Halibut Commission in 1961.

The following other regulatory provisions were all continued: the minimum size limit of 26 inches heads-on or five pounds heads-off for halibut; the prohibition of the use of dory gear and nets of any kind in fishing for halibut; the termination after November 15 of permits for the retention and possession of halibut caught incidentally by setline gear during fishing for other species in Areas 1A, 1B, 2, 3A, 3B South and 3B North; and, the beginning of the statutory closed season on December 1 in any area that might still be open by reason of the non-attainment of the catch limit which would otherwise determine its closure.

The fishing season in Area 3B North opened on April 10 and terminated on October 1. Area 3B South opened on April 25 and closed on October 1. All other areas were opened on May 10. The season in Areas 2 and 1B terminated on September 7 following announcement on August 29, which provided the customary notice period of approximately 8 days. Area 1A closed on October 1. The season in Area 3A terminated on August 23 with announcement on August 4, giving the customary 18 days notice of closure.

STATISTICS OF THE FISHERY

Landings by Regulatory Areas

Landings of halibut in thousands of pounds during 1961 are shown for groups of regulatory areas in the following table, with comparable landings for 1959 and 1960 and for 1931, the year immediately preceding the commencement of regulation by the Commission. The figures include conservative estimates of the halibut caught in contravention of the regulations.

United States and Canadian Catches by Regulatory Areas, in Thousands of Pounds

Year	Areas 1A and 1B	Area 2			Areas 3A, 3B North and 3B South			All Areas		
	U.S.	U.S.	Canada	Total	U.S.	Canada	Total	U.S.	Canada	Total
1931	923	14,609	7,018	21,627	20,907	765	21,672	36,439	7,783	44,222
1959	236	16,575	14,229	30,804	24,010	16,665	40,675	40,821	30,894	71,715
1960	309	16,723	15,086	31,809	21,318	18,527	39,845	38,350	33,613	71,963
1961	258	15,760	13,175	28,935	24,006	16,438	40,444	40,024	29,613	69,637

In Areas 1A and 1B, lying south of Willapa Bay off the coasts of Oregon and northern California, the total catch has been relatively low in recent years in spite of the fact that Area 1A, south of Heceta Head, Oregon, has remained open from May to mid-October. Most of the halibut taken at this southern extreme of the range of the species are now caught incidentally during fishing for other species.

The total catch from Area 2 from all sources in 1961 was 28.9 million pounds, about 2.2 million pounds below the average of the previous three years. The increase of 1.5 million pounds provided in the catch limit for the single season in 1961 was more than offset by the elimination of the second season which in 1960 yielded 3.2 million pounds. The current condition of the stocks in Area 2 had indicated a need for at least a temporary reduction in removals.

Included in the total production from Area 2 in 1961 are 307,000 pounds of halibut caught incidentally to other setline fishing, chiefly for blackcod after the area was closed.

In Area 3A during its single season from May 10 to August 23 the catch amounted to 34.0 million pounds, 1.0 million pounds above the 33-million-pound

catch limit. A part of this excess was the result of some fishing in contravention of the regulations in Area 3A before opening and after closure.

In Area 3B South, a total of 2.5 million pounds was taken in 1961 compared to 4.3 million pounds in 1960. The catch was less than desired because of an unexpected prolongation of the season in Area 3A which reduced autumn fishing in Area 3B South.

In Area 3B North, a total of 3.9 million pounds was taken in 1961 compared to 5.7 million pounds in 1960 and 4.1 million in 1959. The reduced production in 1961 resulted from more vessels landing their first fares in the distant railhead ports rather than in central Alaska, thereby foregoing the opportunity of making a second trip to Bering Sea before Area 3A opened.

As in previous years, the Bering Sea catch was largely taken before Area 3A opened and most of the 3B South catch after Area 3A closed. Catches in thousands of pounds from Areas 3B North and 3B South from 1956 to 1961 were as follows:

	1961	1960	1959	1958	1957	1956
Area 3B South.....	2,482	4,323	6,321	2,387	1,352	612
Area 3B North.....	3,919	5,688	4,113	2,180	47	267

In addition to the foregoing catch in southeastern Bering Sea, some halibut must also have been caught by Japanese and Russian trawlers fishing for bottom fish on the flats to the north and east of the edge grounds where Canadian and United States fishermen operate. However, on the basis of tag recoveries, the results of exploratory trawling in the same region and information releases, it is believed that Japanese and Russian catches consisted largely of small halibut and contained comparatively small quantities of halibut of commercial size.

Total Pacific coast catch by United States and Canadian vessels from all areas in 1961 totaled 69.5 million pounds. Though below the all-time high total of 71.9 million pounds taken in 1960, it equaled the 69.6 million average of the previous three years, 1958 to 1960. The reduction in 1961 was due largely to the elimination of the second season in Area 2.

Landings by Ports

The distribution of halibut landings in thousands of pounds from all areas is shown according to regions and ports or groups of ports for 1961 in the following table, with comparable data for 1959 and 1960.

United States and Canadian Landings by Regions and Ports
in Thousands of Pounds

Ports	1959			1960			1961		
	U.S.	Canada	Total	U.S.	Canada	Total	U.S.	Canada	Total
California and Oregon	338	—	338	420	—	420	371	—	371
Seattle	17,471	2,925	20,396	15,849	2,444	18,293	12,671	420	13,091
Other Wash.	477	50	527	725	937	1,662	1,893	1,493	3,386
Vancouver, B.C.	—	5,609	5,609	—	8,495	8,495	—	6,782	6,782
Vancouver I.	—	1,887	1,887	—	2,160	2,160	—	1,085	1,085
Prince Rupert	318	14,388	14,706	1,063	14,670	15,733	1,755	15,160	16,915
Other B.C.	—	1,934	1,934	—	1,663	1,663	—	1,887	1,887
S.E. Alaska	17,717	1,900	19,617	15,851	720	16,571	20,368	835	21,203
Central Alaska	4,500	2,201	6,701	4,442	2,524	6,966	3,007	1,804	4,811
TOTALS	40,821	30,894	71,715	38,350	33,613	71,963	40,065	29,466	69,531

Landings in California and Oregon in 1961 remained at substantially the same level as in 1959 and 1960. Seattle landings in 1961 continued the decline of the previous year due to a sharp decline in deliveries by Canadian vessels and further diversion of vessels to other Washington ports, particularly Bellingham, and to Ketchikan in Southeastern Alaska.

Landings in Vancouver were lower than in 1960 but were still above those of 1959. Prince Rupert receipts in 1961 continued the increasing trend noted for 1959 and 1960. Southeastern Alaska landings were higher than in the previous two years but receipts in central Alaska from both United States and Canadian vessels showed a notable decline.

Canadian landings in the United States ports totaled 4.6 million pounds, considerably under those of recent years. Landings of United States vessels in Canadian ports in 1961 of 1.8 million pounds were higher than during the previous two years.

Catch Per Unit Fishing Effort

All halibut vessels of five net tons or over are required to keep records showing the date, the fishing location, the amount of gear fished and the estimated catch of halibut in pounds for each fishing operation. These records are collected and analyzed to determine the average catch per standardized unit of fishing effort in the various areas and subsections thereof and in the different seasons. The resultant returns per unit of effort are then compared with those of earlier years to ascertain whether changes in relative abundance have occurred and to measure the magnitude of such changes.

In Area 2 as a whole, the catch per unit effort was slightly lower than in 1960 but was at the general level that prevailed from 1957 to 1959. The catch per unit effort was lower on Cape Scott and Goose Islands grounds and in northern Hecate Strait and Southeastern Alaska. In lower and middle Hecate Strait it was slightly above 1960.

The Area 3A catch per unit effort maintained the general level of the past ten years when appropriate allowances were made for the greater efficiency of the gear resulting from the increased use of octopus bait since 1958.

In Area 3B South a slightly higher catch per unit effort partly offset the sharp decline that occurred in 1960. The increase probably reflected the reduction in the amount of fishing in the area in 1961.

In southeastern Bering Sea in Area 3B North, the catch per unit effort was about the same as in 1960 but considerably lower than in 1958 and 1959. The declining trend in catch per unit effort, observed changes in catch composition and results from tagging experiments all indicate that current fishing, including such catches as are being made by foreign trawlers, is providing a level of utilization of adult halibut in the section of southeastern Bering Sea, where United States and Canadian fishermen operate, as high and possibly higher than on grounds in Areas 3A and 2.

LENGTH OF THE FISHING SEASONS

There was a progressive shortening of the fishing seasons during the two decades after the outset of regulation in 1932. This was a consequence of the increasing abundance of halibut under regulation which attracted many additional

vessels to the fleet by reason of the larger and more profitable fares. By 1953 the season in Area 2 was reduced to 24 days and in Area 3A to 52 days from 250 days and 258 days respectively in 1932.

The concentration of fishing within such very short periods of the year was not conducive to a balanced utilization of the various stock components. For a number of years, some sections of the grounds both south and west of Cape Spencer had shown clear indications of being overfished, others, of being somewhat underfished.

Adoption of multiple seasons by the Commission in 1954 under authority of the Convention of 1953, adjustment of opening dates and of boundary lines of some of the regulatory areas, and the institution of a voluntary between-trip lay-in program by the fleets in 1956 resulted in a substantial lengthening of the period of the year over which fishing took place.

The duration of the season or combined seasons in number of days for each area are shown below for the years 1951 to 1961 inclusive.

Year	Area 1A	Areas 1B and 2	Area 3A	Area 3B*
1951	56	28	56	56
1952	60	26	60	17
1953	52	24	52	25
1954	117	29	68	94
1955	132	31	93	116
1956	156	44	104	127
1957	168	54	144	168
1958	165	66	119	198
1959	168	75	92	198
1960	168	98	85	198
1961	144	120	105	159*

*In 1961 Area 3B was divided into Areas 3B South and 3B North. The season in the latter, Bering Sea, lasted 174 days, 15 days longer than in Area 3B South.

The length and the disposition of the seasons in Areas 2 and 3A during the 1951 to 1961 period are shown in Figure 2.

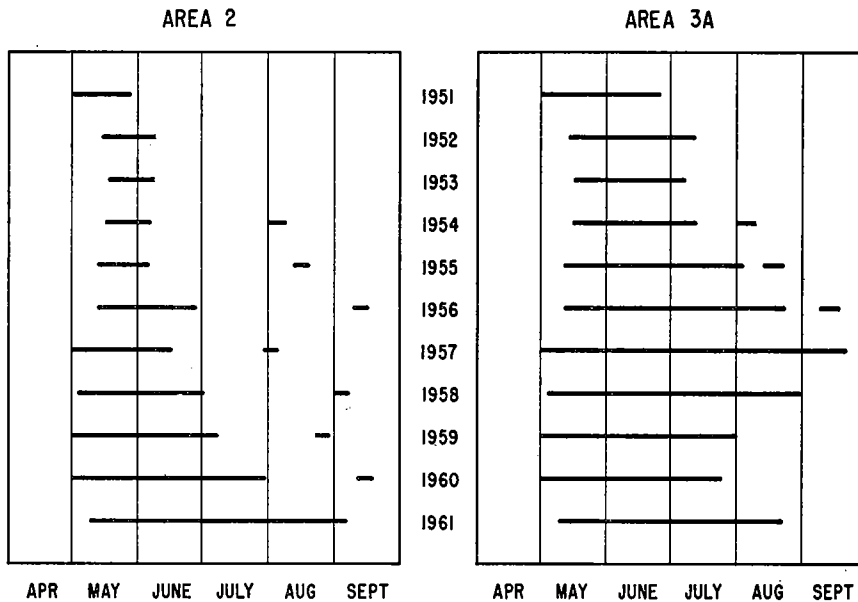


Figure 2. Length of seasons in Areas 2 and 3A during the years 1951 to 1961 inclusive.

In Area 2 the 1961 season was substantially prolonged over that of 1960 by the 10-day later opening. The short delay extended the season beyond the first week of July, by which time the many vessels of the salmon fleet usually terminate their halibut activity. With the small halibut fleet remaining, the season was lengthened considerably even though only a relatively small proportion of the catch limit remained to be taken. Under these conditions the single season in 1961 encompassed the period of the year previously covered by two seasons and eliminated the need for a second season.

In Area 3A the ten-day delay in opening in 1961 was also instrumental in prolonging the season and extending it well into the month of August. It stopped the trend toward a shorter season in Area 3A, brought about by continuing additions to the fleets and the increased effectiveness of gear which resulted from the use of octopus bait after 1958. If the length of season in 1961 can be maintained, it should obviate any need for reinstating a second season in the area.

COMPOSITION OF THE CATCHES

Investigations of the composition of the stocks on important grounds and associated studies of recruitment, mortality and growth are maintained on a continuous basis to obtain information which is essential for evaluation of the effects of current regulation and fishing upon the stocks and for determining the stock levels required for maximum sustainable yield.

For practical reasons this research is based primarily upon representative samples of lengths and corresponding samples of otoliths obtained from commercial catches at the time of landing. However, because sex and maturity cannot be distinguished in the halibut as landed due to the removal of the sex organs at sea, the market samples must be supplemented as frequently as possible with comparable samples obtained at sea where the sex and stage of maturity can also be determined.

The number of commercial trips sampled at ports of landing and at sea in 1961 and the number of measurements, otoliths and sex determinations secured from the various regions are summarized in the following table. An additional 8,700 measurements, including more than 4,000 with otoliths and sex data, were secured during exploratory trawling operations between Unimak Pass and the east end of Kodiak Island. The small-halibut survey provided 6,600 measurements including 1,300 with otoliths and sex data.

Age determinations in 1961 were made on over 36,000 otoliths. These included 23,000 from the current year's total collection of 37,326 and 13,000 from samples made in previous years.

A new method of sampling the catches which would utilize the relationship between size of otolith and fish length was further explored. From preliminary tests it is believed that this method will be at least as accurate for some purposes as present techniques of measuring actual fish lengths, and will be more efficient in that it will permit better sampling with little, if any, increase in laboratory and field assistance.

Efforts to develop a practicable method of estimating the sex composition of market samples were also pursued, using associated measurements such as the depth of the body cavity which could be incorporated in the sampling procedure. Perfection of such a technique would eliminate the necessity of placing observers

Summary of Catch Sampling in 1961 showing Measurements, Otoliths
and Sex Data according to Area of Origin

Fishing Areas	Number of Trips			Number of Fish			
	Port Sampling	Sea Sampling	Total	Measurements Only	Measurements and Otoliths	Measurements, Otoliths and Sex	Total
Area 2							
Washington-Vancouver I.	3	—	3	564	321	—	885
Cape Scott-Goose Is.	17	5	22	8,991	2,140	1,200	12,331
Dixon Entrance	6	—	6	763	825	—	1,588
Hecate Strait	40	3	43	12,441	5,385	1,198	19,024
Southeastern Alaska	51	2	53	17,085	4,815	1,121	23,021
Total Area 2	117	10	127	39,844	13,486	3,519	56,849
Areas 3A and 3B							
Cape Spencer-Cape Cleare	22	1	23	7,093	2,955	503	10,551
Cook Inlet-Shelikof St.	5	—	5	1,929	700	—	2,629
Portlock-Albatross Banks	24	6	30	10,433	3,328	1,716	15,477
Trinity Is.-Chirikof I.	12	8	20	7,295	1,680	2,245	11,220
Shumagin Is. & West (3BS)	6	—	6	1,183	801	—	1,984
Bering Sea (3BN)	6	1	7	2,969	840	243	4,052
Total Areas 3A & 3B	75	16	91	30,902	10,304	4,707	45,913
Total Areas 2, 3A & 3B	192	26	218	70,746	23,790	8,226	102,762

on fishing boats, a costly but essential activity which was instituted in 1960 to secure samples of known sex from the commercial catches. More sex samples could be obtained at a much lower cost per sample.

Several new techniques for calculation of total and natural mortality were applied to the halibut data in further efforts to improve the reliability of such estimates. Fluctuations in availability, presently inseparable from real changes in abundance, continue to affect the results.

Studies of spawner-progeny relationships were also carried forward. Evaluation of year-class strength, as measured by the virtual-population method, which appears to be the best available for halibut, indicates that variable selection by the fishery makes unreliable the estimates of the potential contribution to the fishery by year classes which are still contributing. More years of observation will be necessary before accurate estimates can be made of the strengths of the year classes which are now maintaining the fishery, and before conclusions can be drawn regarding spawner-progeny relationships.

Age composition samples from the various important grounds in Area 2 showed the same stronger year classes as in 1960, but the high availability of the young classes which have sustained the fishery in recent years appeared to be diminishing more rapidly than usual. The 1951 year class declined sharply in 1961. The 1954 class, which has been contributing unusually heavily to the catches for a group so young, continued to be the dominant group on some grounds in Hecate Strait in 1961 but it, also, was at a much lower level of abundance than in 1960. The availability of the older groups continued low on the Goose Islands grounds and in Hecate Strait.

In 1960 and 1961, the 1954 and 1951 year classes alone accounted for over 40 percent of the numbers of fish in the total commercial catch on Goose Islands grounds. It was hoped that their abundance would be sustained to an age at which their greater average weight would make an even greater contribution to the catches. However, they appear to be declining prematurely, possibly because of the unduly high dependence of the fishery upon them in the last few years. There is no indication from the age compositions from any section of Hecate Strait that an improvement in the yield can be expected there in the near future.

In Southeastern Alaska the decline in older fish in all sections since 1958 appears to have leveled off somewhat in 1961. The 1951 year class, predominant on these grounds, continued strong. The 1954 class, which was slow to appear in Alaska, began to make a strong entry in late summer catches.

Though samples from Portlock and Albatross banks in Area 3A continue to contain good proportions of older fish, the availability of all groups except the 1951 class declined from 1960. The 1951 year class, notably strong on all grounds, has made the strongest appearance of any year class in Area 3A in two decades.

Halibut on the Portlock-Albatross grounds showed the same seasonal pattern of declining availability as in other recent years. The generally high availability of the younger modal groups in the early season declined to moderate levels by late summer. The high levels at the opening of the season and the subsequent decline may be attributable in part to a concentration of the halibut in the gully areas where they are readily taken by setline gear at that season.

In 1961 there was little change from 1960 in the composition or general availability of the halibut in the Shumagin Islands-Davidson Bank sections of Area 3B South. Samples again showed the complicated seasonal changes in availability which are assumed to be associated with movements of fish in that region. From a low level of abundance in May, the availability of older fish suddenly increased in June and then slowly declined throughout the remainder of the season until in September when older fish were at nearly the same level as at the beginning of the season. Young fish were highly available in May, declined until July and then resumed a strong position during the rest of the season.

On the Bering Sea edge between Unimak Pass and Pribilof Islands where there has been a substantial fishery for several years, the age composition has been progressively altered to become one of younger fish. In 1961 the 1951 year class was by far the most abundant group on these grounds, as it has been elsewhere on the Pacific coast. The availability of fish, 12 years of age and older, which had declined sharply through 1960 in association with intensified fishing in the area, leveled off somewhat in 1961. It is interesting to note that this leveling-off coincided with an increased recovery in the edge of fish that had been tagged there in 1956.

The current annual rate of fishing mortality for halibut on Bering Sea edge, estimated from age composition data, is about 40 percent. Net emigration, the difference between migrations from and migrations to the edge may be as high as 30 percent. A high emigration is also indicated from the Makushin Bay and Slime Bank grounds where, despite the low level of fishing, there is a high total disappearance and the average age is relatively low.

These findings are in agreement with the results of tagging experiments in the same locations, which also show a high emigration from Bering Sea as well as a high utilization by the fishery within southeastern Bering Sea.

GROWTH STUDIES

As growth rate is an important factor in determining the yield produced by recruits into a fishery, studies of the growth of the halibut to determine differences from one region to another and of changes from one time to another are an essential part of the Commission's program of research.

Intensive study of the growth of halibut was continued in 1961, utilizing measurements of the widths and of the annual growth zones on the otoliths to estimate the lengths of fish at each earlier age. The usability of this method for halibut has been well demonstrated by investigation.

During the year, the growth zones in the otoliths of 6400 fish were measured for various purposes. Of these, the measurements of all growth zones of about 1900 otoliths were used for the annual assessment of growth on the major fishing grounds. About 3900 measurements were used in the study of an alternative method of sampling the commercial catches, and the measurements of about 600 otoliths were utilized in a study of the identification of the sex of dressed halibut. The otoliths were obtained from commercial landings, from commercial catches at sea and from the catches of research vessels.

In general, the growth rates of halibut on the major grounds, both south and west of Cape Spencer, have not changed during the last few years. An apparent increase in growth rate of the four- to six-year-old halibut, noted in catches from

Goose Islands grounds and Hecate Strait in 1960, was again observed in the catches from the same grounds in 1961. However, acceptance of this apparent increase in growth rate must be deferred due to the selectivity of setline gear against small fish, the selectivity exercised by fishermen in the choice of fishing locations, and a noticeable lack of older and larger fish in the catches. Data from additional years are required to determine whether the suggested increase in growth rate is real or an artifact.

TAGGING EXPERIMENTS

Tagging experiments are used to determine the migrations and relative utilization of halibut in different regions and on different banks, information that plays an important role in the Commission's regulatory program. Tagging also provides measures of both fishing and natural mortality which are required for scientific management of the stocks.

In 1961, tagging of halibut was done incidentally during the trawl survey of bottom fish off the coast of Alaska, which was conducted by the Commission at the request of the two Governments and is described in a later section. During this survey viable halibut, which were not required for other studies, were tagged and released. Tagging was also done during the operation of a trawl vessel for studies of the habits, distribution and abundance of halibut below commercial size. Additional halibut were tagged through the cooperation of the United States Bureau of Commercial Fisheries during trawler operations of that agency. The numbers of halibut tagged during the foregoing operations and their general geographic distribution are shown in the following table.

Region	Source			Total
	IPHC Trawl Survey	U.S. Bureau Comm. Fish	Small Halibut Investigations	
Bering Sea	—	116	—	116
Unimak Pass-Shumagin I.....	916	—	—	916
Shumagin I.-Trinity Is.....	1,923	—	—	1,923
Trinity Is.- Marmot I.....	1,477	—	898	2,375
Marmot I.- Middleton I.....	—	228	170	398
Middleton I.-Cape Spencer.....	—	599	289	888
Icy Straits	—	—	57	57
Cape Flattery	—	2	—	2
TOTAL	4,316	945	1,414	6,675

A total of 1116 tag recoveries were reported in 1961 compared to 880 in 1960. The recoveries during 1960 and 1961 from experiments in 1958, 1959 and 1960 are summarized in the following table. The increased recoveries in 1961 reflected the change in availability of tags released in 1960, from the usual low level in the zero year, the year of tagging, to a higher level in the first full year of recovery.

Three Bering Sea tags that had been recovered in 1960 by the Japanese trawl fishery in eastern Bering Sea and five recovered in 1961 were reported in 1961. No tag recoveries were received from the Russian fishery during the year.

Recoveries from tagging experiments conducted during the years 1949 to 1955 inclusive on grounds between Cape Scott and Dixon Entrance in Area 2 show a progressive increase in the percentages of recoveries from earlier to later experiments. Recoveries through 1961 by the setline fishery from 3307 fish tagged in the region

Summary of 1960 and 1961 Tag Recoveries from
1958 to 1960 Tagging Experiments

Year and Location	Month	Number Tagged	Number of Recoveries by Season						
			1960*				1961		
			Regular	2nd	Other**	Total	Regular	Other	Total
SOUTH OF CAPE SPENCER									
1958 Experiments									
Frederick Sound	March-April	1,158	41	8	3	52	40	1	41
Chatham Strait	March-April	261	12	1	—	13	5	—	5
Stephens Passage	April	111	3	—	2	5	7	—	7
1960 Experiments									
Goose Is.	April	2,289	—	—	—	—	193	30	223
Goose Is.	August	1,012	—	—	—	—	158	27	185
Masset Nursery	May	175	—	—	—	—	11	6	17
Masset Nursery	August	132	—	—	—	—	3	1	4
Freeman Pass	May-June	147	—	—	—	—	16	4	20
Northern Hecate Strait	May-July	351	—	—	—	—	21	6	27
Dixon Entrance	May	107	—	—	—	—	10	1	11
Cape Bartolome	May	33	—	—	—	—	1	—	1
Timbered I.	May	316	—	—	—	—	15	7	22
Timbered I.	July	1,787	—	—	—	—	124	4	128
Coronation I.	May-July	426	—	—	—	—	21	3	24
Cape Ommaney	June	315	—	—	—	—	23	1	24
Point Amelia	July	1,098	—	—	—	—	60	3	63
West Coast Graham I.	August	700	—	—	—	—	29	2	31
Two Peaks	August	168	—	—	—	—	30	5	35
Butler Cove	May-July	265	—	—	—	—	20	1	21
WEST OF CAPE SPENCER									
1958 Experiments									
Marmot Bay and Kitoi Bay	May-June	222	2	—	—	2	1	—	1
1959 Experiments									
Bering Sea edge	May	1,270	26	—	2(2)	28	11	3(2)	14
Bering Sea edge	June	365	3	—	2(1)	5	2	1(1)	3
Bering Sea edge	July	82	2	—	—	2	1	1	2
Aleutian chain	June	87	—	—	—	—	1	1	2
Makushin Bay	August	389	13	—	—	13	1	—	1
Slime Bank	June-July	1,907	11	—	—	11	8	1(1)	9
Slime Bank	July	963	5	—	1(1)	6	1	—	1

*Zero-year recoveries are not comparable and are omitted.
**Includes recoveries by out-of-season setline, trawl and unknown gear.
Numbers in parentheses indicate number of recoveries by foreign vessels.

in 1955 totaled 1089 or 33.0 percent, with the Goose Islands and northern Hecate Strait experiments showing the highest recoveries, namely 33.1 and 34.5 percent respectively. The high levels of recovery in recent years coupled with observed changes in the age composition of the halibut catches in the region indicate a need for close control of the removals to prevent overexploitation.

Halibut from the large tagging experiments in Bering Sea in 1956 and 1959 continued to be recaptured in significant numbers throughout the grounds between Unimak Pass and Cape Spencer off the southern coast of Alaska and to a lesser extent in Area 2 off Southeastern Alaska, British Columbia, Washington and Oregon. Among the recoveries in Area 2 in 1961, one fish tagged on the edge in Bering Sea in 1959 was recovered off Coos Bay, Oregon; and another tagged west of the Pribilof Islands in 1959 was recovered off Lapush, Washington. The distances traversed along the trend of the coast were 2195 and 2035 miles respectively. The only greater distance between the point of tagging and recapture was by a halibut tagged in 1930 off Unalaska Island in Bering Sea and recovered in 1936 off Cape Mendocino, California, a distance of about 2305 miles.

STUDIES OF HALIBUT BELOW COMMERCIAL SIZE

Studies of halibut below commercial size are being conducted to determine whether relationships can be established between the abundance of juveniles, prior spawning stocks, environmental conditions and future recruitment to the fishery.

This program of research, begun in 1955, has not yet covered a sufficient period of years to resolve such complex relationships, particularly in a long-lived species such as the halibut. However, considerable consistency has already been observed in the relative abundance of one-year-olds and two-year-olds on all sections of the coast and the relative abundance of five-year-olds and older of the same year classes in the commercial fishery in Area 2, where the fish enter the fishery at a young age. From this it is believed that advance information regarding the recruitment that can be expected in the fishery from each spawning may well be obtained by year-to-year sampling to determine the relative abundance of one-year-olds and two-year-olds.

In 1961, the trawler VICTORY MAID was chartered for 100 days, from June 12 to September 18, at approximately the same season as in other years. Sampling with bottom trawls was conducted in the regions where the yearly catches of very young have been consistently good, particularly on inshore concentrations near Kodiak Island and Cape St. Elias in Area 3A and in Shelikof Bay in Area 2.

Some exploration on offshore grounds and on additional inshore grounds was permitted by good weather. Three new concentrations of juveniles were discovered—one off Kodiak Island, one off the Trinity Islands in Area 3A, and another within Icy Strait in Area 2. The latter is especially important because it provided relatively large numbers of three-, four- and five-year-olds which may be compared with the catches of one-year-olds of the same year classes elsewhere and particularly in Shelikof Bay, the only location in Area 2 where adequate concentrations of the latter have been found.

In an attempt to increase the catches of the larger precommercial sizes off British Columbia to a useful level, additional exploratory fishing was conducted there. The inside passages of Southeastern Alaska were also explored further. In

both regions most of the grounds explored were untrawlable and in neither were significant numbers of juveniles encountered. Inability to obtain usable samples of juveniles off British Columbia and the southern portion of Southeastern Alaska during the past seven years indicates that sampling in these regions is not practicable except on a purely incidental basis as research vessels pass through the two regions.

One hundred and sixty-five effective hauls were made, 107 with 1 $\frac{1}{4}$ -inch and 58 with 4 $\frac{1}{4}$ -inch mesh trawls in depths ranging from 6 to 104 fathoms. Fifteen other hauls were rendered ineffective by tearing of nets.

A total of 9250 small halibut ranging from one to 25 inches in length and from less than one to 10 years of age were caught. Samples taken included 3500 length measurements, 1800 sex determinations, and 1200 otoliths. The stomach contents of over 1200 small halibut were also examined. Over 7000 fish, most of which were not seriously injured, were released. Of these, approximately 1400, mostly one-year-olds, were tagged with plastic dart tags off Kodiak Island, Prince William Sound, at Cape St. Elias and in Icy Strait where the chances of early recovery appear to be the most favorable.

The number of halibut at each age in the 1961 catches according to locality and age were as follows:

Locality	Age										Total	
	0	1	2	3	4	5	6	7	8	9		10
Area 2												
Queen Charlotte Sd.....	—	—	—	—	1	—	1	1	—	—	—	3
Hecate Strait	—	—	4	2	1	2	1	—	—	—	—	10
Dixon Entrance	9	—	—	—	1	—	—	—	—	—	—	10
Cape Addington	—	—	—	1	2	2	1	—	—	—	—	6
Shelikof Bay	1,086	63	2	3	—	—	—	—	—	—	—	1,154
Stephens Passage	—	—	—	—	—	1	—	—	—	—	—	1
Icy Strait	—	—	—	20	110	51	19	12	8	1	1	222
Area 3A												
Cape Fairweather	—	—	—	3	19	8	5	—	—	—	—	35
Cape St. Elias	3,104	508	45	70	166	33	9	4	1	—	1	3,941
Prince William Sd.....	216	360	40	19	11	4	2	2	—	—	—	654
Cook Inlet	3	156	110	13	7	—	—	—	—	—	—	289
Kodiak Island	320	2,050	135	35	15	—	1	—	—	—	—	2,556
Trinity Islands	28	311	3	—	—	—	—	—	—	—	—	342
Chirikof Island	—	4	17	1	4	1	—	—	—	—	—	27
Total	4,766	3,452	356	167	337	102	39	19	9	1	2	9,250

Samples of small halibut have been secured each year from southeastern Bering Sea since 1956, through the courtesy of the United States Bureau of Commercial Fisheries which has retained small halibut taken while trawling in that region during investigations of king crab. The months of operations, the amount of fishing done and the numbers of small halibut captured during those years in which gear of comparable mesh was used were as follows:

Year	Months	Hauls		Halibut Caught	
		Number	Duration	Number	Per Hour Haul
1958	April-July	127	60 min.	1,690	13.3
1959	May and August.....	98	60 min.	1,419	14.5
1960	August	70	60 min.	847	14.7
1961	July-August	40	60 min.	123	3.1
Total		513		4,283	8.7

The above catches from Bering Sea ranged from 7 to 25 inches in length and from 2 to 8 years of age, with three-year-olds most numerous and four-year-olds next so. The halibut were taken in depths ranging from 20 to 70 fathoms on the flat grounds between the Alaska Peninsula and Cape Newenham where halibut of sub-commercial size were found to be widely dispersed and susceptible to capture by a trawl fishery. It is possible that the sharp drop in catch per unit effort in 1961 was a result of the intensive trawl fishery being conducted for bottom fish in the same region by Japanese and Russian trawlers.

The trawl investigations of the distribution and availability of halibut and associated bottom species south of the Alaska Peninsula in 1961, described in the following section, proved to be an abundant and valuable source of data regarding halibut below commercial size. Prior to the survey, on the basis of setline fishing, it was believed that halibut of sub-commercial size were largely segregated from those of commercial size and probably in shallower water. Preliminary work on the survey data has revealed that the above is not the case and that small halibut—two-, three- and four-year-olds—are dispersed inside the 100-fathom line throughout the survey area including the grounds where the setline fishery for halibut operates.

TRAWL SURVEY

At the request of the Governments of Canada and the United States, the Commission planned and on 1 May 1961 began a comprehensive twelve-month investigation of the distribution and availability of halibut and of other associated bottom or demersal species off the southern coast of central and western Alaska using bottom otter trawl gear. The survey area extended from the northeastern end of Kodiak Island to Unimak Pass, a distance of 550 miles along the coast, and included about 40,000 square miles of shelf area.

The purpose of the survey was to estimate the potentialities of the region for bottom trawling and the effect that such a fishery might have upon the supply of adult and juvenile halibut.

Three trawlers were chartered, the M/V ARTHUR H., MORNING STAR and ST. MICHAEL with net tonnages of 59, 53 and 73 respectively. The vessels were equipped with standard Pacific coast bottom trawls with codends of 3.5 inch stretched-mesh. Each was manned by a captain and crew of three fishermen plus three biological aides of the Commission, the latter to process the catches and record the pertinent data.

A regular pattern of more than 900 sampling stations was established on parallel north-south lines 15 minutes of longitude apart. Along these lines the stations were located six minutes of latitude apart from shore to the 100-fathom line, with two additional stations, one at 140 fathoms and one at 250 fathoms. The latter depth is approximately the maximum to which most Pacific coast trawlers of the United States and Canada can effectively operate due to the capacity of their cable drums.

Provision was made for sampling the region during three periods of the year to obtain information about the seasonal distribution and availability of halibut and other species to a trawling operation. Two of these periods of sampling, from May to August and from August to December, were completed in 1961.

It was found that fishing could be conducted effectively at only about 45 percent of the stations established in the survey region. Approximately 48 percent of the stations were completely untrawlable due to rough, rocky bottom inside the 100-fathom line and due to the steepness of the continental slope and to pinnacles outside the same line. Hauls attempted at the remaining seven percent of the stations were too short, due to snagging and the tearing of nets, to be deemed effective.

Halibut were caught throughout the area of the survey. They were taken at more than 80 percent of the trawlable stations and represented approximately six percent of the total weight of fish taken. The proportion of halibut to other fish tended to be highest in depths between 20 and 60 fathoms and to decrease with increase in depth. Few halibut were taken at depths exceeding 100 fathoms.

Particularly noteworthy was the fact that although the catches of halibut were low in terms of weight, averaging about 43 pounds per 60-minute haul, they contained large numbers of juveniles. About 85 percent of all halibut by numbers were less than 26 inches long, the minimum legal size in the setline fishery for halibut. Of most frequent occurrence were halibut between 12 and 16 inches long, and from two to three years of age. Definite trends of increase in average age and length of halibut were apparent from the westernmost part of the survey area, Unimak Pass, to Kodiak Island. Data made available by the United States Bureau of Commercial Fisheries in the Kodiak Island to Cape Spencer area indicate that the average size and average age of halibut caught in identical trawls continue to increase to the eastward.

Many species of fish other than halibut were also taken. Among these were turbot, ocean perch, rock sole, flathead sole, rex sole, pollock and blackcod. Catches of other species in general increased with an increase in depth. The average catch per haul was about 500 pounds in the 20-60 fathom range, 700 pounds between 60 and 100 fathoms, and 1300 pounds at the stations outside 100 fathoms. King crab and shrimp were also taken in some places throughout the survey area.