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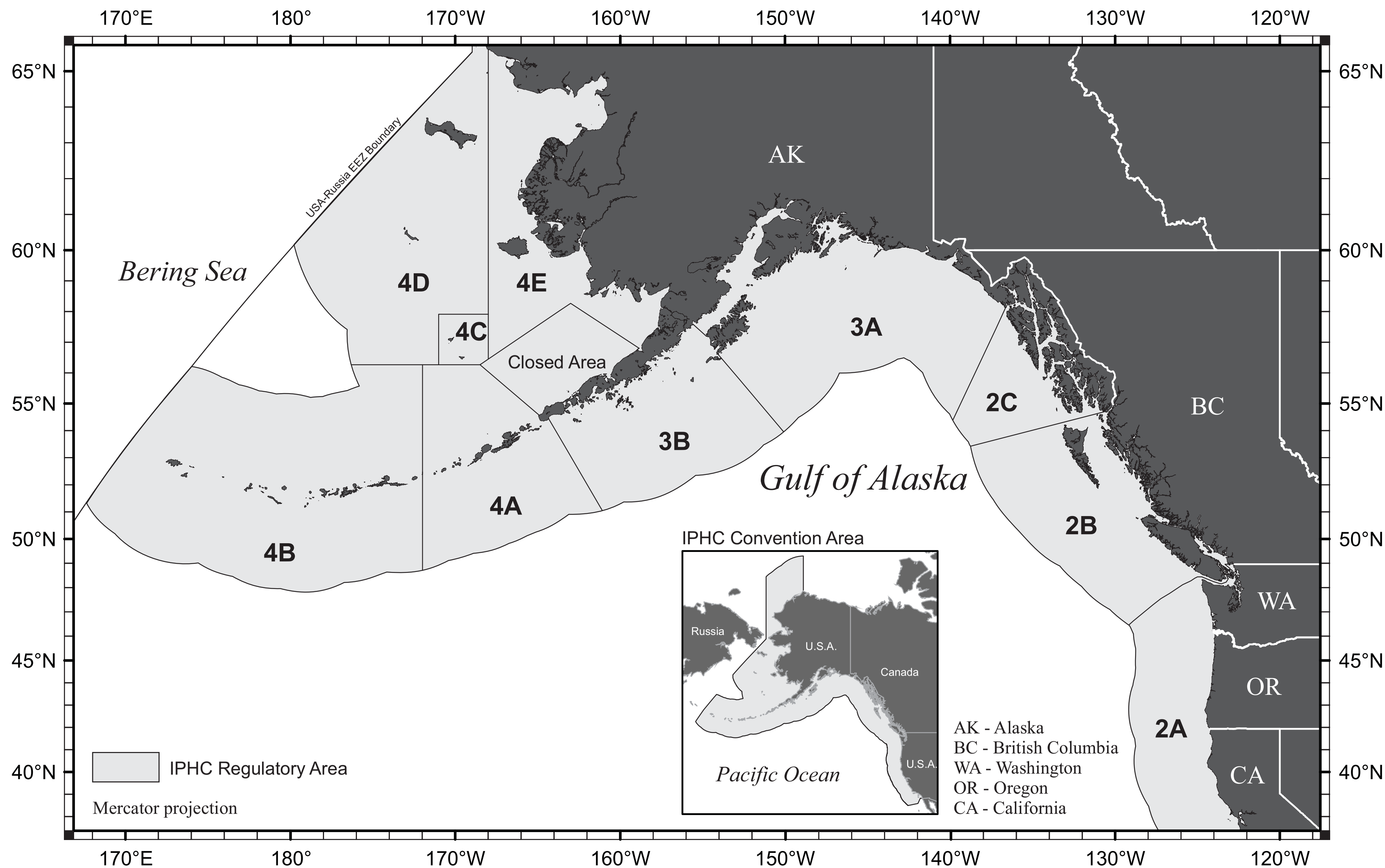
International Pacific Halibut Commission

Annual Report 2018



IPHC Regulatory Areas

ISSN: 0074-7238

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report

2018

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

Commissioners

Robert Alverson | Neil Davis
Peter DeGreef | Chris Oliver
Paul Ryall | Richard Yamada

Executive Director

David T. Wilson, Ph.D

This report produced by IPHC Secretariat
and Katherine Gustafson
2019

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Co-producer

Katherine Gustafson is a freelance writer and editor who resides in the Pacific northwest. She has worked extensively with environmental nonprofits, including Conservation International, World Wildlife Fund, and Oceana. Her first book, Change Comes to Dinner, about positive change in the U.S. food industry, was published in 2012. This is Katherine's fifth year as co-producer of this report.

Preface

The International Pacific Halibut Commission (IPHC) was established in 1923 by a Convention between Canada and the United States of America. The Convention was the first international agreement providing for the joint management of a marine resource. The Commission's authority was expanded by several subsequent conventions, the most recent being signed in 1953 and amended by the Protocol of 1979.

Three (3) IPHC Commissioners are appointed by the Governor General of Canada and three (3) by the President of the United States of America. The Commissioners appoint the Executive Director, who supervises the scientific, technical, field, and administrative staff. The scientific staff collects and analyzes the statistical and biological data needed to manage the Pacific halibut stock within Convention waters. The IPHC headquarters and laboratory are located in Seattle, Washington, U.S.A.

The Commission meets annually to review all regulatory proposals, including those made by the IPHC Secretariat, Contracting Parties, and by industry. The measures adopted by the Commission are recommended to the two governments for approval and implementation. Upon approval the regulations are published in the U.S. Federal Register and the Canada Gazette and are enforced by the appropriate agencies of both governments.

The IPHC 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.

How to interpret this report

Data in this report have been updated using all information received by IPHC through 31 December 2018 and reported at the 95th Annual Meeting in 2019. Some data may have been subsequently updated and readers are encouraged to access the IPHC website for the latest information: https://iphc.int/. 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.

On the Cover

The *F/V Pender Isle*, pictured on the front cover, has been a long-time participant in the IPHC fishery-independent setline survey. The photographer is Jamie Goen, a former member of the Secretariat staff.

ACRONYMS USED IN THIS REPORT

ADEC - Alaska Department of Environmental Conservation
ADF&G - Alaska Department of Fish and Game
BBEDC - Bristol Bay Economic Development Corporation
BSAI - Bering Sea and Aleutian Islands
CDFW - California Department of Fish and Wildlife
CDQ - Community Development Quota
CGOARP - Central Gulf of Alaska Rockfish Program
COAC - Clean Otolith Archive Collection
C&S - Ceremonial and Subsistence
CSP - Catch Sharing Plan
CVRF - Coastal Villages Regional Fund
DFO - Fisheries and Oceans Canada
DMR - Discard Mortality Rate
DO - Dissolved Oxygen
EBS - Eastern Bering Sea
EC - Electronic Monitoring
FISS - Fishery-independent setline survey
GAF - Guided Angler Fish
HCR - Harvest Control Rule
HARM - Halibut Angler Release Mortality
IFMP - Integrated Fisheries Management Plan
IFQ - United States Individual Fishing Quota
IPHC - International Pacific Halibut Commission
IQ - Individual Quota
IVQ - Canadian Individual Vessel Quota
MP - Management Procedure
MPR - Mortality Per Recruit
MSAB - Management Strategy Advisory Board
MSE - Management Strategy Evaluation
NMFS - National Marine Fisheries Service
NOAA - National Oceanic and Atmospheric Administration
NPFMC - North Pacific Fishery Management Council
NPUE - Numbers-Per-Unit-Effort
NSEDC - Norton Sound Economic Development Corporation
ODFW - Oregon Department of Fish and Wildlife
PAT - Pop-up Archival Transmitting
PDO - Pacific Decadal Oscillation
PFMC - Pacific Fishery Management Council
PHI - Prior Hook Injury
PSC - Prohibited Species Catch
PSMFC - Pacific States Marine Fisheries Commission
QS - Quota Share
RDE - Remote Data Entry
RI - Rockfish Index
RSL - Reverse Slot Limit
SRB - Scientific Review Board
SPR - Spawning Potential Ratio
WDFW - Washington Department of Fish and Wildlife
WPUE - Weight-Per-Unit-Effort
XRQ - Experimental Recreational Halibut

Executive Director's message

In 2018, I was again fortunate enough to undertake port visits to St Paul, Kodiak, and Dutch Harbor, where a number of you were gracious enough to take the time to impart your ideas, thoughts and updates on the fishery. St Paul was particularly informative, where I had the opportunity to meet a greater portion of the community during the 4th of July celebrations. A special thank you to the community for welcoming myself, Dr Ian Stewart, and Ms Lara Erikson, and to the *F/V Bay Rose* for permitting us to spend a day observing fishing operations at sea.

Throughout the course of 2018, we have continued to make tremendous progress in enhancing the IPHC's scientific processes and the communication of scientific advice emanating from our core functions as a Secretariat serving the Commission. This has occurred in tandem with an evaluation of the supporting governance procedures of the organization, including how stakeholder inputs are incorporated into the decision-making framework to ensure that all points of view are being adequately considered in a transparent manner. The aim of improved communication, inclusiveness and transparency, was partially delivered upon in 2017 and 2018 via the redesign, population and publication of the IPHC's new and expanded website (https://iphc.int/). The IPHC Secretariat will continue to expand upon the utility of the website, including the development of different ways to publish data and statistics for our stakeholders to access, over the coming year.

IPHC Executive Director Dr. David Wilson and Quantitative Scientist Dr. Ian Stewart ride along during a commercial fishing trip aboard the *F/V Bay Rose*. Photo by Lara Erikson.

From a fishery perspective, we started the year 2018 with the Commission adopting an informal 'fish-down' strategy of the Pacific halibut resource, due largely to our stock assessment that estimated female spawning biomass at the beginning of 2018 to be 40% (26–60%) of the equilibrium unfished spawning biomass level (SB_0). The estimated level of biomass was consistent with the recent primary stock abundance indices: the IPHC fishery-independent setline survey weight-per-unit-effort (WPUE) indices which were down 10% from 2016, and directed longline fishery WPUE which was up 5% from 2016. Such a level of biomass is widely considered to be a reasonable target level for sustaining optimal harvest rates of groundfish species, though species biology and ecology play a large role in determining species-specific levels.

The subsequent stock assessment completed at the close of the 2018 fishing and setline survey seasons, estimated female spawning biomass to be 43% (27-63%) of the equilibrium unfished level (SB_0) at the end of 2018. Of concern however, is that both fishery-dependent and fishery-independent indices were down from 2017, and Pacific halibut recruitment estimates show that the largest recent cohorts of young fish occurred from 1999-2005 and are rapidly decreasing in importance to the fishery. Cohorts from 2006 through 2013 are estimated to be substantially smaller in volume, which suggests that there is a high probability of continued decline in both the stock size and fishery yield as these cohorts move through the fishery, irrespective of fishing pressure. Specifically, the stock biomass is projected to decrease over the period from 2019-21 for all total mortality levels greater than 20 M lb (~9,070 t). Thus, with the Commission adopting total mortality levels of 38.61 M lb (~17,513 t) for the 2019 fishing season, we should expect that female spawning biomass will decrease with a high probability in the coming years.

Rest assured, the IPHC Secretariat staff and I will continue to develop and communicate the best possible scientific advice, to ensure that the Commission is equipped with the information it needs to make informed, timely, and scientifically-based management decisions. The overall aim of course, being to take a precautionary-based approach to fishery management, thereby ensuring a sustainable resource and its associated fishery.

I look forward to engaging with all of you over the coming year, either through the Commission's subsidiary bodies, or in person at our landing ports and communities that so heavily rely on Pacific halibut as a source of income, food, and cultural identity.

David T. Wilson, Ph.D.
Executive Director

Activities of the Commission

The IPHC meets several times a year, in both formal and informal capacities, to consider matters relevant to the Pacific halibut stock, the fisheries, and governance.

94th Session of the IPHC Annual Meeting (AM094; 2018)

The 94th Session of the International Pacific Halibut Commission (IPHC) Annual Meeting (AM094) was held in Portland, Oregon, U.S.A., from 22 to 26 January 2018. The Commission is composed of six members (Commissioners), and for 2018, Dr. James Balsiger of the United States of America presided as Chairperson and Mr. Paul Ryall of Canada presided as Vice-Chairperson. The Commission heard reports from the IPHC Secretariat about the status of the Pacific halibut (*Hippoglossus stenolepis)* population, reviewed finance and administration, discussed bycatch concerns and minimum size limits, considered the suggestions of its subsidiary bodies, and solicited public comments before passing regulations and other decisions.

Both contracting parties agreed that fishery limits for 2018 should be reduced from 2017 levels, but were unable to reach agreement on what those limits should be during the Annual Meeting. This led to more restrictive fishery limits being adopted unilaterally following the meeting.

Fishery limits and fishing periods for 2018

Due to the lack of agreement on fishery limits for 2018, the status quo fishery limits set for the 2017 fishing periods remained in effect for 2018, until such time as the Contracting Parties applied more restrictive measures, as permitted in the IPHC Convention.

The Commission at the 94th Annual Meeting. Photo by Tracee Geernaert.

Canada

On 13 February 2018, Canada, via Fisheries and Oceans Canada (DFO), announced the adoption and implementation of the following '*more restrictive*' 2018 fishery limits for Pacific halibut fisheries in IPHC Regulatory Area 2B:

	Fishery limit (pounds)	Fishery limit (metric tonnes)
IPHC Regulatory Area 2B	**6,223,985**	**2,823.18**
Commercial Total Allowable Catch	5,295,995	2402.25
Recreational Total Allowable Catch	927,990	420.93

United States of America

On 23 March 2018, the United States of America, via NOAA Fisheries, announced the adoption and implementation of the following '*more restrictive*' 2018 fishery limits for the commercial Pacific halibut fisheries in IPHC Regulatory Area 2A, to be effective as of 24 March 2018:

	Fishery limit (pounds)	Fishery limit (metric tonnes)
IPHC Regulatory Area 2A	**1,190,000**	**539.78**
Treaty Indian commercial	389,500	176.67
Non-treaty directed commercial (south of Pt. Chehalis)	201,845	91.56
Non-treaty incidental catch in salmon troll fishery	35,620	16.16
Non-treaty incidental catch in sablefish fishery (north of Pt. Chehalis)	50,000	22.68

On 19 March 2018, NOAA Fisheries announced the adoption and implementation of the following '*more restrictive'* 2018 fishery limits for the Pacific halibut fisheries in IPHC Regulatory Areas 2C, 3A, 3B, 4A, 4B, and 4CDE:

NOAA Fisheries adopted fishery limits totaling 20.52 million pounds for Alaskan waters in 2018.

	Catch limit (pounds)	Catch limit (metric tonnes)
IPHC Regulatory Area 2C	**4,450,000**[1]	**2,018.51**[1]
Commercial (IFQ) & discard mortality	3,640,000	1,651.07
Charter sport	810,000	367.41
IPHC Regulatory Area 3A	**9,450,000**[1]	**4,286.49**[1]
Commercial (IFQ) & discard mortality	7,670,000	3,479.05
Charter sport	1,790,000	811.94
IPHC Regulatory Area 3B	**2,620,000**	**1,188.41**
IPHC Regulatory Area 4A	**1,370,000**	**621.42**
IPHC Regulatory Area 4B	**1,050,000**	**476.27**
IPHC Regulatory Area 4CDE	**1,580,000**	**716.68**
IPHC Regulatory Area 4C	733,500	332.71
IPHC Regulatory Area 4D	733,500	332.71
IPHC Regulatory Area 4E	113,000	51.26

[1] In accordance with the catch sharing plan in place for this IPHC Regulatory Area, this overall total includes estimates for recreational discard mortality.

Thus, the total fishery limit for 2018 was set at 27,933,985 pounds, net weight (12,670.64 metric tons, t), an 11 percent decrease from the 2017 catch limit of 31,400,000 pounds (14,242.80 t).

The Commission designated the 2018 commercial fishing periods (seasons) as follows:

a) IPHC Regulatory Area 2A (Non-Treaty Direct Commercial): 27 Jun, 11 July, 25 July, 8 August, 22 August, 5 September, 19 September.

b) IPHC Canadian and U.S.A. quota-share fisheries: Opening: 24 March – Closing date: 7 November.

Other decisions made at the meeting

The Commission made a range of other decisions at the 94th Session of the IPHC Annual Meeting (AM094) in 2018, including the approval of a range of regulatory changes as follows:

a) The Commission adopted regulatory proposal IPHC-2018-AM094-PropB1 Rev_1, which proposed IPHC Regulation changes to allow the use of leased Individual Fishing Quota (IFQ) by Community Development Quota (CDQ) organizations in IPHC Regulatory Areas 4B, 4C, 4D, and 4E.

The Commission made a variety of other decisions based on proposals submitted prior to the meeting. To view the proposals in their entirety, visit the IPHC meeting webpage: https://iphc.int/venues/details/94th-session-of-the-iphc-annual-meeting-am094

b) The Commission adopted regulatory proposal IPHC-2018-AM094-PropB2, which proposed a clarification to the IPHC Regulations regarding retention of Pacific halibut caught in the recreational charter fisheries in IPHC Regulatory Areas 2C and 3A.

c) The Commission adopted the text proposed in IPHC-2018-AM094-23, as modified during the AM094, in response to stakeholder proposal IPHC-2018-AM094-PropC5, which provided a clarification to the IPHC Regulations regarding filleting of Pacific halibut caught recreationally in Alaska.

d) The Commission adopted the text proposed in IPHC-2018-AM094-23 in response to stakeholder proposal IPHC-2018-AM094-C13, which provided a modification to the IPHC Regulations to allow retention of Pacific halibut taken in long-line or single pot gear in the directed Pacific halibut fishery in Alaska, where such gear is permitted by domestic regulation.

94th Session of the IPHC Interim Meeting (IM094; 2018)

The 94th Session of the IPHC Interim Meeting, held 27-28 November 2018 in Seattle, WA, U.S.A., was an occasion to prepare for the 95th Session of the IPHC Annual Meeting (AM095) scheduled for January/February 2019. The Commissioners and the public were able to hear IPHC Secretariat presentations and discuss a variety of topics, including a review of the 2018 fisheries statistics and preliminary stock assessment results, and the 2019 harvest decision table.

There was also a review of the IPHC research program, as well as discussion about the need for continued reduction in bycatch from trawl fisheries, changes in the spatial distribution of the stock, budgeting, and various regulatory proposals.

IPHC Finances

The IPHC is funded jointly by the governments of Canada and the U.S.A. For fiscal year 2018, the U.S.A. appropriated $4.2 million USD to the IPHC, which included funding designated for pension deficits and leases for the IPHC headquarters. Canada provided $956,035 USD, consisting of $848,720 USD for general contributions, and an additional payment of $107,315 USD to cover pension deficits.

Contracting party funding contributions totaled just over $5.15 million USD in 2018.

Pacific halibut commercial fishery

Commercial landings were down 11 percent from 2017.

The commercial Pacific halibut landings in 2018 totaled 22,710,000 pounds (10,301 metric tons (t)) (Table 1), down 11 percent from 2017. All values in this section are provided as net weight unless otherwise noted. Net weight is defined as the weight of Pacific halibut without gills, entrails, head, ice, and slime. Keep in mind that this chapter reflects data as of 15 Jan 2019 or later as noted. For updates on landings data, please refer to the IPHC website at: http://iphc.int.

Licensing and landings

Licensing

Licensing regulations for IPHC Regulatory Area 2A non-treaty fisheries were unchanged in 2018. All vessels had to procure an IPHC license, harvesters were required to select one type of license, and there was a deadline for the submission of commercial fisheries license applications.

Landings

When Pacific halibut are delivered to a port for processing, they are considered to be "landed" for tracking purposes. The following sections review commercial landings, seasons, and trends for each area, with data from the IPHC, NOAA-Fisheries, Fisheries and Oceans Canada (DFO), Metlakatla

A crewman aboard the *F/V Vanisle* prepares to bring a large Pacific halibut aboard. Photo by Allan Hicks.

Table 1. 2018 Pacific halibut landings (net weight) by IPHC Regulatory Area for 2018 (as of 4 February 2019).

IPHC Regulatory Area	Fishery limits (net weight)		Landings (net weight)		
	pounds	metric tonnes	pounds	metric tonnes	Pct (%)
Area 2A (California, Oregon, and Washington)	**1,190,000**	**539.78**	**1,150,931**	**522.05**	**97**
Non-treaty directed commercial (south of Pt. Chehalis)	201,845	91.56	203,630	92.36	101
Non-treaty incidental catch in salmon troll fishery	35,620	16.16	34,903	15.83	98
Non-treaty incidental catch in sablefish fishery (north of Pt. Chehalis)	50,000	22.68	43,716	19.83	87
Treaty Indian commercial	389,500	176.68	403,754	183.14	104
Treaty Indian ceremonial and subsistence (year-round)	27,000	12.25	27,000	12.25	100
Recreational – Washington	225,366	102.22	222,450	100.90	99
Recreational – Oregon	229,730	104.2	211,322	95.85	92
Recreational – California	30,940	14.03	31,156	14.13	101
Area 2B (British Columbia)	**6,223,985**	**2,823.18**	**6,094,732**	**2,764.52**	**98**
Commercial fishery	5,295,995	2,402.25	5,292,558	2,400.66	100
Recreational fishery	927,990	420.93	802,174	363.86	86
Area 2C (southeastern Alaska)[1]	**4,450,000**	**2,018.51**	**4,128,415**	**1,873**	**93**
Commercial fishery	3,570,000	1,619.32	3,401,415	1,542.85	95
Commercial discard mortality	70,000	31.75	59,000	26.76	84
Guided recreational fishery	810,000	367.41	668,000	303.00	82
Area 3A (central Gulf of Alaska)	**9,450,000**	**4,286.49**	**9,332,255**	**4,233.04**	**99**
Commercial fishery	7,350,000	3,333.91	7,197,255	3,264.62	98
Commercial discard mortality	320,000	145.15	285,000	129	89
Guided recreational fishery	1,790,000	811.94	1,850,000	839	103
Area 3B (western Gulf of Alaska)	**2,620,000**	**1,188.41**	**2,437,783**	**1,105.76**	**93**
Area 4A (eastern Aleutians)	**1,370,000**	**621.42**	**1,217,036**	**552.04**	**89**
Area 4B (central/western Aleutians)	**1,050,000**	**476.24**	**1,036,707**	**470.24**	**99**
Areas 4CDE[2]	**1,580,000**	**716.68**	**1,410,070**	**639.60**	**89**
Area 4C (Pribilof Islands)	733,500	332.71	n/a	n/a	n/a
Area 4D (northwestern Bering Sea)	733,500	332.71	n/a	n/a	n/a
Area 4E (Bering Sea flats)	113,000	51.26	n/a	n/a	n/a
Total	**27,933,985**	**12,670.63**	**26,807,929**	**12,159.86**	**96**

[1]Does not include Metlakatla fishery.

[2]Landings in IPHC Regulatory Area 4CDE are combined to meet confidentiality requirements.

n/a = not available

Indian Community, Washington Indian tribal fisheries management departments (including the Northwest Indian Fisheries Commission, Makah, Lummi, Jamestown S'Klallam, Swinomish, Port Gamble S'Klallam, Quileute, and Quinault Indian tribes), and state agencies including Alaska Department of Fish and Game, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and California Department of Fish and Wildlife.

Landing patterns

In Canada (IPHC Regulatory Area 2B), two out of the 17 ports receiving commercial deliveries in 2018, received 89 percent of the landed catch: Port Hardy and Prince Rupert/Port Edward. Port Hardy (including Coal Harbour and Port McNeill) received 44 percent of the commercial landed catch (2,337,000; 1,060 t), and Prince Rupert received 46 percent (2,437,000 pounds; 1,105 t).

In the U.S.A. (Alaska) the landed catch was 16,700,000 pounds (7,575 t). IPHC Regulatory Area 3A again had the highest fishery limit and landed catch. Seward received the largest portion of the Alaskan commercial catch, with 2,317,000 pounds (1,051 t; 14%). Homer received the second and Kodiak the third largest landing volumes at 14 percent (2,258,000 pounds, 1,024 t) and 12 percent (2,079,000 pounds, 943 t) of the Alaskan commercial landings, respectively. In Southeast Alaska (IPHC Regulatory Area 2C), Petersburg and Sitka received the most in landed weight, together totaling 14% of total commercial Alaskan landings.

Sampling of commercial landings

Sampling of the commercial landings is designed to accurately reflect the fishery deliveries across the full season and among all fishing areas.

Sampling commercial landings is a key component to collecting data on Pacific halibut for the annual IPHC stock assessment. Port samplers collect otoliths (*ear bones*) that when read under a microscope, give the animal's age in years, tissue samples for analysis and sex determination, associated fork lengths and fish weights, as well as logbook information, final landing weights, and any IPHC tags caught during fishing. Lengths and weights of sampled Pacific halibut allow the IPHC to calculate seasonal length-weight ratios by area and, in combination with age data, size-at-age information. Fin tissue samples are analyzed to provide the sex of individual fish and in turn to estimate the sex composition of the commercial catch. Mean weights are combined with final landing weights to estimate landed catch in numbers. Logbook information provides weight-per-unit-effort data, fishing location for the landed weight, and data for research projects. Tags can provide information on migration, growth, exploitation rates, and natural and discard mortality.

Sampling protocols are designed to ensure that the sampled Pacific halibut are representative of the population of landed Pacific halibut; sampling days and places, and percentage of fish sampled are based on landing patterns and are reviewed annually. The protocols can vary slightly from port to port to achieve the appropriate sampling representation.

Considering that vessels travel to multiple IPHC Regulatory Areas and are not limited in where they may land their catch, IPHC port samplers were stationed in ports coastwide. In Canada, IPHC port samplers staffed Port Hardy and Prince Rupert. In the U.S.A. in IPHC Regulatory Area 2A, IPHC port samplers were present in Newport and Charleston, Oregon and in Bellingham,

IPHC port sampler Michelle Drummond and Secretariat staff member Tamara Briggie, sample Pacific halibut in Juneau, AK, U.S.A. Photo by Lara Erikson.

Washington. In addition, samples were taken in several treaty Indian ports in Washington by port samplers from the treaty Indian fishery management offices. Samples from the directed commercial fishery off northern California were collected in Eureka, California by California Department of Fish and Wildlife samplers. In Alaska, the ports of St. Paul, Dutch Harbor, Kodiak, Homer, Seward, Juneau, Sitka, and Petersburg were staffed.

Port samplers collected otoliths from trips representing an estimated 34% of the landed catch in 2018.

Otoliths

Port samplers aimed to collect 11,500 total Pacific halibut otoliths in 2018, with the target for each of IPHC Regulatory Areas 2B through 4B and Area 4CD (combined) set at 1,500 (±500). The target for IPHC Regulatory Area 2A was set at 1,000; subdivided into a target of 650 for Regulatory Area 2A-1 (an area of marine water in Area 2A north of Pt. Chehalis, WA, U.S.A.) treaty Indian fisheries and 350 for Regulatory Area 2A non-tribal commercial fisheries. Samplers collected 11,622 otoliths by sampling from 34 percent of the landed catch in the 642 sampled landings.

Samplers also collected specimens for the Clean Otolith Archive Collection (COAC), which comprises structures gathered from all IPHC otolith collection programs and other research opportunities; these otoliths are not used for age determination, but are cleaned, dried, and stored whole in climate-controlled conditions for future analysis. COAC samples are collected from the fishery-independent setline survey (FISS) unless the sampling rate for the age determination collection is 100%. For this reason, COAC samples were collected from commercial landings from Regulatory Areas 2A, 4B, and 4CD in 2018. The annual COAC target is 100 otoliths from each IPHC Regulatory Area; this target was nearly attained in Regulatory Area 2A and exceeded in Regulatory Areas 4B, and 4CD.

Logbooks

Alongside otolith samples, IPHC port samplers collected logbook information from harvesters. In total, 3,587 logs were collected in 2018 (as of 31 December 2018). A total of 412 (11 percent by count) were collected from Canadian landings, and 3,175 (89 percent by count) were collected from U.S.A. landings.

A total of 31 wire tags were recovered from the U32 wire tagging project that has been ongoing since 2015.

Recovered tags

In 2018, samplers collected 48 tags of several types from tagged Pacific halibut. A total of 31 of these recoveries were from the U32 wire tagging project that were released between 2015 and 2018. Other tag types recovered included archival and dummy archival tags. Tag data collected dockside included fork lengths, otoliths, fin clips, and capture location of the recovered tagged fish.

Electronic data collection

IPHC has digitized data collection to eliminate or reduce the need for post-collection data entry and increase the efficiency of data editing. In 2018, each IPHC port sampler in Alaska used an electronic tablet to input data from paper logbooks into a remote data entry application. Samplers were tasked with entering data from as many of the logs they collected as priorities and time allowed during the course of their regular port sampling duties. Modifications and enhancements to the application continue.

In British Columbia, Canada, samplers were provided with a field version of the log entry program used by the IPHC's Secretariat staff in Seattle. The samplers were tasked with entering as many Canadian paper logs as time permitted, though priority was given to other tasks such as biological sampling. In addition, samplers were supplied with Bluetooth-enabled tablets for collection of electronic logs from vessels using Archipelago Marine Research's FLOAT - Fishing Log Application for Android.

Recreational fishery

The 2018 recreational harvest of Pacific halibut, including discard mortality, was estimated at about 7,189,000 pounds (3,261 t) by the IPHC, using information provided by state and federal agencies from each of the Contracting Parties. The 2018 take was below that of 2017, as well as below the historic levels seen in 2004-08 (when harvest averaged 10.7 million pounds (4,853 t)). The regulations governing recreational fishing of Pacific halibut were specifically geared to each Regulatory Area. Table 2 provides a brief summary of overall catch and more detailed tables providing a summary of seasons and catch can be found on the IPHC website: https://iphc.int.

Total guided sport catch in 2018 is estimated to have been 3.785 million pounds.

Table 2. Summary of 2018 recreational Pacific halibut allocations and catch by IPHC Regulatory Area.

Area	Allocation		Retained catch		% of allocation
	pounds	metric tonnes	pounds	metric tonnes	
2A[1]	486,036	220	465,000	211	96%
2B[1]	927,990	421	802,000	364	86%
2C (charter)[2]	810,000	367	668,000	303	90%
3A (charter)[2]	1,790,000	812	1,850,000	839	104%
3B	no limit		-[n/a]		-
4	no limit		-[n/a]		-

[1] The associated discard mortality for IPHC Regulatory Area 2A is 4,000 pounds (1.8 t) and for Area 2B is 74,000 pounds (33.6 t).
[2] There is no allocation limit for the non-charter recreational fishery in these Regulatory Areas.

IPHC Regulatory Area 2A (California, Oregon, and Washington; U.S.A.)

IPHC Regulatory Area 2A's recreational allocation was based on the Pacific Fishery Management Council's Catch Sharing Plan formula, which divides the overall fishery catch limit among all sectors. The recreational allocation was further subdivided to seven subareas, after 50,000 pounds (22.7 t) were allocated to the incidental Pacific halibut catch in the commercial sablefish fishery in Washington. This subdivision resulted in 225,366 pounds (102.22 t) being allocated to Washington subareas and 229,730 pounds (104.20 t) to Oregon subareas. In addition, California received an allocation of 30,940 pounds (14.03 t). Recreational fishery harvest seasons by subareas varied and were managed in-season in coordination with the Contracting Party agencies, with fisheries opening on 1 May.

IPHC Regulatory Area 2B (British Columbia; Canada)

IPHC Regulatory Area 2B operated under a 115 cm (45.3 inch) maximum size limit, and one Pacific halibut had to be less than 83 cm (32.7 inch) when attaining the two-fish possession limit, with an annual limit of six per license holder. The IPHC Regulatory Area 2B fishery remained open as of the writing of this report. Canada and Alaska both have programs that allow recreational harvesters to land fish that is leased from commercial fishery quota shareholders for the current season. In Canada, 16,648 pounds (7.6 t) were leased from the commercial quota fishery and landed as recreational harvest.

IPHC Fisheries Data Specialist Ed Henry displays a Pacific halibut captured with sport gear. Photo by Claude Dykstra.

Guided sport removals in Areas 2C and 3A are managed using size and bag limits.

IPHC Regulatory Areas 2C, 3A, 3B, and 4 (Alaska; U.S.A.)

The IPHC Regulatory Area 2C charter fishery continued to be managed using a reverse slot limit, allowing for the retention of one Pacific halibut that was ≤ 38 inches (97 cm) or ≥ 80 inches (203 cm) in total length (compared to ≤ 44 inches [112 cm] and ≥ 80 inches [203 cm] in 2017). In IPHC Regulatory Area 3A, charter anglers were allowed to retain two fish, but only one could exceed 28 inches (71 cm) in length. In addition, there was a four-fish annual limit with a recording requirement, one trip per calendar day per charter permit, and no charter retention of Pacific halibut on Wednesdays throughout the season and on 10 July, 17 July, 24 July, 31 July, 7 August, and 14 August.

Similar to Canada, Alaska has programs that allow recreational harvesters to land fish that is leased from commercial fishery quota shareholders for the current season. In IPHC Regulatory Areas 2C and 3A, a total of 64,365 pounds (29.2 t) and 9,052 pounds (4.1 t), respectively, were leased from the commercial quota fisheries in those areas and landed as recreational harvest.

Discard mortality of Pacific halibut in the directed longline fishery

In the commercial Pacific halibut fishery, some Pacific halibut are captured every year that are not kept and, therefore, do not become part of the landed catch. Not all Pacific halibut caught and released at sea survive. Discarded Pacific halibut are subject to release mortality, which form the part of removals known as discard mortality.

Estimates of discard mortality in 2018 amounted to 374 t (825,000 pounds; net weight) (Table 3), which is a decrease of about 16.5 percent from the estimated discard mortality in 2017. Data in this chapter are as of 31 December 2018. There are three main sources of discard mortality accounted for by IPHC: (1) fish caught and never retrieved on lost or abandoned fishing gear; the discard of fish that measure below the legal size limit of 32 inches (U32; 81.3 cm) and subsequently die; and (3) the discard of legal-sized Pacific halibut (O32; ≥32 inches or 81.3 cm) for regulatory reasons, such as a vessel reaching its trip or catch limit.

Discard mortality in the directed fishery was estimated to be 16.5 percent less than in 2017.

Table 3. Commercial discard mortality of Pacific halibut (net weight) by IPHC Regulatory Area, 2018.

IPHC Regulatory Area	Discard Mortality metric tonnes	Discard Mortality Pounds
2A	9.07	20,000
2B	62.60	138,000
2C[1]	26.76	59,000
3A	129.27	285,000
3B	94.35	208,000
4A	30.84	68,000
4B	8.62	19,000
4CDE	12.25	27,000
Total	374.21	825,000

[1]Includes the Metlakatla fishery.

Discard mortality from lost or abandoned gear

In the 1980s and early 1990s in Alaska and British Columbia, ‘derby’ fisheries with short fishing periods led to fishers competing to catch as many Pacific halibut as quickly as possible. This resulted in a considerable quantity of lost fishing gear, which continued to catch fish. Estimates of the amount of missing gear were extrapolated to total catch values using available logbook catch and effort statistics.

The rate of O32 discard mortality from gear loss is calculated by first figuring out the ratio of effective skates lost to effective skates hauled aboard the vessels for trips for which there was a log, then multiplying that number by the total landed catch. "Effective skates" refers to those that include all requisite data (such as skate length, hook spacing, and number of hooks per skate), and for which the gear type met the standardization criteria. The ratio includes both snap gear and fixed-hook gear in all areas. U32 discard mortality from lost gear was calculated in a similar manner incorporating the U32:O32 ratio calculations for discarded U32 Pacific halibut as described below.

Discard mortality from discarded U32 Pacific halibut

The weight of discarded U32 Pacific halibut must be measured indirectly where direct observation and electronic monitoring are not available. Of all the areas, the Canadian fishery (IPHC Regulatory Area 2B; British Columbia) offers the most accurate accounting due to direct observation. Fishers there self-report their discards and are monitored by video on their vessels. In all other IPHC Regulatory Areas, considering that the IPHC fishery-independent setline survey (FISS or setline survey) uses similar fishing gear, the setline survey data have been used as a proxy for the expected encounter rates by area and year. Results are filtered to use setline survey stations with a higher catch rate (by weight) of O32 Pacific halibut, similar to those observed in the commercial fishery. A universal mortality rate of 16 percent has been applied to all Pacific halibut discards from the quota fisheries (Canada and U.S.A.). For derby fisheries in previous years in British Columbia and Alaska, and for the IPHC Regulatory Area 2A directed fishery, a mortality rate of 25 percent is applied. Accordingly, the amount of discarded U32 Pacific halibut in a commercial fishery is estimated by multiplying the ratio of U32 to O32 Pacific halibut by the landed commercial catch and then by the mortality rate for that fishery.

For derby fisheries in previous years in British Columbia and Alaska, and for the IPHC Regulatory Area 2A directed fishery, a discard mortality rate of 25 percent is applied.

Discard mortality for regulatory reasons

In IPHC Regulatory Area 2A, the commercial fishery is still managed by derby fishing periods in which the quantity of fish that can be caught by each vessel is limited by a fishing period limit and size of vessel. This results in catches that may exceed the vessel or trip limits, so that "excess" O32 Pacific halibut are discarded. Some skippers logged the amount of discards, which were then compared to the landed catch of Pacific halibut for those trips to arrive at a ratio of landed Pacific halibut to O32 discarded Pacific halibut. This ratio was then applied to all landed catch reported on fish tickets to determine the discard of O32 Pacific halibut for all landings to which the mortality rate of 25 percent was applied. U32 Pacific halibut were accounted for in a similar manner incorporating the U32:O32 ratio calculations for discarded Pacific halibut. The amount of Pacific halibut retained by the IPHC Regulatory Area 2A salmon and sablefish fisheries was not included in these numbers, however, as they were accounted for under bycatch mortality estimates. Finally, quota share fisheries in British Columbia and Alaska were not included in these numbers. These fishers typically discard small amounts of fish (if any) on the last fishing trip of the season.

SUBSISTENCE HARVEST

Pacific halibut that are caught by those who have traditionally relied on this fish as a critical food source or for customary purposes are classified as "subsistence," as opposed to recreational or commercial catch. Subsistence harvest is barred from resale, so by nature does not make up a part of the commercial catch. The IPHC defines subsistence harvest further as Pacific halibut taken in: 1) the sanctioned First Nations Food, Social, and Ceremonial (FSC) fishery in British Columbia, Canada; 2) the federal subsistence fishery in Alaska, U.S.A.; 3) tribal Indian Ceremonial and Subsistence (C&S) fisheries in Washington State, USA; and 4) U32 Pacific halibut (those under the legal size limit of 32 inches or 81.3 cm) retained by commercial fishers in IPHC Regulatory Areas 4D and 4E (U.S.A.) under IPHC regulations. In the latter case, IPHC permits U32 Pacific halibut to be retained because of its history of customary use in the area and because the remote location makes it unlikely that these fish will end up being commercially traded. State and federal regulations require that 'take-home' Pacific halibut caught during commercial fishing be recorded as part of the commercial catch on the landing records, so those fish caught within the commercial fisheries and not sold are accounted for as commercial landings and are not included in the estimates here. Table 4 provides a summary of catch followed by more detail for each area.

Subsistence harvest is defined as removals of Pacific halibut that are harvested for food and customary purposes and is barred from being sold.

Table 4. Subsistence Pacific halibut fisheries removals (net weight) by IPHC Regulatory Area, 2018.

IPHC Regulatory Area	Subsistence Removals	
	metric tonnes	**pounds**
2A	12.70	28,000
2B	183.70	405,000
2C	197.99	436,500
3A	100.92	222,500
3B	6.44	14,200
4A	3.67	8,100
4B	0.14	300
4C	1.95	4,300
4D	<0.05	<100
4E	18.78	41,400
4D/4E[1] (CDQ U32)	4.54	10,000
Total	**530.39**	**1,169,300**

[1] 2016 Alaska estimates were carried over for the 2018 catch estimate, with the exception of IPHC Regulatory Area 4D/4E subsistence harvest in the CDQ fishery, which were updated.

Estimated harvests by area

Canada (IPHC Regulatory Area 2B; British Columbia)

The FSC fishery constituted British Columbia's subsistence harvest. Fisheries and Oceans Canada (DFO) has estimated the same level of harvest for this fishery since 2007.

U.S.A. (IPHC Regulatory Area 2A; California, Oregon, and Washington)

The subsistence allocation in IPHC Regulatory Area 2A consists of the C&S fishery that the tribes have subdivided from their fishery limit.

U.S.A. (IPHC Regulatory Areas 2C, 3, and 4; Alaska)

The Pacific halibut subsistence catch is estimated at just under 1.2 million pounds for 2018.

After the Alaska subsistence program began in 2003, the Alaska subsistence catch declined until 2013, after which it rose until 2016. A new 2016 estimate was used for 2016 through 2018. The Alaska estimates for the subsistence Pacific halibut harvest typically lag by a year, so the 2018 estimates are not yet complete.

Pacific halibut. Photo by Joe Petersen.

Regulations on the subsistence fishery in Alaska set by NOAA Fisheries include a registration program, and specifications on the type of gear, including the number of hooks and daily bag limits. The IPHC sets the fishing season dates.

According to Alaska Department of Fish and Game's voluntary annual survey, IPHC Regulatory Area 2C pulled in the most Pacific halibut as subsistence, followed by IPHC Regulatory Area 3A. The remaining IPHC Regulatory Areas accounted for a small fraction of the total.

Retention of U32 Pacific halibut in the CDQ fishery

The IPHC allows commercial Pacific halibut vessels fishing for certain Community Development Quota (CDQ) organizations in IPHC Regulatory Areas 4D and 4E (Bering Sea) to retain U32 (fork length < 32 inches or 81.3

cm) Pacific halibut under an exemption requested by the North Pacific Fishery Management Council. The CDQ harvest supplements the Alaskan personal use catch. In 2018, retention of U32 Pacific halibut in the CDQ fishery was 9,989 pounds (4.5 t), an increase from the 7,380 pounds (3.4 t) of Pacific halibut retained in 2017. Changes in harvest each year tend to reflect the amount of effort by local fishing fleets and the availability of fish in their nearshore fisheries.

Bristol Bay Economic Development Corporation

The Bristol Bay Economic Development Corporation (BBEDC), the southernmost of the three CDQ organizations, comprises 17 member villages on the shores of Bristol Bay, AK: Port Heiden, Ugashik, Pilot Point, Aleknagik, Egegik, King Salmon, South Naknek, Naknek, Levelock, Ekwok, Portage Creek, Ekuk, Clark's Point, Dillingham, Manokotak, Twin Hills, and Togiak. The BBEDC aims to use sustainable fish harvesting to improve community life and livelihoods in its member communities. The BBEDC reported that in 2018, twenty-one harvesters brought in a catch of 801 U32 Pacific halibut, weighing 8,510 pounds (3.9 t), a 62 percent increase from 2017. As in 2017, vessels out of Togiak landed the majority of Pacific halibut, followed by those at Dillingham.

Remote communities in Alaska harvest U32 Pacific halibut for personal use during the CDQ fishery.

Coastal Villages Regional Fund

The Coastal Villages Regional Fund (CVRF) lies between the Norton Sound Economic Development Corporation (NSEDC) to the north, and the BBEDC to the south. It comprises 20 remote coastal villages: Platinum, Goodnews Bay, Quinhagak, Eek, Napaskiak, Oscarville, Napakiak, Tuntutuliak, Kongiganak, Kwigillingok, Kipnuk, Chefornak, Nightmute, Toksook Bay, Mekoryuk, Tununak, Newtok, Chevak, Hooper Bay, and Scammon Bay. In 2018, for the fifth year in a row, CVRF reported that their fishers landed zero Pacific halibut and no fish were received by their facilities in Chefornak, Hooper Bay, Kipnuk, Mekoryuk, Toksook Bay, and Tununak.

Norton Sound Economic Development Corporation

The NSEDC is the northernmost of the three organizations, centered on Nome, AK. The NSEDC's purpose is to provide fishing opportunities for its 15 member communities, which are primarily on the coast of the Seward Peninsula, bounded by Kotzebue Sound on the north and Norton Sound on the south: Saint Michael, Stebbins, Unalakleet, Shaktoolik, Koyuk, Elim, Golovin, White Mountain, Nome, Teller, Brevig Mission, Wales, and the island communities of Little Diomede, Gambell, and Savoonga. In 2018, the area's only plant at Nome, received 147 U32 Pacific halibut, weighing 1,479 pounds (0.7 t), a decrease of 60 percent from 2017.

Discard mortality of Pacific halibut in non-directed fisheries

Discard mortality of Pacific halibut from non-directed fisheries was at a 26-year low in 2018.

Discard mortality of Pacific halibut in this section consists of fish caught incidentally by fisheries targeting other species and that cannot legally be retained (a.k.a. bycatch). Discard mortality in non-directed fisheries refers only to those fish that subsequently die due to capture. This section summarizes the estimated discard mortality in non-directed fisheries across fisheries where Pacific halibut are incidentally caught and discarded within the IPHC Convention Area.

There has been a declining trend in discard mortality in non-directed fisheries over the last few decades, with 2018 representing the lowest level in 26 years. In 2018, there were an estimated 6,057,000 pounds (2,747.4 t) of Pacific halibut bycatch mortality, representing a small 0.20 percent decrease from the 6,070,000 pounds (2,753.3 t) recorded in 2017. Estimates for 2018 are preliminary and subject to change as new information becomes available. Current values are available on the IPHC website: https://iphc.int.

Sources of information for discard mortality in non-directed fisheries

The IPHC relies on observer and electronic monitoring programs run by government agencies from Canada and the U.S.A. for discard mortality in non-directed fisheries information. In Canada, Fisheries and Oceans Canada (DFO) monitors fisheries off British Columbia (IPHC Regulatory Area 2B where there is 100 percent fishery monitoring for the groundfish trawl and hook-and-line fisheries. There are varying levels of monitoring for non-groundfish fleets in British Columbia.

Non-target species can be caught with all types of gear. This is the result of a tow conducted during the NOAA Fisheries groundfish trawl survey in the Aleutian Islands. Photo by Paul Logan.

In the U.S.A., the NOAA Fisheries (National Marine Fisheries Service, NMFS) monitors trawl fisheries off the coast of Alaska (IPHC Regulatory Areas 2C-4) and the west coast (Area 2A). Off the west coast, there is 100 percent fishery monitoring for the trawl groundfish fishery. There are varying levels of monitoring on non-trawl fleets. Several fishery programs in Alaska have a mandatory '100 percent' monitoring requirement, including the Central Gulf of Alaska (GOA) Rockfish Program, the Bering Sea/Aleutian Islands (BSAI) Community Development Quota (CDQ) fisheries, the American Fisheries Act pollock cooperatives, and the BSAI Amendment 80 fishery cooperatives. In Alaska, an annual deployment plan (ADP) provides the scientific guidelines that determine how vessels not involved in these full coverage programs are chosen for monitoring, including vessels in the directed Pacific halibut Individual Fishing Quota (IFQ) fishery.

Discard mortality rates

The percentage of Pacific halibut that die as a result of being caught (called discard mortality rate or DMR) varies by both fishery and area. If observers are present, DMRs are calculated by judging the likelihood of survival for the Pacific halibut they see, using pre-set criteria. For fisheries without observers, assumed DMRs are used, which are based on similar fisheries in other areas where data are available.

The number of Pacific halibut that die as a result of capture and discard varies among fisheries and areas.

Discard mortality in non-directed fisheries by IPHC Regulatory Area

This section describes the estimated bycatch mortality from each IPHC Regulatory Area (Table 5).

Table 5. Discard mortality in non-directed fisheries estimates of Pacific halibut (net weight) by year, IPHC Regulatory Area, and fishery, for 2018. Estimates are preliminary.[1]

Regulatory Area and Gear Type	Discard mortality in non-directed fisheries	
2A	metric tonnes	pounds
Groundfish Trawl	N/A	N/A
IFQ Bottom Trawl	25.4	56,000
Other Groundfish Trawl	0.45	1,000
Groundfish Pot	0	0
Hook & Line	32.7	72,000
Shrimp Trawl	0	0
Total	58.5	129,000
2B		
Groundfish Bottom Trawl	131.5	290,000
Total	131.5	290,000
2C		
Crab Pot	0.5	1,000
Groundfish Trawl	0	0
Hook & Line (non-IFQ) 7	1.4	3,000
Hook & Line (IFQ)	12.7	28,000
Chatham Str. Sablefish	N/A	N/A
Clarence Str. Sablefish	N/A	N/A
Total	14.5	32,000

3A		
Scallop Dredge	10.9	24,000
Groundfish Trawl	689.5	1,520,000
Hook & Line (non-IFQ)	27.7	61,000
Hook & Line (IFQ)	20.9	46,000
Groundfish Pot	1.36	3,000
Pr Wm Sd Sablefish n/a	N/A	N/A
Total	750.2	1,654,000
3B		
Crab Pot	0	0
Scallop Dredge	0	0
Groundfish Trawl	195	430,000
Hook & Line (non-IFQ)	8.2	18,000
Hook & Line (IFQ)	5.9	13,000
Groundfish Pot	0.9	2,000
Total	210	463,000
4A		
Crab Pot	0	0
Scallop Dredge	0	0
Groundfish Trawl	106.6	235,000
Hook & Line (non-IFQ)	15.9	35,000
Hook & Line (IFQ)	0.9	2,000
Groundfish Pot	1.36	3,000
Total	124.7	275,000
4B		
Crab Pot	0	0
Groundfish Trawl	95.3	210,000
Hook & Line (non-IFQ)	5.9	13,000
Hook & Line (IFQ)	0.9	2,000
Groundfish Pot	0.9	2,000
Total	103	227,000
4CDE+CA		
Crab Pot	16.8	37,000
Scallop Dredge	0	0
Groundfish Trawl	1,251.9	2,760,000
Hook & Line (non-IFQ)	96.2	190,000
Hook & Line (IFQ)	0	0
Groundfish Pot	0	0
Total	1,354.9	2,987,000
4 Subtotal		
Crab Pot	16.8	37,000
Scallop Dredge	0	0
Groundfish Trawl	1,453.8	3,205,000
Hook & Line (non-IFQ)	108	238,000
Hook & Line (IFQ)	1.8	4,000
Groundfish Pot	2.27	5,000
Total	1,582.6	3,489,000
GRAND TOTAL	2,747.4	6,057,000

[1] Note that some totals may not sum precisely due to rounding.

Discard mortality in non-directed fisheries was estimated at 6.057 million pounds in 2018.

Canada (IPHC Regulatory Area 2B; British Columbia)

In Canada, Pacific halibut bycatch in trawl fisheries is capped at 750,000 pounds net weight (453.6 t round weight) by DFO. Non-trawl bycatch is handled under the IFQ system within the directed Pacific halibut fishery cap. The reported bycatch mortality data were complete through September. Projections for the full calendar year 2018 were made by extrapolating to the full 12 months.

U.S.A. (IPHC Regulatory Area 2A; California, Oregon, and Washington)

As in prior years, the bottom trawl fishery and hook-and-line fishery for sablefish were responsible for the bulk of the bycatch mortality in IPHC Regulatory Area 2A. Groundfish fisheries in Area 2A are managed by NOAA Fisheries, following advice and recommendations developed by the Pacific Fishery Management Council (PFMC). Pacific halibut bycatch in the trawl IFQ fishery (also called trawl catch shares) in this area is capped at 100,000 pounds of O32 (> 32 inches fork length; 81.3 cm) Pacific halibut.

U.S.A. (IPHC Regulatory Area 2C; Southeast Alaska)

NOAA Fisheries reported bycatch by hook-and-line vessels fishing in the outside (federal) waters of IPHC Regulatory Area 2C in 2018. The vessels in this area were mostly targeting Pacific cod and rockfish in open access fisheries, and sablefish in the IFQ fishery. In state waters, fisheries that take bycatch include pot fisheries for red and golden king crab, and tanner crab. Information is provided periodically by ADFG, and the estimate was again rolled forward for 2018.

U.S.A. (IPHC Regulatory Area 3; Eastern, Central, and Western Gulf of Alaska)

Trawl fisheries are responsible for the majority of the bycatch in these IPHC Regulatory Areas, with hook-and-line fisheries a distant second. State-managed crab and scallop fisheries are also known to take Pacific halibut as bycatch, but at low levels. IPHC Regulatory Area 3 remains the area where bycatch mortality is estimated most poorly. Observer coverage for some fisheries is relatively limited. Limited observer coverage, along with tendering, loopholes in trip scheduling, and safety considerations, likely results in observed trips not being representative of all trips.

U.S.A. (IPHC Regulatory Area 4; Bering Sea/Aleutian Islands)

The Pacific cod fishery is conducted in the late winter/early spring and late summer, and is the major fishery in this IPHC Regulatory Area with Pacific halibut bycatch. In this IPHC Regulatory Area, almost all of the vessels are required to have 100 percent observer coverage because of vessel size and the requirements of their fishery cooperative; very few small vessels fish Pacific cod or other flatfish in this IPHC Regulatory Area. Because of this high level of observer coverage, bycatch estimates for IPHC Regulatory Area 4 fisheries are considered more reliable. Pots are used to fish for Pacific cod and sablefish and fish very selectively. Bycatch rates are quite low and survival is relatively high. Within the Bering Sea, bycatch has typically been the highest in IPHC Regulatory Area 4CDE due to the groundfish fishery in the area.

Because there is high observer coverage in Area 4, discard mortality estimates are considered more reliable than in some other areas.

Fishery-independent survey activities

Every year the International Pacific Halibut Commission (IPHC) conducts a fishery-independent setline survey (FISS or setline survey), participates in NOAA-Fisheries (National Marine Fisheries Service, NMFS) trawl surveys, and receives survey data from other organisations. Activities during these cruises include collection of biological and oceanographic data, tagging and release of fish, and other projects.

IPHC fishery-independent setline survey (FISS)

Thirteen vessels were chartered in 2018 to complete stations from Oregon to the Bering Sea.

The IPHC fishery-independent setline survey (FISS) gathers catch rate information to monitor changes in biomass in the Pacific halibut population. The FISS uses standardised methods, including bait, gear, fishing locations, and time of year, to gain a balanced picture that can be compared over a large area and from year to year.

When other species are caught on the FISS, their presence provides data about bait competition, commonly known as 'hook competition'. Other species catch data also provide an indication of their abundance over time, making them valuable for population assessments, management, and potential avoidance strategies.

Design and procedures

The 2018 IPHC fishery-independent setline survey (FISS) covered both nearshore and offshore waters of Oregon, and Washington, U.S.A., British

Crewman Conner McLellan of the *F/V Free to Wander* baits gear during the IPHC FISS. Photo by Jack Cramer.

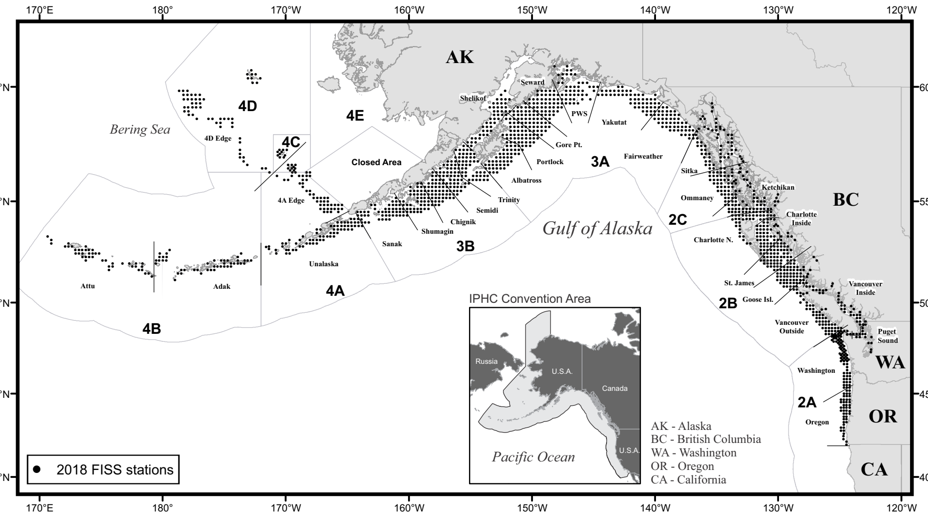


Figure 1. Stations fished during the 2018 fishery-independent setline survey.

Columbia, Canada, and Alaska, U.S.A., including southeast Alaska, the central and western Gulf of Alaska, Aleutian Islands, and the Bering Sea continental shelf (Figure 1). The IPHC chartered 13 commercial longline vessels for FISS operations. During a combined 88 trips and 806 charter days, these vessels fished 30 charter regions. Each region required between 12 and 37 days to complete.

The FISS was conducted via stations arranged in a grid of 10x10 nautical miles with a depth range of 20-275 fathoms (36-503 m) in most areas. In 2018, an additional 136 stations were added to IPHC Regulatory Area 2B and 44 stations to Regulatory Area 2C as a continuation of the multi-year coastwide effort to expand the FISS depth profile and update calibration with other fishery-independent surveys. These included stations as shallow as 9 fathoms (16 m) and as deep as 436 fathoms (797 m). IPHC Regulatory Area 2A was fished with a densified grid of 26 stations in the Washington charter region, and repeating the 14 stations in Puget Sound. Of the 1,496 FISS stations planned for 2018, a total of 1,458 (97.5%) were surveyed and incorporated into the stock assessment analysis.

Eight skates were set at each station in IPHC Regulatory Area 2A and in Regulatory Area 4CDE. IPHC Regulatory Areas 2B, 2C, 3A, 3B, 4A, and 4B had seven skates of baited gear set at each setline survey station in all charter regions. Setline survey sampling work involved each vessel setting from one to four stations every day, with boats setting gear as early as 0500 hrs and allowing it to soak for at least five hours (but not overnight, if possible) before hauling. Data from gear soaked longer than 24 hours were discarded from the setline survey, as were sets for which predetermined limits for lost gear, snarls, depredation, or displacement were exceeded. Setline survey gear consisted of fixed-hook, 1,800-foot (549 m) skates with 100 circle hooks of size 16/0 spaced 18 feet (5.5 m) apart. The length of the gangions ranged from 24 to 48 inches (61 to 122 cm). Each hook was baited with 1/4 to 1/3 pounds (0.11 to 0.15 kg) of chum salmon.

A big thank you to the following fishing vessels for their work on the FISS in 2018:

Bold Pursuit
Clyde
Free to Wander
Kema Sue
Norcoaster
Pacific Surveyor
Pender Isle
Polaris
Predator
Seymour
St. Nicholas
Vanisle
Vansee

Quantitative Scientist Dr. Allan Hicks with a large Pacific halibut caught during the 2018 FISS by the *F/V Vanisle*. Photo credit: Allan Hicks.

Routine biological data collected on each Pacific halibut in the sample includes fork length, sex, maturity, prior hooking injury, and otolith for aging.

Sampling protocols

Following protocols set out in the 2018 Fishery-Independent Setline Survey Manual, shipboard sea samplers assessed the functionality of bird avoidance devices during setting of the gear, and also recorded the number of hooks set and baits lost per skate. During gear retrieval, the sea samplers recorded hook status (whether hooks were pulled up empty or what species were captured) for the first 20 consecutive hooks of each skate.

Sea samplers recorded lengths of all Pacific halibut caught along with the corresponding skate numbers, and assessed the sex and maturity, prior hooking injury (PHI) incidence and severity, and evidence of depredation for each fish captured. They also collected otoliths from a randomized subsample or from every captured Pacific halibut for later age determination.

The male fish were assessed as either mature or immature, and the females were categorized as immature, ripening, spawning, or spent/resting. The sex and maturity level of U32 (fork length < 32 inches or 81.3 cm) Pacific halibut was recorded only if that fish was randomly selected for otolith removal or was already dead upon hauling. All U32 Pacific halibut not selected for otolith collection were measured and released alive.

Bait purchases

To ensure consistency from year to year, the bait used for the setline survey is always No. 2 semi-bright (Alaska Seafood Marketing Institute grades A through E), headed and gutted, and individually quick-frozen chum salmon. In August 2017, the IPHC Secretariat began arranging bait purchases for the 2018 FISS. Approximately 157 t (345,000 pounds) of chum salmon were utilized from three suppliers. Bait usage is based on 0.37 pounds per hook, resulting in approximately 259 pounds per seven-skate station. Bait quality was monitored and documented throughout the season and found to meet the standard as described above.

Fish sales

O32 (fork length ≥ 32 inches or 81.3 cm) Pacific halibut caught during setline survey work are generally kept and sold as a way to offset the cost of the setline survey. Most vessel contracts contain a lump sum payment along with a 10 percent share of the Pacific halibut proceeds. Rockfish and Pacific cod landed incidentally during the setline survey are also kept, because they rarely survive the trauma of capture and release. Proceeds from retained bycatch captured in U.S.A. waters are divided equally between the vessel (for handling expenses) and the appropriate state management agency. For boats in Canadian waters, Fisheries and Oceans Canada (DFO) kept all the bycatch proceeds, but paid a bycatch processing fee to those boats. The IPHC does not keep any proceeds from the sale of bycatch species.

During the 2018 FISS, IPHC's chartered vessels delivered a total of 819,975 pounds (~372 t) of Pacific halibut to 26 different ports. The coastwide average price per pound was $5.74 USD, amounting to sales totaling $4.7 million USD.

Field personnel

The 2018 FISS vessels were staffed by 26 sea samplers, who worked a total of 1,919 person-days, including travel days, sea days, and debriefing days. Two samplers are typically aboard each setline survey vessel. At a given time, one sea sampler handles fish, collects data, and samples on deck, while the other sea sampler, in a portable shelter, records data and observations and stores samples collected by the deck sea sampler. Three sea samplers were deployed on some vessels in some areas to support additional data collection or special research projects. The IPHC also deployed four sea samplers on the NOAA-AFSC trawl survey—two on the *F/V Ocean Explorer* for three legs during the Gulf of Alaska groundfish trawl survey, and two on the *F/V Vesteraalen* for three legs and one on the fourth leg of the *F/V Alaska Knight* during the Bering Sea groundfish trawl survey.

The coastwide average ex-vessel price per pound for 2018 FISS Pacific halibut was $5.74 USD.

2018 FISS sea samplers and associated Secretariat Staff. Photo by Tom Kong.

Additional research projects

In addition to core operations, the FISS is a platform for a number of IPHC research projects as well as external special projects and data collections. Details of those projects are contained in the Biological Research section of this report.

IPHC fishery-independent setline survey results

As always, the IPHC targeted the summer months—May, June, July, and August—for setline survey work, and the vast majority (about 98%) of all stations were surveyed in those months. The early part of the setline survey season saw the greatest activity; coastwide activity declined early in August and was fully completed by mid-September.

There was an estimated six percent decrease in the average catch rate of Pacific halibut for all sizes in the 2018 FISS compared to 2017.

Weight and number per unit effort (WPUE)

As a result of including both commercial and non-commercial fishing grounds, the setline survey results have an average weight per unit effort (WPUE) for all IPHC Regulatory Areas below that of the directed longline fleet (Table 6).

Table 6. The average total raw WPUE figures for the IPHC Regulatory Areas, 2018.

Regulatory Area	kg/skate	lbs/skate	Station Count
2A	9	20	118
2B	33	72	297
2C	87	191	164
3A	57	125	374
3B	22	49	231
4A	18	39	110
4B	22	49	89
4C	35	77	20
4DE	12	27	61

Compared to 2017 results, setline survey WPUE increased in IPHC Regulatory Areas 2A (+50%), 3A (+8%), and 4C (+3%). WPUE decreased in IPHC Regulatory Areas 2B (-8%), 2C (-12%), 3B (-27%), 4A (-25%), 4B (-8%) and 4D (-5%). Since 2011, IPHC Regulatory Area 2C's WPUE has exceeded Area 3A's, and has been the highest WPUE of all the regions. Although weight is the primary unit of measure when studying population and removals, the number of Pacific halibut is also a critical measure.

There was an estimated six percent decrease in the average catch rate (by weight) of Pacific halibut of all sizes caught and an estimated five percent decrease in average catch rate by weight of O32 Pacific halibut when compared to 2017. In 2018, there was an estimated seven percent decrease in the numbers of Pacific halibut captured, following a 24 percent decrease from 2016 to 2017.

Bycatch

Around 112 species of fish and invertebrates were captured as bycatch by the IPHC setline survey. The predominant incidental catches in IPHC Regulatory

Areas 2A, 2B, 2C, and 3A were sharks. The most frequent incidental catch in IPHC Regulatory Areas 3B, 4A, and 4D was Pacific cod. In IPHC Regulatory Areas 4B and 4C, the “other species” category was most common and was comprised of yellow Irish lord sculpins (*Hemilepidotus jordani*), unidentified starfish, grenadiers (*Macrouridae*), and arrowtooth flounder (*Atheresthes stomias*).

Size and age observations

Just upwards of 47 percent of Pacific halibut caught during the IPHC fishery-independent setline survey (FISS) were smaller than the current commercial legal size limit (U32) with a median fork length of 79 cm (31 inches). In 2018, median length increased in IPHC Regulatory Areas 2B and 2C, decreased in 2A, 4A and 4CDE, and was unchanged in 3A, 3B and 4B. IPHC Regulatory Areas 3B, and 4A had median lengths below the legal-size limit. The largest median length was in IPHC Regulatory Area 2C (93 cm or 36.6 inches).

The sex composition of FISS-caught O32 Pacific halibut varied widely among IPHC Regulatory Areas, ranging from 46 (4B) percent to 92 (4CDE) percent female. As in the prior year, IPHC Regulatory Area 4B had the lowest percentage of females in the catch—not surprising considering this area has had less than 50 percent females consistently since 1998 (apart from 2017). Also, as in previous years, IPHC Regulatory Area 4C showed the highest concentration of females. Most female Pacific halibut caught during the setline survey period (i.e., summer months) were in the ripening stage and expected to spawn in the upcoming season.

This was the fifth year of a six-year survey expansion project and included expansion stations in Areas 2B and 2C.

Setline survey expansions in 2018

In 2018, 129 expansion stations were surveyed in IPHC Regulatory Area 2B and 44 in Area 2C. The IPHC is nearing the end of a six-year fishery-independent setline survey (FISS) expansion with the primary purpose of reducing the potential for bias in the indices of Pacific halibut density and abundance. The expansion, begun in 2014 in IPHC Regulatory Areas 2A and 4A, and set to be completed in 2019, moves the setline survey into deep (275-400 fathoms; 503-731 m) and shallow (10-20 fathoms; 18-37 m) waters, and into gaps in the 20-275 fathom (37-503 m) waters not covered by the standard 10-nautical-mile station grid. Observations have shown there to be significant commercial harvest in deep waters, particularly in IPHC Regulatory Area 4A, and in shallow waters in some areas. It is apparent that the current setline survey range does not cover the entirety of Pacific halibut habitat. Other gaps within the 20-275 fathom (37-503 m) range are at times substantial, particularly in IPHC Regulatory Areas 2B and 4.

NOAA Fisheries groundfish trawl surveys

Annual Bering Sea shelf survey

The IPHC has participated in the National Oceanic and Atmospheric Administration (NOAA) Fisheries groundfish trawl survey on the eastern Bering Sea shelf annually since 1998. These bottom trawl surveys tend to capture Pacific halibut smaller than those caught during either the commercial fishery or the

IPHC FISS, and the data serves as an additional data source, verification tool, and forecasting tool for Pacific halibut stock analysis.

The 2018 trawl survey took place aboard two vessels, the *F/V Vesteraalen* and *F/V Alaska Knight*. The survey was originally scheduled to cover the standard station grid only, but a “rapid-response” survey (which included the *F/V Alaska Knight* only) was added in-season to survey the northern Bering Sea, which was surveyed in 2010 and 2017 and is anticipated to repeat every few years. The emergency survey was prompted by unusually warm bottom temperatures on the eastern Bering Sea shelf and concerns that many fish populations had shifted northward outside of the regular survey area. The rapid response survey covered a similar but smaller area than the earlier standard surveys in the north, and it utilized a 30x30 nautical mile sampling grid, rather than the 20x20 nautical mile standard grid used in 2010 and 2017.

The IPHC sampler was aboard the *F/V Vesteraalen* for the standard stations and during that time, a total of 379 otoliths were collected for aging along with assessments for sex, maturity, and prior hooking injuries. Thirty Pacific halibut were likewise sampled during the northern extension aboard the *F/V Alaska Knight*. A total of 343 fish that were < 82 cm fork length were wire tagged and released during the standard survey from the *Vesteraalen* and 24 during the northern extension. Additionally, during the standard survey, NOAA personnel aboard the *F/V Alaska Knight* wire tagged and released 401 Pacific halibut.

According to the NOAA Fisheries trawl survey results, the swept-area abundance estimates for both the Bering Sea and Aleutian Islands decreased slightly compared to the last sampled year.

The swept-area abundance estimate for 2018 was 50.5 million fish, which reflects a small decrease from the 53 million fish estimated in 2017, and a continuation of the decreasing trend started in 2006. Total biomass was estimated at just under 278 million pounds, which was only a slight decrease from the 279 million pounds estimated in 2017. Note that trawl surveys capture Pacific halibut as small as about 20 cm (8 inches) fork length and can miss fish that are greater than about 100 cm (39 inches) fork length.

In the north, the 2018 abundance estimate of just over 4.6 million fish indicated an increase of about 9% over the 2017 estimate. Biomass was estimated to be up 22% from 2017. The average fork length was 65.6 cm, substantially larger than the 54.1 cm average fork length observed during the standard survey. Similar results were also observed in 2010 and 2017.

Biennial Aleutian Islands survey

The NOAA Fisheries Aleutian Islands Bottom Trawl Survey has taken place every two years since 2000 and every three years prior to that. The IPHC has been on board four times since 2000, including 2018. This year, two survey vessels (*F/V Ocean Explorer* and *F/V Sea Storm*) sampled the area from Islands of Four Mountains to Stalemate Bank. The IPHC sampler was deployed on the *F/V Ocean Explorer* for the duration of the survey.

A total of 195 otoliths were collected for aging, along with assessments for sex, maturity, and prior hooking injuries. Additionally, 148 Pacific halibut that were < 82 cm fork length were wire tagged and released. Swept-area abundance was estimated at 6.7 million fish, which was about a 4% decrease from the 7.0 million fish estimated in 2016. Biomass in 2018 was estimated at 63 million pounds, which was essentially unchanged from 2016.

Population assessment

Since 1923, one of the IPHC's primary tasks has been to assess the population (or stock) of Pacific halibut, a complex undertaking that requires some explanation. In 2018, the IPHC undertook its annual coastwide stock assessment of Pacific halibut using a range of updated data sources. This section covers three main topics that have bearing on the population assessment process: (1) the data sources available for the Pacific halibut stock assessment and related analyses, (2) the results of the stock assessment, and (3) the outlook for the stock, scientific advice, and future research directions.

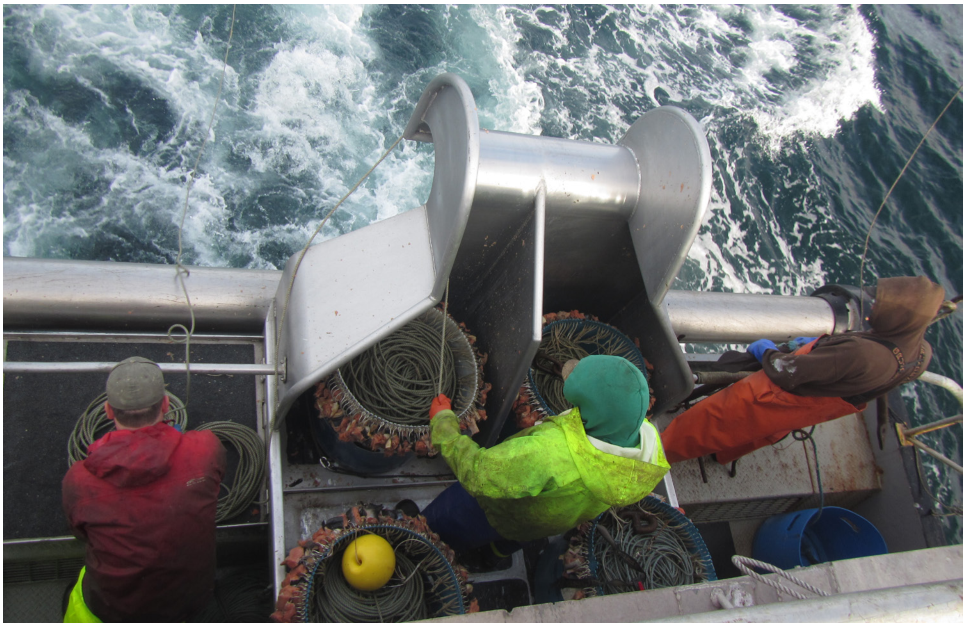
A variety of information is included in the stock assessment analysis including fishery-dependent and fishery-independent data, auxiliary data such as the state of the Pacific Decadal Oscillation, and historical trend information.

Data sources

The data for the stock assessment is based on fishery and fishery-independent data, as well as auxiliary data. The data sources also include historical information going back to the late 1800s, which allows scientists to better identify cyclical trends over time that may be of import to the current population. While data collection has continuously improved and is now the best it has ever been, the historical data are incomplete and/or imperfect, limiting the conclusions that can be drawn.

Historical data

Known Pacific halibut removals (mortality) consist of target fishery landings and discard mortality (including research), recreational fisheries, subsistence, and bycatch mortality in fisheries targeting other species (where Pacific halibut



The crew aboard the *F/V Vanisle* setting gear during the 2018 fishery-independent setline survey. Photo by Allan Hicks.

retention is prohibited). Over the period 1918-2018 removals have totaled 7.2 billion pounds (~3.3 million metric tons, t), ranging annually from 34 to 100 million pounds (16,000-45,000 t) with an annual average of 63 million pounds (~29,000 t). Annual removals were above this long-term average from 1985 through 2010, were relatively stable near 42 million pounds (~19,000 t) from 2014-17, and decreased by 8% in 2018.

Total removals for the period 1918-2018 are estimated to be 7.2 billion pounds (~3.3 million metric tons).

2018 fishery-dependent and fishery-independent survey data

Fishery-dependent data includes information from commercial, recreational, personal use, and non-Pacific halibut target fisheries. Pacific halibut landings data from the commercial fishery since 1981 have been reported to IPHC by way of commercial fish tickets. Since 1991, Fisheries and Oceans Canada (DFO) and NOAA Fisheries have provided estimates of subsistence (or personal use) harvests. These estimates are not made every year in all cases, so in some instances they must be interpolated for intervening years.

Both fishery and fishery-independent data are used to assess: 1) weight-per-unit-effort (WPUE), numbers-per-unit-effort (NPUE), 2) age distributions, and 3) weight-at-age. The primary source of trend information is the IPHC fishery-independent setline survey (FISS); however, IPHC considers the commercial fishery WPUE to be another indicator for the stock, and so its estimates are also treated as a proxy for density, while accounting for possible changes in fishery practices and locations from year to year.

Coastwide commercial Pacific halibut fishery landings in 2018 were approximately 23.5 million pounds (~10,660 t), a low for the last decade. NOAA Fisheries and DFO estimate bycatch of Pacific halibut from non-Pacific halibut fisheries and report it annually to the IPHC, though this estimation varies widely in quality depending upon the year, fishery, type of estimation method, and many other factors. The peak level of bycatch occurred in 1992, with over 20 million pounds (~9,070 t) caught, and has mostly declined since then, with an estimated 6.1 million pounds (~2,750 t) caught in 2018 (just about on par with the 6 million pounds [2,720 t] caught in 2017). The total recreational removals were estimated to be 7.2 million pounds (~3,260 t), down 5% from 2017. Mortality from all sources in 2018 was estimated to be 38.7 million pounds (~17,570 t).

The 2018 FISS detailed a coastwide aggregate NPUE (modelled via the space-time methodology) which showed a second consecutive year of decrease, down 7% from 2017, with individual Biological Regions ranging from a 6% increase (Region 4B) to a 15% decrease (Region 2). The WPUE of legal (O32, ≥ 81.3 cm or 32 inches) Pacific halibut, the most comparable metric to observed commercial fishery catch rates, was 5% lower than the 2017 estimate at the coastwide level, constituting the lowest value in the time series. Individual IPHC Regulatory Areas varied from a 12% increase (Regulatory Area 4B) to a 19% decrease (Regulatory Area 2C). The FISS sampling associated with the expansion in Region 2 (Regulatory Areas 2A, 2B, and 2C) revised the estimated relative catch-rates in this region compared to the rest of the coast, and reduced the variability about the estimates by approximately 48%.

Commercial fishery WPUE (based on extensive, but still incomplete logbook records available for this assessment) decreased 11 percent at the coastwide level, with most fisheries, gears, and IPHC Regulatory Areas decreasing from the 2017 estimates. A bias correction for each Regulatory Area based on the last six years of resulting from additional logbooks available after

F/V Bold Pursuit **while on charter with the IPHC for the fishery-independent setline survey. Photo by Daniella Griffay.**

The FISS results detailed a second consecutive year of decreasing NPUE when modelled via the space-time methodology.

the assessment deadline in early November resulted in an estimate of a 13% decrease coastwide and negative trends for all Regulatory Areas except Area 2A (+5%) and 4B (+2%). In addition to reporting tribal and non-tribal commercial fishery trends in IPHC Regulatory Area 2A separately, catch-rates reported for snap gear and fixed-hook gear are also delineated for comparison.

All available information was finalized on 9 November 2018 in order to provide adequate time for analysis and modeling. As has been the case in all years, some data are incomplete, or include projections for the remainder of the year. These include commercial fishery WPUE, commercial fishery age composition data, and 2018 mortality estimates for all fisheries still operating after 9 November. All preliminary data series in this analysis will be fully updated as part of the 2019 stock assessment.

Auxiliary inputs

The population assessment includes a number of additional information sources that are treated as data, even though they represent the products of analyses themselves. These are: 1) the weight-length relationship, 2) the maturity schedule, 3) estimates of ageing bias and imprecision, and 4) the regimes of the Pacific Decadal Oscillation (PDO). Details of these data sources are as follows.

1. The headed and gutted weight (net pounds) of a Pacific halibut can be estimated via a simple equation of weight-length relationship that uses fork length as its variable. As length increases, weight corresponds at a rate slightly greater than cubic increase.

For the assessment, it is necessary to know the age at which female fish mature. The maturity schedule for female Pacific halibut has remained stable over time and it is estimated that 50% are mature at 11.6 years and nearly all are mature by 17 years of age.

2. Female Pacific halibut are estimated to become sexually mature on a set schedule that has been estimated to be stable through several historical investigations. Across all Regulatory Areas, half of all female Pacific halibut become sexually mature by 11.6 years, and nearly all fish are mature by age 17.

3. Age estimates are based on the counting of rings on an otolith, a method that is by nature subject to bias and imprecision, however slight. That being said, it is relatively easy to estimate the age of Pacific halibut (compared to other groundfish), and analysis shows that the current aging method—referred to as “break-and-bake”—is remarkably precise.

4. The PDO is a pattern of Pacific climate variability that changes about every 30 years. Research has shown that during the 20th century these environmental conditions have been correlated with the recruitment of Pacific halibut. In “positive” phases of the PDO (through 1947, and 1977-2006), the stock saw an increase in younger fish. The PDO’s longest “negative” phase since the late 1970s occurred from 2006 through 2013. Highly positive values were observed over 2014-18; however, it is unclear if this represents a change of phase or a different set of environmental conditions altogether.

Stock distribution estimation

This is achieved using the modelled FISS WPUE index of Pacific halibut density, weighted by bottom area. To account for factors that are known to affect setline survey catch rates, two adjustments to the raw WPUE prior to modelling are made for survey timing relative to the harvest and hook competition. The measure of “hook competition” accounts for competition from all species including other Pacific halibut. Adjusting for the presence of such competition reduces bias in the observed WPUE index of density. As with the timing adjustment, adjustments for competition are also applied at the station level.

Stock distribution

Modelled survey WPUE (a proxy for density of all sizes of Pacific halibut captured by the setline survey), and the geographical extent of Pacific halibut habitat, are used to produce the best available estimates of the stock distribution by Biological Region (Figure 2). Trends over the last five years indicate that population distribution has been relatively stable with 2018 estimates inside or close to the credible intervals for recent years. The survey expansion in 2018 scaled down the estimates for the entire time-series for Region 2 relative to those produced in 2017 and previously, and Region 2 was scaled down further from 2017-18 due to the sharp decrease in modelled survey WPUE in IPHC Regulatory Area 2C in 2018. Over a decadal time-period (survey data prior to 1993 is insufficient to support modelling of WPUE or stock distribution) there has been an increasing proportion of the coastwide stock occurring in Biological Region 2 and a decreasing proportion occurring in Region 3. It is unknown to what degree either of these periods corresponds to historical distributions from the mid-1900s or to the average distribution likely to occur in the absence of fishing mortality. From the modelled 2018 fishery-independent setline survey, the stock distribution for Pacific halibut was estimated as shown in Table 7.

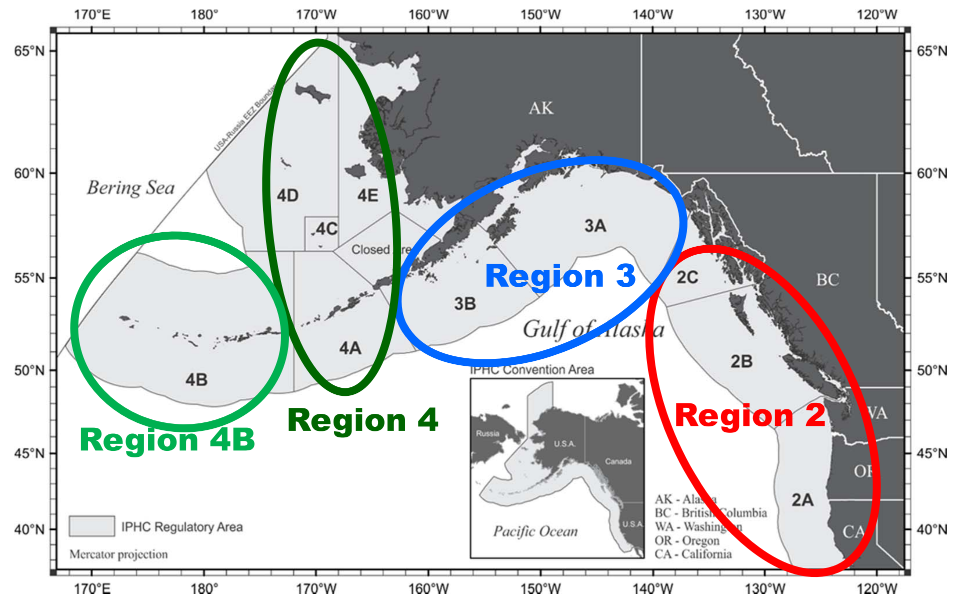


Figure 2. IPHC Regulatory Areas can be divided into four biological regions that are more meaningful for population studies.

Biological regions are used to describe stock distribution, and provide a better representation of biological patterns than IPHC Regulatory Areas.

Table 7. Recent regional stock distribution estimates based on modelling of the fishery-independent setline survey data.

Region	All sizes stock distribution
Region 2 (2A, 2B, 2C)	23.1%
Region 3 (3A, 3B)	51.2%
Region 4 (4A, 4CDE)	20.4%
Region 4B	5.2%

Population assessment at the end of 2018

Stock assessment

The methods for undertaking the population assessment for Pacific halibut have been improved many times over the last 30 years due to a continual effort to improve model assumptions and analytical approaches. For the last six years, a method called the "ensemble approach" has been used as a way to make the process both stronger and more flexible to future model changes. Originating from the field of weather and hurricane forecasting, it recognizes that there is no "perfect" assessment model, and that robust risk assessment can only be achieved with the inclusion of multiple models in the estimation of management quantities (and the uncertainty about these quantities).

This basic assessment approach used in 2018 remains unchanged and continues to make use of the extensive historical time series of data, as well as integrating both structural and estimation uncertainty via an ensemble of individual models. For 2018, the four models were equally weighted, as work to date on retrospective and predictive performance continues to suggest that each can be considered approximately equally plausible. Within-model uncertainty from each model was propagated through to the ensemble results. The risk analysis and decision table include the full range of uncertainty from all the models in the assessment. Therefore, key quantities such as reference points and stock size are reported as distributions, such that the entire plausible range can be evaluated. Point estimates reported in this stock assessment correspond to median values from the ensemble, and can therefore be described probabilistically.

Spawning Biomass and recruitment trends

The results of the 2018 stock assessment indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2011. That trend is estimated to have been largely a result of decreasing size-at-age, as well as somewhat weaker recruitment strengths than those observed during the 1980s. Since the estimated female spawning biomass (SB) stabilized near 190 million pounds (~86,200 t) in 2011, the stock is estimated to have increased gradually to 2016. The SB at the beginning of 2019 is estimated to be 199 million pounds (~90,300 t), with an approximate 95 percent confidence interval ranging from 125 to 287 million pounds (~56,700-130,200 t) (Figures 3 and 4). Comparison with previous stock assessments indicates that the 2017 results are very close to estimates from the 2012 through 2017 assessments, all of which lie very close to the median estimate. The 2018 SB estimate from the 2018 stock assessment is only 1% larger than the estimate from the 2017 stock assessment. However, the uncertainty is larger as the effects of the revised time-series in Biological Region 2 influenced each of the individual models differently, and resulted in a greater difference in the magnitude of the terminal year's estimated spawning biomass.

Two of the four ensemble models indicate higher recruitment during favorable PDO conditions. However, this relationship may not be relevant to the most recent years where many environmental indicators have been anomalous relative to historical periods.

Based on the two long time-series models, average Pacific halibut recruitment is estimated to be higher (70 and 56 percent for the coastwide and AAF models, respectively) during favorable PDO regimes, a widely used indicator of productivity in the north Pacific. Historically, these regimes included positive conditions prior to 1947, poor conditions from 1947-77, positive conditions from 1978-2006, and poor conditions from 2007-13. Annual averages from 2014 through October 2018 have been positive; however, many other environmental indicators, current, and temperature patterns have been anomalous relative to historical periods, and therefore historical patterns of productivity related to the PDO may not be relevant to the most recent few years.

Reference points

A comparison of the median 2019 ensemble SB to reference levels specified by the interim management procedure suggests that the stock is currently at 43 percent (approximate 95 percent credible range = 27-63 percent) of specified unfished levels (relative to the SB specified by the current management procedure). The probability that the stock is below the SB30 percent level is estimated to be 11 percent, with less than a 1 percent chance that the stock is below SB20 percent. Consistent with the interim management procedure (while improvements are ongoing), estimates of spawning biomass are compared to equilibrium values representing poor recruitment regimes and relatively large size-at-age. Alternative reference points include the spawning biomass estimated to have occurred at the lowest point in the historical time-series (1977-78), as well as the spawning biomass that would be estimated to occur at present (given recent recruitment and biology) in the absence of fishing. The two long time-series models provide a comparison with SB levels estimated to have occurred during the historically low stock sizes of the 1970s: the AAF model suggests that recent stock sizes are at 114 percent of those levels, and the coastwide model at 185 percent. The estimates of current spawning biomass relative to the dynamic reference point (the current stock size predicted to have occurred if no fishing had taken place) range from 27-43 percent among the four stock assessment models, with an average value of 37 percent. The recent time-series shows that the 2018 estimate corresponds to slightly lower fishing intensity than 2014-2016, with the most recent five years considerably below values from 2000-2013.

Sources of uncertainty

This stock assessment includes uncertainty associated with estimation of model parameters, treatment of the data sources (e.g., short and long time-series), natural mortality (fixed vs. estimated), approach to spatial structure in the data, and other differences among the models included in the ensemble. This results in a broad representation of uncertainty in stock levels and projections relative to analyses for many other species. Although this is an improvement over the use of a single assessment model, there are important sources of uncertainty that are not included. The 2018 stock assessment results highlight two important sources of current uncertainty: the relative strength of the 2011 and 2012 year-classes, and the scale of the recent biomass. The combination of new data available in 2018 and different responses among the models comprising the stock assessment ensemble have resulted in greater uncertainty in current and projected biomass and fishing intensity than seen in recent years.

Two primary uncertainties continue to hinder our current understanding of the Pacific halibut resource: 1) the sex-ratio of the commercial catch (not sampled due to the dressing of fish at sea), which in tandem with assumptions regarding natural mortality, determine the productivity of the stock, and 2) the treatment of spatial dynamics and movement rates among Areas, which have very strong implications for the current stock trend.

Other important contributors to assessment uncertainty and potential bias include recruitment, size-at-age, and some estimated components of the fishery removals. The link between Pacific halibut recruitment strengths and environmental conditions remains poorly understood, and there is no guarantee that observed correlations will continue in the future. Therefore, recruitment variability remains a substantial source of uncertainty in current stock estimates due to the lag between birth year and direct observation in the fishery and survey data (6-10 years). Reduced size-at-age relative to levels observed in the 1970s is the most important driver of recent stock trends, but its cause also remains unknown. The historical record suggests that size-at-age changes relatively slowly; therefore, although projection of future values is highly uncertain, near-term values are unlikely to be substantially different than those currently observed.

The survey expansion, which was in its fifth year in 2018, provides data for areas that have not been surveyed in the past and reduces uncertainty in the stock assessment.

A wide range of sensitivity analyses were conducted during the development of the 2015 stock assessment. These efforts form the primary basis for the identification of important sources of uncertainty outlined above. The most important contributors to estimates of both population trend and scale included: the sex-ratio of the commercial catch, the treatment of historical selectivity in the long time-series models, and natural mortality. Several sensitivity analyses were revisited in 2017 in order to update and illustrate their importance, particularly with regard to the IPHC's research program.

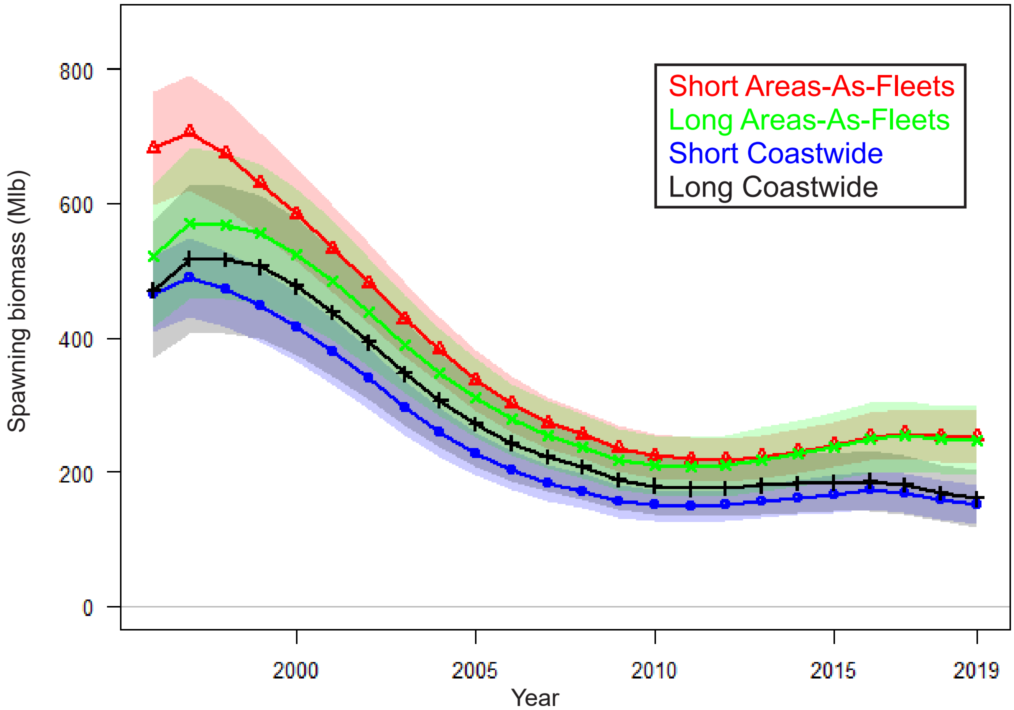


Figure 3. Estimated spawning biomass trends (1996-2019) based on the four individual models included in the 2018 stock assessment ensemble. Solid lines indicate the maximum likelihood estimates; shaded intervals indicate approximate 95% credible intervals.

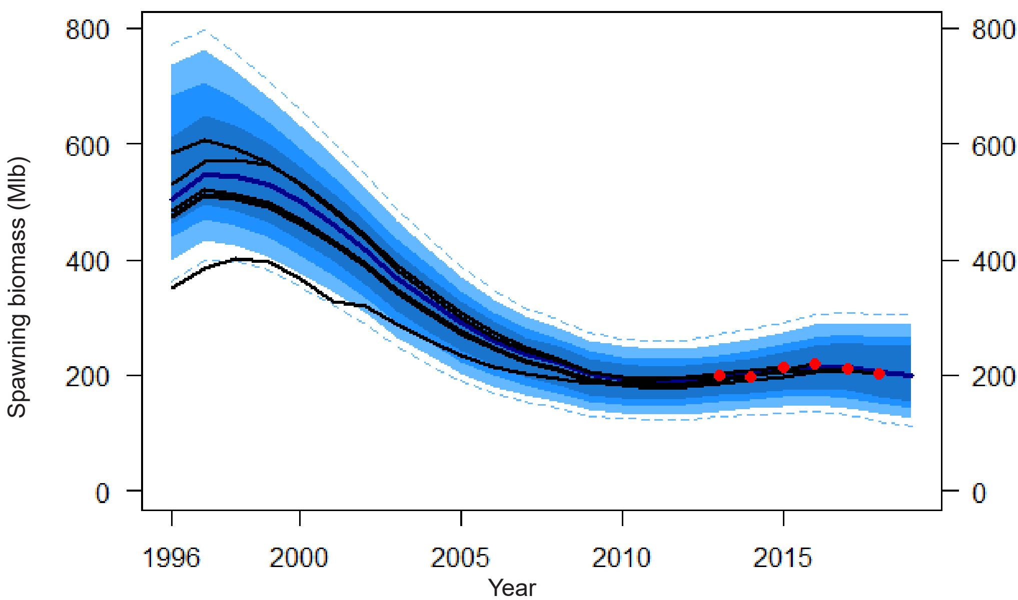


Figure 4. Retrospective comparison among recent IPHC stock assessments. Black lines indicate estimates of spawning biomass from assessments conducted from 2012-2017 with the terminal estimate shown as a point, the shaded distribution denotes the 2018 ensemble: the dark blue line indicates the median (or "50:50 line") with an equal probablity of the estimate falling above or below that level; colored bands moving away from the median indiate the intervals containing 50/100, 75/100, and 95/100 estimates; dashed lines indicating the 99/100 interval.

For this year’s stock assessment the focus of sensitivity analyses was in better understanding the effects of data collected during 2018. During development of the stock assessment, two sources of information were identified as particularly important to the results: the survey expansion conducted in Regulatory Areas 2A, 2B, and 2C in 2018, and the age data collected during 2018 coastwide. The 2018 FISS expansion sampled portions of Regulatory Areas 2B and 2C that had never before been included in the annual survey design. Time series from previous years' survey modelling were much more uncertain than those produced for this assessment. Adding this new and more precise information to the stock assessment models produced slightly less pessimistic results toward the end of the time-series for the two Areas-As-Fleets models. This difference among the four models is due to the treatment of data sources in a less aggregated manner than in the Areas-As-Fleets models. For this sensitivity, after all other data sources had been included, the modelled survey time-series was revised to exclude the new information (expansion stations) from Regulatory Areas 2A, 2B, and 2C. This resulted in trends much more similar to the 2017 stock assessment, and a closer correspondence among the four models for the last several years of the estimated time-series than observed with all data included.

The second notable change in assessment results due to newly available data was the increased estimates of recruitment in 2011 and 2012 relative to 2006-10. To explore whether this change in recruitment was a function of updated productivity estimates in the models or whether it was in fact informed by new data directly, a second sensitivity was conducted that excluded the age information from 2018, but retained all other new trend and mortality data. This sensitivity estimated much lower recruitment strengths for 2011-12. The sensitivity to these new data serves to underscore the importance of next year’s observations which could enhance or contradict those from 2018.

Each of the models contributing to this assessment underwent a retrospective analysis, with neither coastwide model revealing any strong pattern in the most recent years. All models’ estimates for the most recent four years of the retrospective analysis were within the currently estimated confidence intervals.

Outlook

Stock projections indicate a gradual stock decrease between 2019 and 2021 with catches of 20 Mlbs or greater.

Stock projections were conducted using the integrated results from the stock assessment ensemble, summaries of the 2018 fishery, and other sources of mortality, as well as the results of stock distribution calculations and the target harvest rates. The projections required estimating stock distribution, applying area-specific harvest rates to estimate yield and removals, and calculating the total mortality and projecting the stock trends both one and three years into the future. This is explained further in the following sections.

Projections indicate gradual stock decrease between 2019 and 2021, with the risk of stock decline growing rapidly for TCEYs above 20 million pounds (~9,070 t) and becoming more pronounced by 2020.

The decision table (Table 8) includes a range of harvest levels and risk assessments, including the ’reference’ Spawning Potential Ratio (SPR=46%). The TCEY corresponding to the reference SPR (40 million pounds, ~18,140 t, total removals) corresponds to a 87/100 (87 percent) chance of stock decline in 2020

Table 8. Harvest decision table for 2019. Columns correspond to yield alternatives and rows to risk metrics. Values in the table represent the probability, in "times out of 100" (or percent chance) of a particular risk.

		2019 Alternative	No fishing mortality					Status quo		Reference SPR=46%								
		Total mortality (M lb)	0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8	
		TCEY (M lb)	0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0	
		2019 Fishing intensity	$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$	
		Fishing intensity interval	-	56-87%	41-76%	31-67%	27-63%	26-62%	25-61%	25-60%	24-59%	23-59%	23-58%	22-57%	22-56%	21-55%	17-49%	
Stock Trend (spawning biomass)	in 2020	is less than 2019	1	3	26	60	77	81	84	87	90	92	93	95	96	97	>99	a
		is 5% less than 2019	<1	<1	1	10	26	30	34	37	39	41	43	45	48	50	78	b
	in 2021	is less than 2019	1	7	41	75	90	93	94	96	97	98	98	99	99	99	>99	c
		is 5% less than 2019	<1	1	11	42	57	61	65	69	73	77	80	83	87	90	99	d
	in 2022	is less than 2019	1	12	51	82	93	94	96	97	98	98	99	99	99	>99	>99	e
		is 5% less than 2019	<1	3	28	58	76	79	83	86	88	90	92	93	95	96	>99	f
Stock Status (Spawning biomass)	in 2020	is less than 30%	5	7	11	14	17	17	18	18	19	19	20	20	21	21	25	g
		is less than 20%	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	h
	in 2021	is less than 30%	3	7	13	20	24	25	25	26	27	27	27	28	29	29	33	i
		is less than 20%	<1	<1	<1	<1	1	1	1	1	2	2	2	3	3	4	10	j
	in 2022	is less than 30%	2	8	17	25	28	29	29	30	30	31	31	32	33	33	41	k
		is less than 20%	<1	<1	<1	2	4	5	6	7	8	9	10	12	13	15	24	l
Fishery Trend (TCEY)	in 2020	is less than 2019	0	<1	18	26	40	45	51	56	60	63	66	69	73	77	95	m
		is 10% less than 2019	0	<1	12	25	29	33	37	42	47	51	54	58	62	66	95	n
	in 2021	is less than 2019	0	<1	20	28	46	51	56	60	64	67	70	73	77	81	97	o
		is 10% less than 2019	0	<1	16	26	35	39	44	49	53	56	59	63	66	71	97	p
	in 2022	is less than 2019	0	<1	22	32	50	54	58	62	66	69	72	76	79	83	98	q
		is 10% less than 2019	0	<1	19	28	40	45	49	53	56	60	62	66	69	73	98	r
Fishery Status (Fishing intensity)	in 2019	is above $F_{46\%}$	0	<1	16	25	35	40	46	50	56	59	62	65	69	72	92	s

and a 37 percent chance of at least a five percent decline through 2020. There is a less than one-third chance (<34/100; 34 percent) that the stock will decline below the threshold reference point in projections for all the levels of Total Constant Exploitation Yield (TCEY) up to 48.1 million pounds (~21,820 t) evaluated over three years; for TCEYs exceeding that level, the probability begins to increase rapidly.

Scientific advice

Sources of mortality

In 2018, total mortality was near the lowest values estimated over the last 100 years (34 million pounds; ~15,420 t), down from 2017. In 2018, 82% of the total mortality was retained compared to 83% in 2017.

Fishing intensity

The 2018 mortality from all sources corresponds to a point estimate of SPR = 49% (there is a 34% chance that fishing intensity exceeded the IPHC's reference level of 46%). The Commission does not currently have a coastwide limit fishing intensity reference point.

The IPHC does not have an explicit coastwide fishing intensity target or limit reference point, making it difficult to determine if current levels of fishing intensity are consistent with the interim harvest strategy policy objectives. However, given the healthy female spawning biomass and the TAC set for 2018 only being marginally higher than the levels estimated to maintain biomass at current high levels, on the weight-of-evidence, the stock is classified as '**not subject to overfishing**'.

Stock status (spawning biomass)

Female spawning stock biomass of Pacific halibut at the beginning of 2019 was estimated to be 43% (27–63%) of the SB_0 (unfished levels) defined by the interim harvest strategy policy. The probability that the stock is below the SB_{30} level is estimated to be 11%, with less than a 1% chance that the stock is below SB_{20}. Thus, on the weight-of-evidence available, the Pacific halibut stock is determined to be '**not overfished**' (SB_{2019} > SB20%). Projections indicate that the target fishing intensity is likely to result in declining biomass levels in the near future.

Female spawning stock biomass was estimated to be 43% of unfished levels and was determined to be "not overfished" which indicates a level greater than 20%.

Stock distribution

Regional stock distribution has been stable within estimated credibility intervals over the last five years. Region 2 currently represents a greater proportion, and Region 3 a lesser proportion of the coastwide stock than observed in previous decades.

Future research in support of the stock assessment

Research in support of the IPHC's stock assessment, Management Strategy Evaluation (MSE), and harvest strategy policy methods is ongoing, *The stock assessment process includes continuing efforts to decrease uncertainty around mortality estimates as well as refining methods for inclusion of data.*

IPHC port sampler Lisa Vitale and Fisheries Data Specialist Aregash Tesfatsion preparing for the commercial season. Photo by Lara Erikson.

and responds to new developments in the data or analyses necessary each year. New approaches are tested, reported to the IPHC's SRB (generally in June), refined (and reviewed again in October, as needed), and ultimately incorporated in the development of the best scientific information available for the annual management process. Current technical research priorities include:

1. Maintaining consistency and coordination between MSE, and stock assessment data, modelling, and methodology.

2. Incorporation of sex-ratio at age information from genetic analysis of 2017 commercial landings.

3. Incorporation of a refined modelled FISS time-series applying whale depredation criteria refined for 2018 to the entire survey data set (1993-2017), and re-analyzing these data with the space-time model for use in the stock assessment models.

4. Updating the software on which the individual assessment models are developed to the most recently available version of Stock Synthesis in order to allow evaluation of newly available features of potential utility to the Pacific halibut assessment. These include estimation of observation error variance terms, process error variance terms, and other features to be explored.

5. Continued refinement of the ensemble of models used in the stock assessment, potentially including new models with a more broad range of natural mortality estimates, particularly for the short time-series models.

6. Continued development of weighting approaches for models included in the ensemble, potentially including fit to the survey index of abundance, and retrospective and predictive performance.

7. Exploration of methods for better including uncertainty in discard mortality and bycatch estimates in the assessment (now evaluated only via alternative catch tables or model sensitivity tests) in order to better include these sources of uncertainty in the decision table.

8. Bayesian methods for fully integrating parameter uncertainty may provide improved uncertainty estimates within the models contributing to the assessment, and a more natural approach for combining the individual models in the ensemble.

IPHC will continue to develop weighting approaches for models included in the ensemble.

Harvest strategy policy

> *The interim reference spawning potential ratio of 46% was based on status quo over the years 2014-2016.*

Harvest strategy policy has a long history at the IPHC and many analyses and simulation studies have informed the development of past policies, and resultant harvest strategies. The IPHC Harvest Strategy Policy provides a framework for applying a science-based approach to setting harvest levels for Pacific halibut throughout the Convention Area. The policy results in a procedure that uses scientific and management procedures to determine the coastwide Total Constant Exploitation Yield (TCEY) across all Areas, as well as the TCEY and Fishery Constant Exploitation Yield (FCEY) for each Region.

In 2017 the Commission agreed to modify the policy by separating the scale (coastwide fishing intensity) and the distribution of fishing mortality. In 2018, the Management Strategy Evaluation (MSE) process provided recommendations on the scale portion of the policy. The first step in the modified harvest strategy policy would be to determine the TCEY from the coastwide fishing intensity (scale) on the coastwide stock based on Spawning Potential Ratio (SPR). Once the coastwide TCEY is determined it is split into a TCEY for each IPHC Regulatory Area. This second step is the distribution of catch. This separation of scale and distribution accounts for all mortality from all sources, and allows Commissioners to separate the decision of coastwide fishing intensity from distributing the TCEY.

The interim harvest strategy (also referred to as the SPR-based harvest strategy) currently centers around a fishing mortality rate that corresponds to a SPR of 46 percent (a 54 percent reduction in the spawning potential). The MSAB recommended SPR values between 40% and 46% after reviewing the recent MSE results. The SPR can be thought of as the percentage of spawning potential for a fish over its lifetime given a constant level of fishing. For example, a fish may have many chances to spawn without fishing, but that potential will be reduced with fishing. The interim SPR of 46 percent was based on status quo over the years 2014-16, and is also called the reference SPR.

Schooners tied up at Fishermen's Terminal, Seattle, Washington, U.S.A. Photo by Steve Keith.

Management Strategy Evaluation

Management Strategy Evaluation (MSE) is a formal process in which to evaluate the performance of alternative management procedures for the Pacific halibut fishery against defined goals and objectives. Incorporating uncertainty about stock parameters and dynamics into the MSE can identify management procedures that are robust to those uncertainties. At the IPHC, the MSE process has been interactive, with a Management Strategy Advisory Board (MSAB) made up of stakeholders and managers involved in the resource. The MSAB will provide suggestions that are evaluated against objectives defined by all of the parties involved.

Management Strategy Advisory Board (MSAB)

The MSE process at the IPHC includes involvement of stakeholders, managers, and IPHC Secretariat scientists.

The central role of the Management Strategy Advisory Board (MSAB) is to provide advice to the Commission on options for fishery objectives, performance metrics, candidate management procedures, and to measure the performance of various management strategies against the defined objectives. After meeting twice in 2018, the MSAB suggested primary and secondary objectives, and evaluated management procedures related to the coastwide fishing intensity. A recommendation was made that the Commission consider a range of fishing intensities that reduce the spawning potential of the stock to between 40 and 46% of spawning potential without fishing (this is called the Spawning Potential Ratio, or SPR). The MSAB also recommended that future work consist of examining constraints on the annual change in the Total Constant Exploitation Yield (TCEY, or mortality limits) to stabilize the annual variability.

The MSAB will focus on examining management procedures related to distributing the TCEY among IPHC Regulatory Areas. The five-year program of work includes an update for the Commission in January 2020, and final results and recommendations on a coastwide fishing intensity and the distribution of the TCEY will be provided in January 2021, for potential adoption and implementation.

At the IPHC Interim Meeting in Seattle, Washington, U.S.A., MSAB Chairpersons Adam Keizer and Dr. Carey McGilliard along with IPHC Secretariat Quantitative Scientist Dr. Allan Hicks, present the MSAB report. Photo by Tracee Geernaert.

Research

Since its inception, the IPHC has had a long history of research activities devoted to describing and understanding the biology of the Pacific halibut. The main objectives of the IPHC's 5-year Biological and Ecosystem Sciences Research Plan at IPHC are to:

1) identify and assess critical knowledge gaps in the biology of the Pacific halibut;
2) understand the influence of environmental conditions; and
3) apply the resulting knowledge to reduce uncertainty in current stock assessment models.

Biological research activities at IPHC are guided by a 5-year research plan which identifies key areas of study that reflect Commission objectives.

Traditionally, the IPHC Secretariat proposes new projects annually that are designed to address key biological issues as well as the continuation of certain projects initiated in previous years. Proposals are based on staff input as well as input from the Commissioners, stakeholders, and specific subsidiary bodies to the IPHC such as the Scientific Review Board (SRB) and the Research Advisory Board (RAB). Proposed research projects are presented to the Commissioners for feedback and subsequent approval. Importantly, biological research activities at IPHC are guided by a Five-Year Research Plan that identifies key research areas that follow Commission objectives (Table 9).

Table 9. A summary of the key research areas as described in the Five-Year Research Plan for the period 2017-21.

Key research areas	Description
Migration and Distribution	Improve our knowledge of Pacific halibut migration throughout all life stages in order to achieve a complete understanding of stock distribution and the factors that influence it
Reproduction	Provide information on the sex ratio of the commercial landings and improve current estimates of maturity
Growth and Physiological Condition	Describe the role of some of the factors responsible for the observed changes in size-at-age over the past several decades and provide tools for measuring growth and physiological condition in Pacific halibut
Discard Mortality and Survival	Provide updated estimates of discard mortality rates (DMRs) in both the directed longline, recreational and trawl fisheries
Genetics and Genomics	Describe the genetic structure of the Pacific halibut population and provide the means to investigate rapid adaptive changes in response to fishery-dependent and fishery-independent influences

Research projects on these five main research areas are selected for their important management implications. In addition to these five research areas, IPHC is conducting environmental monitoring for oceanographic physical parameters and for contaminant and parasite presence in Pacific halibut. Furthermore, the IPHC conducts data collection programs from fishery-independent sources such as the IPHC setline survey and commercial fishery landings, which are described in other chapters of this report.

Migration and distribution

Wire tagging to study migration of young Pacific halibut

In 2015, the IPHC began a long-term effort to wire-tag young Pacific halibut with the goal of providing data on juvenile Pacific halibut movement and growth. Migration information on adult Pacific halibut has been well documented in recent tagging studies, but less is known about juvenile Pacific halibut movement. This tagging effort began with a pilot study on the National Oceanic and Atmospheric Administration's (NOAA) Fisheries groundfish trawl surveys in 2015. Tagging has continued on the trawl surveys and was expanded to the IPHC fishery-independent setline survey (FISS) in 2016.

In 2018, a total of 2,663 U32 Pacific halibut were wire tagged, fin clipped, and released as part of a multiyear migration study.

In 2018, a total of 2,663 small Pacific halibut (< 82 cm fork length or "U32") were tagged and released. Of this total, 1,747 U32 Pacific halibut were tagged during the FISS and 916 U32 Pacific halibut were tagged and released during the NOAA Fisheries trawl survey. Tissue samples (fin clips) for genetic analyses were also collected from tagged fish.

Deployment and reporting of pop-up archival transmitting (PAT) tags to study seasonal and interannual dispersal of Pacific halibut on Bowers Ridge (Area 4B)

The IPHC has conducted a series of PAT tag studies in the Bering Sea and Aleutian Islands (BSAI) region in order to identify winter spawning locations, determine the timing of seasonal movements, and investigate mixing within the

A small Pacific halibut is tagged and ready for release aboard the NOAA Fisheries groundfish trawl survey. Photo by Christina Conrath.

All but one fish tagged on Bowers Ridge were also there at the time of reporting. The one fish that had relocated, was on the shelf edge in IPHC Regulatory Area 4D.

BSAI and between the Bering Sea and Gulf of Alaska. However, neither PAT nor passive integrated transponder tagging has been conducted on Bowers Ridge (Area 4B) because this region has not been previously surveyed by the IPHC.

In 2017, IPHC took advantage of the FISS expansion in order to generate data for this unstudied region that will complement prior work. From 5-10 July 2017, twenty-two Pacific halibut ranging from 115-170 cm (45-67 inches) in fork length (FL) were tagged with Wildlife Computers miniPAT pop-up archival transmitting tags. In addition to determining the length of the tagged Pacific halibut, blood samples were obtained for future analysis of plasma hormone levels that might be predictive of individual migratory behavior, and ultrasound was employed to determine sex and the likelihood that tagged females (13 fish) were mature. Sixteen tags were programmed to detach from their host fish to report their location and download environmental data to passing Argos (Advanced research and global observation system) satellites during the 2017-18 spawning season, on 15 January 2018; six tags were programmed to detach and report after 365 days at liberty, in July of 2018. Thirteen of the winter-programmed tags reported locations and data as scheduled; one reported as scheduled but failed to provide locations or data; and two failed to report. One of the summer-programmed tags detached prematurely and reported its location in December of 2017, while the remainder of the summer-programmed tags reported as scheduled. All but one fish were located on Bowers Ridge at the time of tag reporting. The single fish to have departed the region reported in mid-January from St. Matthew Canyon, on the continental shelf edge in IPHC Regulatory Area 4D.

Coastwide deployment of long-term electronic archival tags on U32 Pacific halibut

In 2018 the IPHC began a program in which electronic archival tags capable of recorded temperature, depth, and light levels for periods in excess of five years were deployed coastwide on U32 Pacific halibut. A total of 255 fish ranging in length from 51-81 cm FL were tagged during the course of the FISS, from coastal Oregon to the Area 4D shelf Edge and westward as far as Adak Island in the Aleutians. Additionally, due to the expectation that tag-recovery rates are likely to be low in Area 4B, thirteen fish ranging from 58-79 cm FL were tagged with pop-archival transmitting tags between Adak and Attu Islands. These tags were programmed to report after either 365 (10 fish) or 730 days (3 fish). Additional tag deployments will take place during 2019. The data obtained from these tags will be used to relate rearing temperatures to growth rate and examine dispersal-at-age in Pacific halibut as they grow and recruit into the directed longline fishery.

Evaluating Pacific halibut larval connectivity between the Gulf of Alaska and Bering Sea

While a larval Pacific halibut can somewhat control its position vertically in the water column within a few weeks after hatch, horizontal distribution of larvae is largely determined by the currents that are accessed as well as the strength and direction of those currents. Tagging studies show that there is connectivity of demersal-stage Pacific halibut between the Gulf of Alaska (GOA) and Bering Sea by way of actively migrating fish through Aleutian Island passes. While

IPHC Port Sampler Binget Nilsson, Research Biologist Claude Dykstra, and Biological and Ecosystem Science Branch Manager Josep Planas, conducting research at the Seward Marine Center, Seward, AK, U.S.A. Photo by Kelsey Bockelman.

currents could feasibly carry larvae through any of the Aleutian Island passes, this study focuses on inter-basin connectivity via Unimak Pass, which is the main connection between the GOA and the Bering Sea continental shelves.

The IPHC, in collaboration with NOAA/Eco-FOCI is currently working to achieve a number of project goals. These include: 1) identify the factors contributing to annual differences in larval distribution/dispersal and the resulting settled year classes, 2) model larval dispersal and the contribution of spawning grounds to settlement grounds, 3) assess connectivity of the Gulf of Alaska and Bering Sea populations via larval dispersal through Unimak Pass, Alaska.

The IPHC is working with NOAA to identify dispersal pathways of larvae and the contribution of spawning grounds to settlement areas.

Reproduction

Efforts at IPHC are currently underway to address two critical issues in stock assessment based on estimates of female spawning biomass: the sex ratio of the commercial catch and maturity estimations.

Sex ratio of the commercial landings

In the commercial fishery, Pacific halibut are eviscerated at sea and male and female fish cannot be distinguished at the processing plants in the ports, where biological data are collected by IPHC samplers. Therefore, the sex ratio of the commercial landings has not been determined to date, but having this information would be greatly beneficial to the stock assessment.

In order to obtain accurate sex information, IPHC worked with commercial fishers to establish protocols for sex marking fish at sea on commercial vessels and also worked to genetically determine the sex by developing molecular assays using fin clip samples from offloaded fish. If protocols for sex marking at sea proved to be successful, genetic sex assays could then be used as a validation tool to determine the sex-marking accuracy.

In 2016, a developed sex-marking protocol, involving identifying females by cuts in the dorsal fin and males by a cut in the operculum, was implemented in a voluntary fashion in British Columbia. A total of 10 commercial vessels participated in the study by sex marking a total of 325 Pacific halibut that were sampled for fin clips at the ports by IPHC port samplers. In parallel, work in collaboration with geneticists at the University of Washington resulted in the identification of three genetic markers that were associated with sex. Molecular assays were developed for two of the three markers and it was determined that each of the two had an accuracy of at least 97.5 percent when using samples originating from fish whose sex was identified. The two molecular assays were applied to the 325 fish that were marked at sea in 2016. By comparing the sex-related marking and genetic sex identification for each of these fish, it was determined that the accuracy of sex marking at sea in the 2016 project component was 79 percent. In 2017, the sex marking project involved requesting voluntary participation coastwide from the commercial fleet and from 929 fin clip samples from sex marked at sea fish collected in 84 offloads it was determined that the marking accuracy was 94.2%. Due to the low cost and high accuracy of the developed genotyping techniques, in 2018 the entire sample of aged Pacific halibut from commercial landings, corresponding to approximately 10,000 fish, was genotyped (Figure 5). Therefore, the sex ratio of the commercial landings has been determined for the first time and this information will be used in the 2019 stock assessment.

Geneticists at the University of Washington, in collaboration with IPHC, identified three genetic markers that can be used for sex identification.

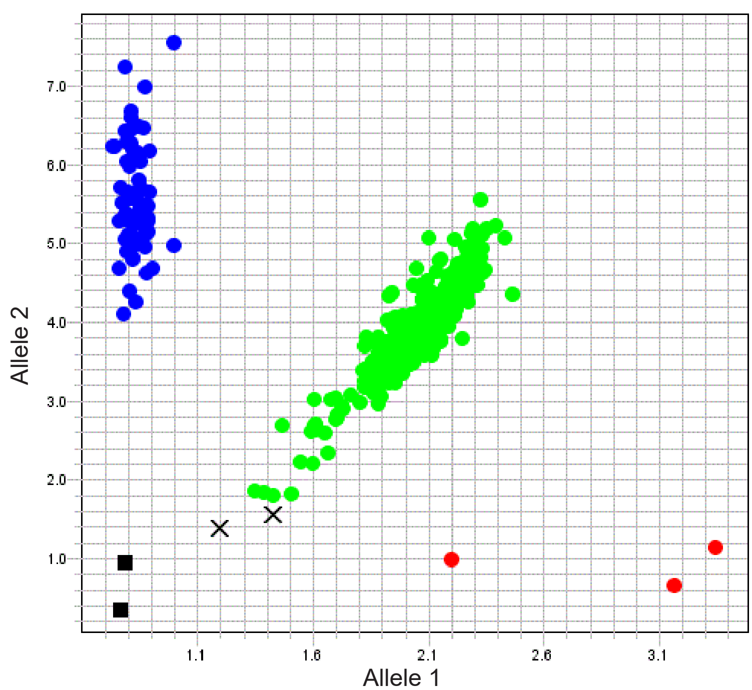


Figure 5. Results of genetic fin clip analysis of the 2017 commercial catch. The blue dots indicate males, green dots are females, and black dots are undetermined. The red dots represent a small portion of samples that do not conform to either the female or male haplotype. The IPHC plans to research these further.

Reproductive assessment of female and male Pacific halibut

Each year, the IPHC fishery-independent setline survey collects biological data on the maturity of female Pacific halibut that are used in the stock assessment. In particular, a female maturity schedule based on characteristics that can be identified through direct examination is used to estimate spawning stock biomass. Currently used estimates of maturity-at-age indicate that the age at which 50 percent of female Pacific halibut are sexually mature is 11.6 years on average. However, the current method using macroscopic visual criteria of the ovaries collected in the field to estimate maturity results in a level of uncertainty. Furthermore, estimates of maturity-at-age have not been revised in recent years and may be outdated. For this reason, current research efforts are devoted to describing reproductive development and maturity in female Pacific halibut.

A recently completed project provided a first description of the changes that take place in the ovary during reproductive development leading to spawning in Pacific halibut by comparing oocyte (egg) stages and characteristics between fish caught during the non-spawning season (summer) and the spawning season (winter) in three different known spawning areas including eastern Bering Sea, central Gulf of Alaska, and southern Gulf of Alaska.

A main goal of the reproductive assessment project is to substantially improve the accuracy of maturity staging techniques which will in turn improve estimates of spawning biomass.

In order to further characterize the gonadal maturation schedule, the IPHC is undertaking a full characterization of the annual reproductive cycle in female and male Pacific halibut. At monthly intervals for 12 consecutive months, from September 2017 to August 2018, 30 female and 30 male Pacific halibut were collected from the Portlock region in the central Gulf of Alaska and a number of different samples were collected for physiological analyses of reproductive parameters. The results of this study will substantially improve the accuracy of current maturity staging techniques, in addition to updating current estimates of maturity-at-age. Overall, the current effort to engage in a comprehensive reproductive monitoring of the adult Pacific halibut population will result in improved estimates of the actual spawning biomass.

Growth and physiological condition

Current studies in this research area are aimed at understanding the possible role of body growth variation in the observed changes in size-at-age (SAA), and at developing tools for measuring growth and physiological condition in Pacific halibut. In view of our limited knowledge on the underlying physiological basis of body growth and, importantly, on the possible contribution of growth alterations in driving changes in SAA, the IPHC is conducting studies to develop and apply tools to evaluate age-specific growth patterns and their response to environmental influences in Pacific halibut over space and time. The specific objectives of these studies are to investigate the effects of temperature, population density, social structure, and stress on biochemical and molecular indicators of body growth. In addition to significantly improving our understanding of the physiological mechanisms regulating growth, this study will identify molecular and biochemical growth signatures that could be used to monitor growth patterns in the Pacific halibut population. At the present time, transcriptomic and proteomic analyses of skeletal muscle from fish subjected to different temperature-induced growth manipulations have resulted in the identification of a number of genes and proteins that could represent potential growth markers for Pacific halibut.

The IPHC upgraded its laboratory facilities to include biological science capabilities such as genetics work that identifies the sex of Pacific halibut from fin clips. Pictured here is a newer member of the Secretariat staff, Anna Simeon who is the Biological Science Laboratory Technician. Photo by Josep Planas.

Discard mortality and survival

Discard mortality rates in the directed longline fleet

In 2017, the IPHC conducted a field experiment investigating the relationship between Pacific halibut release practices, physiological condition, injury levels, and post-release survival in an effort to improve discard mortality rate estimates in the directed Pacific halibut longline fishery. Longline gear was deployed southeast of Chignik, AK, to collect Pacific halibut smaller than 84 cm (33 in), subject them to different hook-release techniques, measure physiological conditions, and tag a subsample of them to determine factors that affect discard mortality. Physiological parameters that will be measured from determinations and samples collected from these fish will include information on condition status at capture (condition index, lipid levels) and post-handling stress levels (blood stress hormones, metabolites, and ions). Electronic monitoring (EM) equipment was also deployed during the project to collect data on the accuracy of its ability to be used to identify release methods. Over two trips and 38 sets, 79 Pacific halibut were fitted with accelerometer pop-up archival transmitting (PAT) tags to assess near-term (96 days) survival, and 1,048 fish were wire tagged to investigate longer-term survival. Vitality (injury and condition) profiles by hook-release method will be developed as a proxy for discard mortality rates on EM trips. PAT tag recoveries in 2018 equated to an estimate of 4% mortality for fish released in excellent condition. An almost perfect (95-100%) agreement between the actual release method used and that captured by EM was observed. Vitality (injury, condition) profiles for each hook-release method are being developed to link the EM trips with hook release data to mortality estimates. Development of physiological data and wire tag recovery will continue in 2019.

Electronic monitoring was used to compare its ability to capture release methods recorded by researchers in the field. There was 95-100% agreement between the two methods.

Genetics and genomics

Sequencing of the Pacific halibut genome

One of the most important biological resources for a fish species with high socio-economic importance and a fascinating life history such as the Pacific halibut is the sequenced genome. Through the genome comes an understanding of the genetic basis of biological processes such as growth or reproduction as well as the genetic and evolutionary changes in Pacific halibut that occur in response to environmental and fisheries-related influences. The IPHC has begun to generate a first draft of the genome of the Pacific halibut.

Environmental monitoring

Oceanographic monitoring

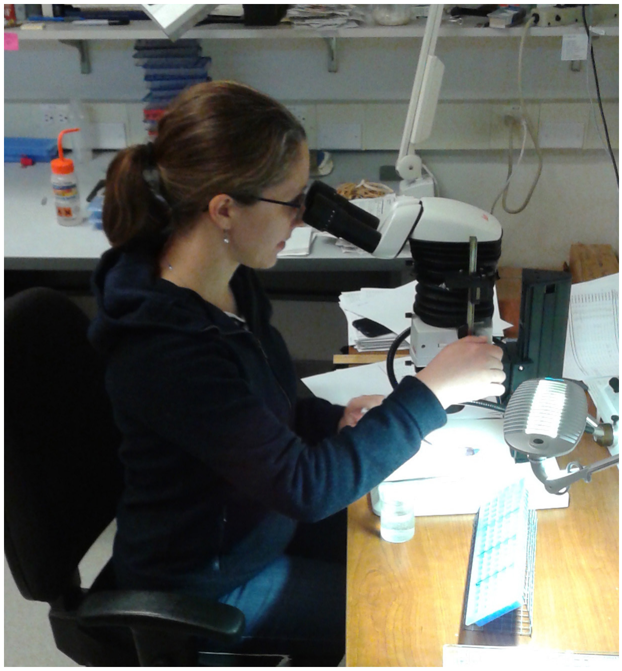
This year marked the tenth consecutive year of the IPHC coastwide oceanographic data collection program whereby water column profiles were attempted at each IPHC fishery-independent setline survey (FISS) station. Oceanographic data were collected using water column profilers manufactured by Seabird Scientific that collected pressure (depth), conductivity (salinity), temperature, dissolved oxygen, pH, and fluorescence (chlorophyll concentration) throughout the water column. The coldest bottom temperatures, which are routinely close to or below 0^{o}C, are typically found around St. Matthew Island in the Bering Sea. However, the Bering Sea experienced temperatures much higher than normal in summer 2018 due to lack of sea ice the winter before, and temperatures around the island ranged from 5.5-8.5^{o}C during the FISS. The coldest coastwide bottom temperature of 2.5^{o}C was still found in the Bering Sea, however, at a FISS expansion station in Area 4D along the continental shelf edge. The severe hypoxic zone found off of the Washington coast in 2017 was not detected in 2018.

The coldest bottom temperatures detected during the FISS are typically experienced around St. Matthew Island in the Bering Sea and are generally close to 0^{o}C or below. In 2018, temperatures around the island averaged 7^{o}C.

Contaminant and parasite monitoring of Pacific halibut

The IPHC has been working cooperatively with the Alaska Department of Environmental Conservation (ADEC) to investigate the presence of heavy metals (arsenic, selenium, lead, cadmium, nickel, mercury, and chromium) and persistent organic pollutants (POPs) in Pacific halibut caught in Alaskan waters since 2002. In 2018, eighty four samples from a variety of sizes were collected in the Prince William Sound (inside waters portion) FISS charter region (20 P, 20 S, 20 M, 20 L, 4 XL), 60 samples were collected in the Shumagin charter region (16 P, 15 S, 12 M, 15 L, 2 XL), and 39 samples were collected in the Trinity charter region (15 P, 10 S, 8 M, 6 L). Samples will be tested for a broad suite of environmental contaminants, including organochlorine pesticides, dioxins, furans, polybrominated diphenyl ethers, polychlorinated biphenyl congeners, methyl mercury, and heavy metals. Additional small muscle and liver tissue samples were collected to be examined for genetic expression of genes that are responsive to contaminant load. Continued collaborative work with ADEC is anticipated.

In 2018, the IPHC continued investigating *Ichthyophonus* incidence in Pacific halibut. *Ichthyophonus* is a protozoan parasite from the class Mesomycetozoea, a highly diverse group of organisms with characteristics of both animals and fungi, which has been identified in many marine fish. The project resampled the three geographically distinct areas (Oregon, Prince William



IPHC Age Lab Technician Dana Rudy examines an otolith to determine the age of the sampled Pacific halibut. Photo by Lauri Sadorus.

Sound, and 4D Edge (Bering Sea) setline survey charter regions) that have been sampled since 2011, to investigate temporal stability of *Ichthyophonus* prevalence. Prevalence in these samples was similar to patterns seen in previous years with Prince William Sound (50%) being much higher than the Bering Sea (14%) and Oregon (8%).

Age data collection

Age distribution of fish caught during the fishery-independent setline survey

The otoliths collected during the fishery-independent setline survey (FISS) provide an age distribution of Pacific halibut coastwide. Of the otoliths collected during the FISS, 12,935 were successfully aged. The most commonly occurring year class for both males and females was 2005 (13-year-olds), with 2,013 caught. Next most common were the year classes 2006 (12-year-olds), with 1,582 caught, and 2004 (14-year-olds), with 1,551 caught.

The IPHC age lab processed roughly 27,000 otoliths in 2018.

In 2018, the youngest and oldest Pacific halibut contained in the FISS samples were three and 47 years old, respectively. The one fish determined to be three years old was a female from Regulatory Area 3A measuring 53 cm fork length (21 inches). The 47-year-old was a male captured in Regulatory Area 4B with a fork length of 141 cm (56 inches). The maximum fork length recorded for FISS-caught Pacific halibut in 2018 was 197 cm (78 inches): a female from Regulatory Area 4B aged at 27 years. The smallest Pacific halibut sampled in the 2018 setline survey measured 47 cm (19 inches) fork length: a female from Regulatory Area 4B aged at four years.

Age distribution of fish caught in the commercial fishery

In 2018, the age distribution of Pacific halibut sampled from commercial landings is based on 11,013 otoliths aged. The 13-year-olds from the 2005 year class were the most abundant (2,030 fish, or 18% of the total). The next most abundant year classes for all IPHC Regulatory Areas combined were 2004 and 2006, each accounting for 13 percent of the sampled catch.

Average fork length of sampled Pacific halibut increased in IPHC Regulatory Areas 2B, 2C, 4A, and 4B in 2018, but decreased in all other areas. Average fork length for all areas combined decreased by 0.6 cm in 2018. The average age from all areas combined in 2018 (13.6 years) was slightly higher than it was in 2017. The youngest and oldest Pacific halibut in the 2018 commercial samples were determined to be four and 43 years old, respectively.

Looking forward

This section summarizes the major decisions made at the 95th Session of the IPHC Annual Meeting (AM095), held 28 January to 1 February 2019 in Victoria, British Columbia, Canada. For a full accounting of documents and presentations provided to the Commission for the meeting, and the final report of the meeting, visit the IPHC webpage:
https://iphc.int/venues/details/95th-session-of-the-iphc-annual-meeting-am095.

Mortality limits

The Commission adopted mortality limits (described as Total Constant Exploitation Yield, TCEY limits) for 2019 as provided in Table 10. These mortality limits include a variety of estimated sources of mortality which are detailed in Table 11.

The Commission adopted a TCEY of 38.61 million pounds at the 2019 Annual Meeting.

Table 10. Adopted TCEY for 2019.

IPHC Regulatory Area	Mortality limit (TCEY) (Mlbs)	Mortality limit (TCEY) (metric tonnes)
2A	1.65	748.42
2B	6.83	3,098.04
2C	6.34	2,875.78
3A	13.50	6,123.50
3B	2.90	1,315.42
4A	1.94	879.97
4B	1.45	657.71
4CDE	4.00	1,814.37
Total (IPHC Convention Area)	**38.61**	**17,513.20**

IPHC Secretariat presents the 2019 Harvest Decision Table to Commissioners and stakeholders at AM095. Photo by Tracee Geernaert.

Table 11. Mortality table projected for the 2019 mortality limits (millions of net pounds) by IPHC Regulatory Area.

Sector	IPHC Regulatory Area								
	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Commercial discard mortality	0.02	0.13	NA	NA	0.19	0.09	0.02	0.04	**0.50**
O26 Bycatch	0.13	0.27	0.03	1.28	0.36	0.18	0.22	1.87	**4.33**
Non-CSP Recreational (+ discards)	NA	0.08	1.38	1.74	0.00	0.01	0.00	0.00	**3.21**
Subsistence	NA	0.41	0.44	0.22	0.01	0.01	0.00	0.06	**1.14**
Total Non-FCEY	0.15	0.88	1.85	3.24	0.57	0.29	0.24	1.96	**9.18**
Commercial discard mortality	NA	NA	0.06	0.31	NA	NA	NA	NA	**0.37**
CSP Recreational (+ discards)	0.60	0.84	0.82	1.89	NA	NA	NA	NA	**4.16**
Subsistence	0.03	NA	NA	NA	NA	NA	NA	NA	**0.03**
Commercial Landings	0.86	5.10	3.61	8.06	2.33	1.65	1.21	2.04	**24.88**
Total FCEY	**1.50**	**5.95**	**4.49**	**10.26**	**2.33**	**1.65**	**1.21**	**2.04**	**29.43**
TCEY	**1.65**	**6.83**	**6.34**	**13.50**	**2.90**	**1.94**	**1.45**	**4.00**	**38.61**
U26 Bycatch	0.00	0.02	0.00	0.37	0.11	0.10	0.01	1.12	**1.73**
Total Mortality	**1.65**	**6.85**	**6.34**	**13.87**	**3.01**	**2.04**	**1.46**	**5.12**	**40.34**

Fishing periods (season dates)

The Commission approved a fishing period of 15 March to 14 November 2019, for the Canada and United States of America quota fisheries. The fishing period will commence at noon local time on 15 March and terminate at noon local time on 14 November 2019 for the following fisheries and areas: the Canadian Individual Vessel Quota (IVQ) fishery in Regulatory Area 2B, and the United States Individual Fishing Quota (IFQ) and Community Development Quota (CDQ) fisheries in Areas 2C, 3A, 3B, 4A, 4B, 4C, 4D, and 4E. All Regulatory Area 2A commercial fishing, including the treaty Indian commercial fishery, will take place between 15 March and 14 November 2019.

In Regulatory Area 2A, the Commission, at the request of the Pacific Fisheries Management Council, retained the 10-hour *derby* fishery for 2019, which will include but not be limited to 26 June, 10 July, 24 July, 7 August, 21 August, 4 September, 18 September, with additional openings and fishing period limits (vessel quota) to be determined and communicated by the IPHC Secretariat. All fishing periods will begin at 08:00 hrs and end at 18:00 hrs local time.

Recommendations

The Commission made a number of additional recommendations including the following:

- The Management Strategy Advisory Board (MSAB) and IPHC Secretariat continue its program of work on the Management Procedure for the Scale portion of the harvest strategy, noting that Scale and Distribution components will be evaluated and presented no later than at AM097 in 2021, for potential adoption and subsequent implementation as a harvest strategy. The management procedure that best meets the primary objectives for coastwide scale is: 1) A target SPR of 40% with a fishery trigger of 30% and a fishery limit of 20% in the control rule; 2) An annual constraint of 15% from the previous year's mortality limit.
- Evaluating and redefining TCEY to include the U26 component of discard mortalities, including bycatch, as steps towards more comprehensive and responsible management of the resource, in coordination with the IPHC Secretariat and Contracting Parties. The intent is that each Contracting Party to the Treaty would be responsible for counting its U26 mortalities against its collective TCEY. This change would be intended to take effect for TCEYs established at the 2020 Annual Meeting.
- The IPHC Secretariat welcomed the opportunity to further address the safety concerns in the Area 2A fishery, and to examine other potential management options for the fishery such as an IFQ or limited entry, as well as its management responsibilities. The Commission recommended that a workshop take place, given the desire for the IPHC to move full management of the fishery from the IPHC (an international fisheries management body) to the relevant domestic agencies.

The Commission recommended a workshop to address options for the management of fisheries in Area 2A.

- The IPHC Secretariat will develop terms of reference for a consultant to undertake a peer review of the IPHC Pacific halibut stock assessment, for implementation in early 2019. The terms of reference and budget shall be endorsed by the Commission inter-sessionally.
- The IPHC Secretariat finalized terms of reference for an expert/consultant to undertake a peer review of the IPHC Pacific halibut MSE, for implementation in early November 2019 and July 2020. The terms of reference and budget shall be endorsed by the Commission inter-sessionally.

Upcoming IPHC meetings

The 2020 Annual Meeting will be held in Anchorage, AK. U.S.A.

Meeting	Date	Location
Interim Meeting (IM095)	25-26 November 2019	Seattle, WA, U.S.A.
Annual Meeting (AM096)	27-31 January 2020	Anchorage, AK, U.S.A.
Annual Meeting (AM097)	25-29 January 2021	Victoria, B.C., Canada

Commission officers

The Commission elected Mr Chris Oliver (U.S.A.) as Chairperson of the IPHC, and Mr Paul Ryall (Canada) as Vice-Chairperson of the IPHC until the close of the 96th Session of the IPHC Annual Meeting in 2020.

Commissioners hear stakeholder advisory group reports at AM095. Pictured left to right: Peter DeGreef (Canada), Neil Davis (Canada), Paul Ryall (Canada), Dr. David Wilson (IPHC Executive Director), Stephen Keith (IPHC Assistant Director), Chris Oliver (U.S.A.), Robert Alverson (U.S.A.), and Richard Yamada (U.S.A.). Photo by Tracee Geernaert.

IPHC Secretariat update

The actvities highlighted in this report account for the majority of IPHC Secretariat time. However, there is also a considerable amount of effort put into public outreach, attending conferences and meetings that enhance knowledge, contributing expertise to the broader scientific community through participation on boards and committees, and seeking further education and training. This section highlights some of those activities.

Committees and organization appointments

- Halibut Advisory Board (Canada) - Dr. David Wilson
- Bering Sea/Aleutian Islands Plan Team - Dr. Allan Hicks
- Bering Sea Fishery Ecosystem Plan Team - Dr. Ian Stewart
- North Pacific Research Board Science Panel - Dr. Josep Planas
- North Pacific Fishery Management Council Scientific and Statistical Committee - Dr. Ian Stewart
- Technical Subcommittee of the Canada-United States Groundfish Committee - Dr. Josep Planas

Conferences and meetings (chronological order)

- Western Groundfish Conference, 12-16 February, Seaside, CA, USA - Claude Dykstra (organizer), Ed Henry (organizer), Dr. Ray Webster, Dr. Josep Planas, Dr. Allan Hicks, Dr. Ian Stewart
- 2018 Ocean Sciences Meeting, 12-16 February, Portland, OR, USA - Lauri Sadorus
- Northeast Pacific Shark Symposium III, 24-25 March, Seattle, WA, USA - Collin Winkowski
- 6th International Otolith Symposium, 15-20 April, Keelung, Taiwan - Dana Rudy
- Invited Plenary speaker, NOAA Fisheries National Stock Assessment Workshop, 22-24 May, Irvine, CA, USA - Dr. Ian Stewart
- International Fisheries Observer and Monitoring Conference, 11-15 June, Vigo, Spain - Claude Dykstra, Lara Erikson
- Tuna Regional Fisheries Management Organization (RFMO) Management Strategy Evaluation (MSE) Meeting, 13-15 June, Seattle, WA, USA - Dr. Allan Hicks, Dr. David Wilson
- Coastwide Salmonid Genetics Meeting, 19-21 June, Mukilteo, WA, USA - Anna Simeon
- 7th meeting of the Regional Fishery Body Secretariats' Network (RSN), 13 July, Rome, Italy - Dr. David Wilson
- International Biometric Conference, 8-13 July, Barcelona, Spain - Dr. Ray Webster
- 33rd Session of the UN-FAO Committee on Fisheries (COFI33), 9-13 July, Rome, Italy - Dr. David Wilson
- BSAI Plan Team Assessment Methods Workshop, 27-28 July, Seattle, WA, USA - Dr. Allan Hicks
- 13th International Congress on the Biology of Fish, 16-19 August, Calgary, Alberta, Canada - Dr. Josep Planas
- American Fisheries Society Annual Meeting, 19-23 August, Atlantic City, NJ, USA - Ed Henry, Dr. Allan Hicks
- Canadian Science Advisory Secretariat Regional Peer Review Meeting, 10-11 October, Nanaimo, British Columbia, Canada - Dr. Ian Stewart
- Microsoft Dynamics User Group Summit, 15-18 October, Phoenix, AZ, USA - Tamara Briggie, Kelly Chapman
- North Pacific Marine Science Organization (PICES) Annual Meeting, 27 October - 2 November, Yokohama, Japan - Dr. David Wilson, Dr. Josep Planas

Aspiring young scientists examine otoliths through microscopes at the Seattle Aquarium Discover Science Weekend interactive display sponsored by IPHC. Photo by Lara Erikson.

Outreach

- Booth at the Pacific Northwest Sportsman's Show, 7-11 February, Portland, OR, USA - Joan Forsberg, Dr. Ian Stewart, Collin Winkowski, Dr. Josep Planas
- Commercial fishing trip ride-alongs hosted by Jeff Kauffmann, St. Paul, AK, USA, and Jim Hubbard, Seward, AK, USA - Dr. Ian Stewart, Dr. David Wilson
- Booth at the Fisherman's Fall Festival, 15 September, Seattle, WA, USA - Stephen Keith, Claude Dykstra, Dana Rudy, Dr. Josep Planas
- Booth at the Seattle Aquarium Discover Science Weekend, 10-12 November, Seattle, WA, USA - Caroline Robinson, Dr. Josep Planas, Ed Henry, Stephen Keith, Collin Winkowski, Lara Erikson
- Booth at the Pacific Marine Expo, 18-20 November, Seattle, WA, USA - Huyen Tran, Lara Erikson, Stephen Keith, Dana Rudy, Caroline Robinson, Ed Henry

Academic affiliations

- Affiliate faculty, Alaska Pacific University, Anchorage, AK, USA - Dr. Josep Planas
- Affiliate faculty, University of Washington School of Aquatic and Fishery Sciences, Seattle, WA, USA - Dr. Ian Stewart
- Lecturer, *Beautiful Graphics in R: mapping*, University of Washington, Seattle, WA, USA - Dr. Allan Hicks
- Graduate student committee member, Alaska Pacific University, Anchorage, AK, USA - Dr. Josep Planas, Dr. Ian Stewart

Education and training

- Supervisory Development 1: Fundamentals - Collin Winkowski
- Genomic and Transcriptomic Sequencing workshop - Anna Simeon

Thank You

The IPHC wishes to thank all of the agencies, industry, and individuals who helped us in our investigations this year in support of the Commission's mandate. A special thank you goes to the following:

- Personnel in the many processing plants who assist the IPHC port sampling and fishery-independent setline survey programs by storing and staging equipment and supplies.
- The Bering Sea and Aleutian Islands NOAA-Fisheries survey groups for saving us a spot on their groundfish trawl surveys and for tagging Pacific halibut for us on the Bering Sea trawl survey vessel.
- The NOAA National Marine Mammal Laboratory and the Central Bering Sea Fishermen's Association for providing us space at their St. Paul residences when our field biologists are in town.
- Jamestown S'Klallam, Lummi, Makah, Port Gamble S'Klallam, Quinault, Quileute, and Swinomish biologists for port sampling IPHC Regulatory Area 2A tribal commercial fisheries.
- CDQ managers for providing the total number and weight of undersized Pacific halibut taken and retained by authorized persons and the methodology used to collect these data.
- The NOAA-Fisheries (NMFS) Observer Program for deploying observers on the IPHC Regulatory Area 2A directed commercial fishery, and for collecting, documenting, and forwarding tags recovered during observer deployments on commercial vessels.
- The Alaska Fisheries Science Center (AFSC) for including the IPHC in the process of obtaining research authorization in accordance with the Marine Mammal Protection Act.
- The PFMC and NPFMC for their ongoing coordination with the IPHC.
- Fisheries and Oceans Canada staff for their ongoing coordination, in particular with electronic logbooks and with IPHC fishery-independent setline survey operations given protected habitats and species.
- State and federal agency staff from both Canada and the USA, as well as government contractors, for their assistance in the provision of data for recreational, subsistence, and commercial fisheries, the provision of Pacific halibut bycatch estimates, and for their assistance in conducting the IPHC fishery-independent setline survey.
- The captains, crew, and plant personnel, as well as those individuals from outside agencies, whose dedicated contributions and efforts make the IPHC operations a success.

2018 Publications

The IPHC publishes three serial publications - Annual reports, Scientific reports, and Technical Reports - and also prepares and distributes regulation pamphlets, information bulletins, and news releases. All items published by the IPHC can be found on the IPHC webpage (https://iphc.int). Articles and reports produced during 2018 by the Commission and Secretariat staff are shown below.

Claussen, J., David, S., O'Reilly, K., Henry, E., and N. Sopinka. (2018). #Welcome: Introducing the AFS Science Communication Section. Fisheries. 43: 121. https://doi.org/10.1002/fsh.10046

Drinan, D. P., Loher, T. and Hauser, L. (2018) Identification of genomic regions associated with sex in Pacific halibut. Journal of Heredity 109(3):326-332. https://doi.org/10.1093/jhered/esx102

Henry, E. (2018). The International Pacific Halibut Commission and Social Media. Fisheries 43(3): 139-142. https://doi.org/10.1002/fsh.10032

Hershberger, P. K., Gregg, J. L. and Dykstra, C. L. (2018) High-prevalence and low-intensity *Ichthyophonus* infections in Pacific halibut. Journal of Aquatic Animal Health 30:13-19. https://doi.org/10.1002/aah.10011

International Pacific Halibut Commission (2018) Annual Report 2017. Int. Pac. Halibut Comm. Seattle, WA, USA. 76 p. https://iphc.int/uploads/pdf/ar/iphc-2017-annual-report.pdf

LeBris, A., Fisher, J. A. D., Murphy, H. M., Galbraith, P. S., Castonguay, M., Loher, T. and Robert, D. (2018) Migration patterns and putative spawning habitats of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of St. Lawrence revealed by geolocation of pop-up satellite archival tags. ICES Journal of Marine Science 75(1):135-147. https://doi.org/10.1093/icesjms/fsx098

Loher, T. and Soderlund, E. (2018) Connectivity between Pacific halibut *Hippoglossus stenolepis* residing in the Salish Sea and the offshore population, demonstrated by pop-up archival tagging. Journal of Sea Research 142: 113-124. https://doi.org/10.1016/j.seares.2018.09.007

Monnahan, C. C. and Stewart, I. J. (2018) The effect of hook spacing on longline catch rates: implications for catch rate standardization. Fisheries Research. 198: 150-158. https://doi.org/10.1016/j.fishres.2017.10.004

Nielsen, J. K., Rose, C. S., Loher, T., Drobny, P., Seitz, A. C., Courtney, M. B. and Gauvin, J. (2018) Characterizing activity and detecting bycatch survival of Pacific halibut with accelerometer Pop-up Satellite Archival Tags. Animal Biotelemetry 6:10. https://doi.org/10.1186/s40317-018-0154-2

Stewart, I. J. and Hicks, A. C. (2018) Interannual stability from ensemble modelling. Canadian Journal of Fisheries and Aquatic Sciences. 75(12): 2109-2113. https://doi.org/10.1139/cjfas-2018-0238

Reward offered for every IPHC tag returned

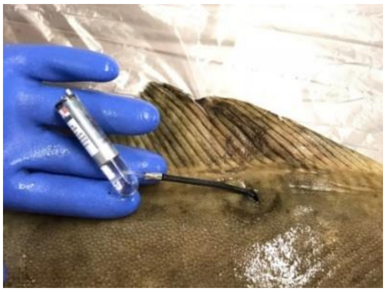
IPHC regulations allow Pacific halibut of any size bearing an IPHC tag to be landed regardless of gear type, fishery, or time of year.

If you've caught a tagged Pacific halibut, you can contact the IPHC (secretariat@iphc.int or 206-634-1838) to see if there is a port sampler nearby to assist in the data collection.
If you are landing in a port not staffed by an IPHC employee or other agency fish sampler, please **return the tag with the following information: recovery date and location, fish length, sex, otoliths, and finder's name and address to the IPHC's Seattle office at the following address:**

IPHC, 2320 West Commodore Way, Suite 300, Seattle, WA 98199, USA.

Archival tags

- These tags record temperature, depth, and light levels.
- Two types of archival tag have been used in the most recent releases. Both types attach to the fish's dark side near the dorsal fin using dart-and-tether:
    - A. Small fixed archival tags that remain on the fish until recaptured (Picture A, below left).
    - B. Larger "pop-up" tags which release from the tether at a pre-programmed date (Picture B, below right).
- Rewards for the recovery of archival tags range from **$300 to $500**, depending on tag type and how much information is provided to the IPHC upon recapture.



A

B

The dart and tether should be removed along with the tag. The dart and tether from a pop-up tag that has been released is rewarded at **$50**. If only the tether is returned, the reward is **$10** or a hat.

Wire tags

- The plastic-coated wire tags come in various colors, marked with IPHC contact information and tag number, and are attached to the cheek area of the dark side of the fish (Picture C, below left).
- A subset of these fish, tagged with orange tags with the text "PLEASE PHOTOGRAPH TAIL" are part of a study investigating whether pigmentation patterns on the white side of the tail persist through life and, if so, whether these natural markings can be used to track individuals over time. The IPHC would like finders of these tags to photograph the tail on the **white** side (Picture D, below right) and provide the photo along with the tag and associated recovery information to an IPHC port sampler or the IPHC's Seattle office.
- The usual reward for a wire tag is **$10 cash or an IPHC tag hat** for each tag returned. The reward for a wire tag bearing the text "PLEASE PHOTOGRAPH TAIL" is **$20 or two hats** if both tag and tail photo are provided.
- Some wire tags have a higher reward amount which is printed on the tag.

C

D

Tag-related questions can also be directed to secretariat@iphc.int. More information on Pacific halibut tagging studies can be found on the IPHC website: **https://iphc.int/management/science-and-research**

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Kelly Chapman	Administrative Services	Front Office Assistant
Stephanie Hart	Administrative Services	Administrative Assistant
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