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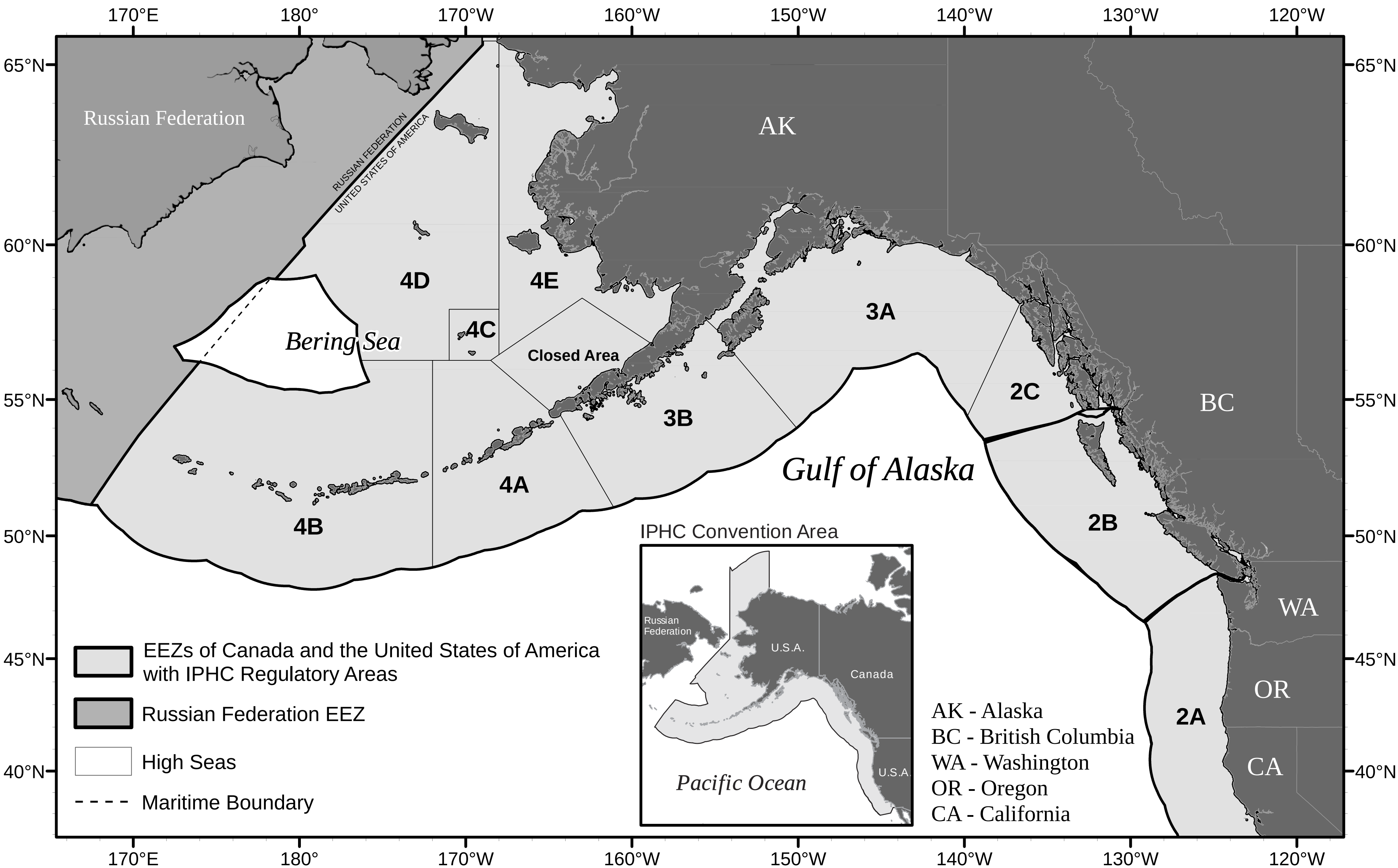
INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report 2019



IPHC Regulatory Areas

ISSN: 0074-7238

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report

2019

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
2020

International Pacific Halibut Commission
2320 West Commodore Way, Suite 300
Seattle, WA 98199-1287, U.S.A.
https://www.iphc.int

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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.

Pacific halibut sculptures featured on the cover staged and photographed with artist's permission by Joan Forsberg and Edward Henry.

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.

Data in this report have been updated using all information received by IPHC through 31 December 2019 and reported at the 96th Annual Meeting in 2020. 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

Learn more about the cover artist Robbie Carver by visiting Robbiecarver.com

"*As a marine wildlife sculptor who lives and works by the sea, I value not only the delicate balance we share with the world, but also how that balance sustains us. Over the period of my life I have learned that by listening to others and keeping an open mind I have been able to influence others into newer more positive ways to act within our ever shrinking environment. One conversation, one handshake, one smile is all it takes sometimes to make that connection with a person and share something with them that simply makes them stop and give the world around them a moment of consideration.*

My art has taken me to many places around the world, including the hard corners of the map where people continue to exploit the sea for reasons that are hard to reconcile. However, casting judgment upon those people and actions has never worked in changing a single mind. What does work is listening and forming a human connection with an individual. I am lucky in that while I make art, I can also make a difference in the way I share it."
Robbie Carver

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

Throughout 2019, the IPHC Secretariat has continued to make tremendous progress in enhancing our scientific processes and the communication of scientific advice emanating from our core functions as a Secretariat serving the Commission. This has continued to occur in tandem with an evaluation of the supporting governance procedures of the organisation, 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 delivered upon in 2017, 2018, and now again in 2019 via improved stakeholder engagement, meeting process (inclusiveness, recording, reporting), and the IPHC's expanded website (https://www.iphc.int). The IPHC Secretariat will continue to increase the utility of our 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. Photo by Lara Erikson.

The IPHC's Fishery-Independent Setline Survey, under new management, broke several records, including the greatest number of stations ever fished (1,588), most number of commercial fishing vessels chartered (18), and completed the 6-year expansion station series in Regulatory Areas 3A and 3B.

From a fishery perspective, we started the year with the Commission again 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 2019 to be 43% (27–63%) 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 (FISS) weight-per-unit-effort (WPUE) indices which were down 5% from 2017, and directed longline fishery WPUE which was down 13% from 2017. 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 2019 fishing and IPHC Fishery-Independent Setline Survey seasons, estimated female spawning biomass to be 32% (22-46%) of the equilibrium unfished level (SB_0; noting that the reference point was updated to reflect the current biology and demographics of the stock) at the end of 2019. Fishery-dependent catch rates were up 1% but fishery-independent indices were again down by 5% at the coastwide level from 2018, 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 2010 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 2021-23 for all total mortality levels greater than 20 Mlbs (~9,072 t) (TCEY = 18.4 million pounds; ~8,350 t). Thus, with the Commission adopting total mortality levels of 38.3 M lbs (~17,373 t) (TCEY = 36.60 M lb; ~17,513 t) for the 2020 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 fisheries.

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 Commission is composed of six members (Commissioners), and meets several times a year, in both formal and informal capacities, to consider matters relevant to the Pacific halibut stock, the fisheries, and governance. All meeting documents, presentations, and reports are posted on the IPHC website (https://www.iphc.int).

95th Session of the IPHC Annual Meeting (AM095; 2019)

The 2019 Annual Meeting was held in Victoria, BC, Canada with Mr. Paul Ryall presiding as Chairperson and Mr. Chris Oliver as Vice-Chairperson.

The 95th Session of the IPHC Annual Meeting (AM095) was held in Victoria, BC, Canada, from 28 January to 1 February 2019. For AM095, Mr. Paul Ryall of Canada presided as Chairperson and Mr. Chris Oliver of the United States of America 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 stakeholder concerns, considered the suggestions of its subsidiary bodies, and solicited public comment before adopting regulations and making other decisions.

Fishery limits and fishing periods for 2019

The Commission recommended to the governments of Canada and the United States of America a total mortality limit for 2019 of 38,610,000 pounds (17,513.20 t) net weight[1], and adopted the mortality limits for each IPHC Regulatory Area as described in Table 1.

[1] Note that all weight values in this section are expressed in terms of net weight, meaning the weight of Pacific halibut that is without gills and entrails, head-off, washed, and without ice and slime.

Photo by Allan Hicks.

Table 1. Adopted mortality limits (net weight) from AM095.

IPHC Regulatory Area	Mortality limit (TCEY) (Mlbs)	Mortality limit (TCEY) (metric tons)
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**

The total adopted mortality limits totaled 38.61 million pounds (17.51 tonnes).

The area and sector fishery limits resulting from the IPHC-adopted total mortality limits and the application of the existing Contracting Party catch sharing arrangements were as described in Table 2.

Thus, the total fishery limit (FCEY) for 2019 was set at 29.43 million pounds (13,349.22 metric tons), a 5.4 percent increase from the fishery limits of 27,933,985 pounds (12,670.64 metric tons) implemented by the Contracting Parties in 2018.

The Commission adopted fishing periods for 2019 as follows:

- All commercial fishing for Pacific halibut in all IPHC Regulatory Areas could begin no earlier than 15 March and must cease on 14 November.
- For the IPHC Regulatory Area 2A non-tribal directed commercial fishery, 10-hour fishing periods could take place on 26 June, 10 July, 24 July, 7 August, 21 August, 4 September, and 18 September, with additional openings and fishing period limits (vessel quota) to be determined and communicated by the IPHC Secretariat.

Other decisions made at the meeting

The Commission made a range of other decisions at the 95th Session of the IPHC Annual Meeting, including recommendations concerning the following:

- The IPHC's ongoing Management Strategy Evaluation (MSE);
- The process of transferring management of fisheries in IPHC Regulatory Area 2A from the IPHC (an international fisheries management body) to the relevant domestic agencies;
- The peer review of the IPHC stock assessment to take place during 2019; and
- The completion of the second performance review of the IPHC (PRIPHC02) during 2019.

The Commission adopted the fishing period of 15 March to 14 November for 2019.

Table 2. Fishery limits and application of the existing Contracting Party catch sharing arrangements.

IPHC Regulatory Area	*fishery limits (net weight)*	
	pounds (lb)	**metric tons (t)**
Area 2A (California, Oregon, and Washington)	**1,500,000**	**680.39**
Non-treaty directed commercial (south of Pt. Chehalis)	254,426	115.41
Non-treaty incidental catch in salmon troll fishery	44,899	20.37
Non-treaty incidental catch in sablefish fishery (north of Pt. Chehalis)	70,000	31.75
Treaty Indian commercial	497,000	225.44
Treaty Indian ceremonial and subsistence (year-round)	28,000	12.70
Recreational – Washington	277,100	125.69
Recreational – Oregon	289,575	131.35
Recreational – California	39,000	17.69
Area 2B (British Columbia) (includes recreational catch allocation)	**5,950,000**	**2,698.90**
Area 2C (southeastern Alaska) (combined commercial/guided recreational)	**4,490,000**	**2,036.63**
Commercial fishery (3,610,000 catch and 60,000 incidental mortality)	3,670,000	1,664.68
Guided recreational fishery (includes catch and incidental mortality)	820,000	371.95
Area 3A (central Gulf of Alaska) (combined commercial/guided recreational)	**10,260,000**	**4,653.86**
Commercial fishery (8,060,000 catch and 310,000 incidental mortality)	8,370,000	3,796.57
Guided recreational fishery (includes catch and incidental mortality)	1,890,000	857.29
Area 3B (western Gulf of Alaska)	**2,330,000**	**1,056.87**
Area 4A (eastern Aleutians)	**1,650,000**	**748.43**
Area 4B (central/western Aleutians)	**1,210,000**	**548.85**
Areas 4CDE	**2,040,000**	**925.33**
Area 4C (Pribilof Islands)	910,000	412.77
Area 4D (northwestern Bering Sea)	910,000	412.77
Area 4E (Bering Sea flats)	220,000	99.79
Total	**29,430,000**	**13,349.22**

95th Session of the IPHC Interim Meeting (IM095; 2019)

The 95th Session of the IPHC Interim Meeting, held 25-26 November 2019 in Seattle, WA, USA, was an occasion to prepare for the 96th Session of the IPHC Annual Meeting (AM096) scheduled for 3-7 February 2020. For IM095, Mr. Chris Oliver of the United States of America presided as Chairperson and Mr.

IPHC Quantitative Scientists Dr. Ian Stewart and Dr. Allan Hicks at IM095. Photo by Edward Henry.

Paul Ryall of Canada presided as Vice-Chairperson. The Commissioners and the public were able to hear IPHC Secretariat presentations and discuss a variety of topics, including a review of the 2019 fisheries statistics and preliminary stock assessment results, and the preliminary 2020 harvest decision table.

The IPHC is funded jointly by the governments of Canada and the USA.

IPHC Finances

The IPHC is funded jointly by the governments of Canada and the USA. For fiscal year 2019, Canada provided $848,720 USD for general contributions. The USA appropriated $4,395,000 USD to the IPHC, which included funding designated for pension deficits and IPHC headquarters contributions.

Pacific halibut commercial fishery

As of 31 December, total commercial landings totalled just over 10.6 tonnes (23.5 million pounds)

Commercial fishing is the activity of catching fish for commercial profit. The commercial Pacific halibut landings in 2019 totaled 10,643 tonnes or 23,464,000 pounds (Table 3). 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 31 December 2019. For updates on landings data, please refer to the IPHC website at: https://www.iphc.int.

Licensing and landings

Licensing

Licensing regulations for IPHC Regulatory Area 2A non-tribal fisheries were unchanged in 2019. 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, Fisheries and Oceans Canada (DFO), NOAA Fisheries, Metlakatla 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.

Pacific halibut offload in Homer, AK, USA. Photo by Lara Erikson.

Table 3. 2019 Pacific halibut landings (net weight) by IPHC Regulatory Area (as of 31 December 2019).

IPHC Regulatory Area	Fishery limits (net weight)		Landings (net weight)		Percent
	tonnes	pounds	tonnes	pounds	(%)
Area 2A (California, Oregon, Washington)	**680**	**1,500,000**	**611**	**1,346,404**	**90**
Non-tribal directed commercial	115	254,426	115	252,761	99
Non-tribal catch in salmon troll fishery	20	44,899	20	43,417	97
Non-tribal catch in sablefish fishery	32	70,000	36	79,360	113
Treaty Indian commercial	225	497,000	224	494,568	100
Treaty Indian ceremonial and subsistence	13	28,000	27,000	28,000	100
Recreational – Washington	126	277,100	122	270,024	97
Recreational – Oregon	131	289,575	160	160,306	55
Recreational – California	18	39,000	8	17,968	46
Area 2B (British Columbia)	**2,699**	**5,950,000**	**2,681**	**5,911,605**	**99**
Commercial fishery	2,313	5,100,000	2,310	5,092,520	100
Recreational fishery	381	840,000	372	819,085	98
Area 2C (southeastern Alaska)[1]	**2,037**	**4,490,000**	**1,861**	**4,102,622**	**91**
Commercial fishery	1,637	3,610,000	1,537	3,388,622	94
Commercial discard mortality	27	60,000	36	80,000	133
Guided recreational fishery	372	820,000	288	634,000	77
Area 3A (central Gulf of Alaska)	**4,654**	**10,260,000**	**4,650**	**10,250,699**	**100**
Commercial fishery	3,656	8,060,000	3,582	7,897,699	98
Commercial discard mortality	141	310,000	160	353,000	114
Guided recreational fishery	857	1,890,000	907	2,000,000	106
Area 3B (western Gulf of Alaska)	**1,057**	**2,330,000**	**995**	**2,194,580**	**94**
Area 4A (eastern Aleutian Is.)	**748**	**1,650,000**	**622**	**1,372,332**	**83**
Area 4B (central/western Aleutian Is.)	**549**	**1,210,000**	**444**	**977,742**	**81**
Areas 4CDE and Closed	**925**	**2,040,000**	**745**	**1,641,820**	**80**
Area 4C (Pribilof Islands)	413	910,000	n/a	n/a	n/a
Area 4D (northwestern Bering Sea)	413	910,000	n/a	n/a	n/a
Area 4E (Bering Sea flats)	100	220,000	n/a	n/a	n/a
Total	**13,349**	**29,430,000**	**12,609**	**27,797,804**	**94**

[1]Does not include Metlakatla fishery.

n/a = not available

Landing patterns

In Canada (IPHC Regulatory Area 2B), two out of the 17 ports receiving commercial deliveries in 2019, received 90 percent of the landed catch: Port Hardy and Prince Rupert/Port Edward. Port Hardy (including Coal Harbour and Port McNeill) received 40 percent of the commercial landed catch (913 tonnes; 2,013,000 pounds), and Prince Rupert received 50 percent (1,163 tonnes; 2,564,000 pounds).

In the USA (Alaska) the landed catch was 7,938 tonnes (17,500,000 pounds). IPHC Regulatory Area 3A again had the highest fishery limit and landed catch. Homer received the largest portion of the Alaskan commercial catch, with 1,142 tonnes (2,517,000 pounds; 14%). Kodiak received the second and Seward the third largest landing volumes at 14 percent (927 tonnes; 2,043,000 pounds, 1,024 t) and 11 percent (895 tonnes; 1,974,000 pounds) of the Alaskan commercial landings, respectively. In Southeast Alaska (IPHC Regulatory Area 2C), Sitka and Juneau received the most in landed weight, together totaling 14% of total commercial Alaskan landings.

Sampling of commercial landings

The 2019 target for commercially landed Pacific halibut otolith collection was 11,500 samples coastwide.

Sampling commercial landings is a key component to collecting data on Pacific halibut for the annual IPHC stock assessment. IPHC Fisheries Data Specialists (Field Staff) 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-

IPHC Fisheries Data field staff along with those working at Seattle Headquarters to collect fishery landings data throughout the 2019 commercial season. Photo by IPHC Secretariat.

IPHC Field Data Specialist Michele Drummond and Seattle-based Secretariat staff member Kamala Carroll sampling an offload in Juneau, AK, USA. Photo by Lara Erikson.

at-age information. Fin tissue samples are analyzed to provide the sex of individual fish and, in turn, estimate the sex composition of the commercial landings. 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.

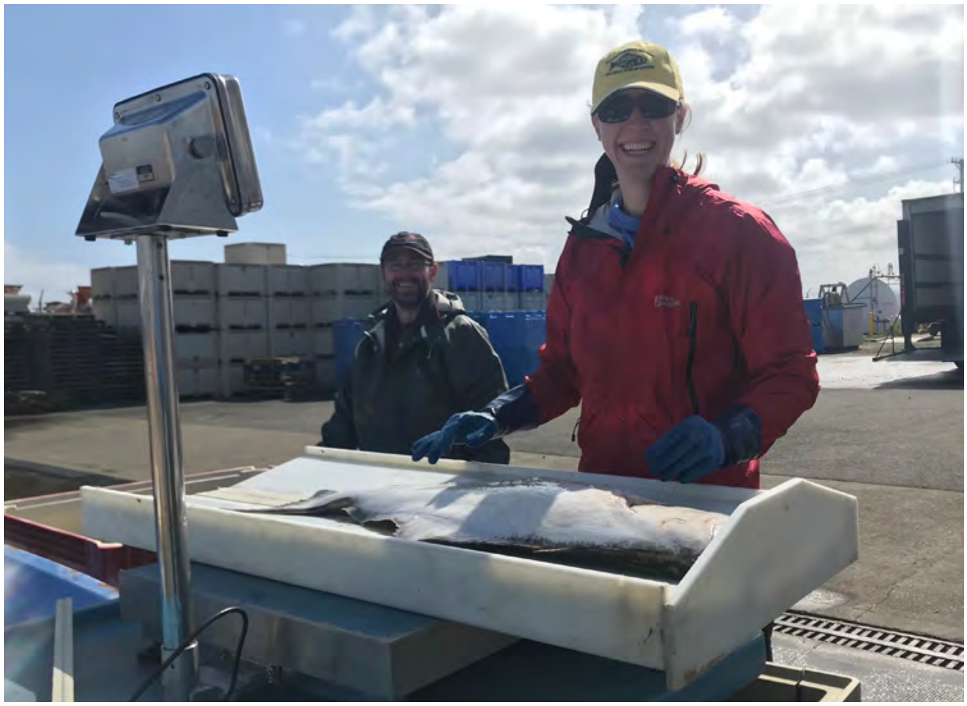
Sampling protocols are designed to ensure that the sampled Pacific halibut are representative of the population of landed Pacific halibut; sampling days and places, and percentage of fish sampled are based on landing patterns and are reviewed annually. The protocols can vary slightly from port to port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

IPHC Field Staff collected 3,389 logs in 2019; 14 percent from Canadian landings and 86 percent from USA landings.

Considering that vessels travel to multiple IPHC Regulatory Areas and are not limited in where they may land their catch, IPHC field staff were stationed in ports coastwide. In Canada, IPHC Fisheries Data Specialists staffed Port Hardy and Prince Rupert. In the USA. in IPHC Regulatory Area 2A, IPHC Fisheries Data Specialists were present in Newport and Charleston, Oregon and in Ilwaco and Bellingham, Washington. In addition, samples were taken in several ports in Washington by staff 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 staff. In Alaska, the ports of St. Paul, Dutch Harbor, Kodiak, Homer, Seward, Juneau, Sitka, and Petersburg were staffed by IPHC.

Otoliths

The IPHC Secretariat aimed to collect 11,500 total Pacific halibut otoliths in 2019, 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 the treaty Indian fisheries and 350 for IPHC Regulatory Area 2A non-tribal directed commercial fisheries. All collections resulted in 11,215 otoliths by sampling from 34 percent of the landed catch in the 737 sampled landings.



IPHC Secretariat Staff member Caroline Robinson and Quinault Tribal biologist Alan Sarich port sampling in Area 2A. Photo by Edward Henry.

IPHC Fisheries Data Specialists 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 IPHC Regulatory Areas 2A, 4B, and 4CD in 2019. The annual COAC target is 100 otoliths from each IPHC Regulatory Area; this target was not attained in Regulatory Area 4B (66%) but was exceeded in Regulatory Areas 2A, and 4CD.

Fisheries Data Specialists processed 44 tag recoveries in 2019.

Logbooks

Alongside otolith samples, IPHC Fisheries Data Specialists collected logbook information from harvesters. In total, 3,389 logs were collected in 2019 (as of 31 December 2019). A total of 478 (14 percent by count) were collected from Canadian landings, and 2,911 (86 percent by count) were collected from USA landings.

Recovered tags

In 2019, IPHC Fisheries Data Specialists collected 44 tags of several types from tagged Pacific halibut. A total of 40 of these recoveries were from U32 wire tagging releases conducted between 2015 and 2018 and which included subsets from discard mortality and tail pattern recognition studies. Other tag types recovered included archival and dummy archival tags. Tag data collected dockside included fork lengths, weight(s), 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. Each IPHC Fisheries Data Specialist in Alaska used an electronic tablet to input data from paper logbooks into a remote data entry application. Specialists 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 duties. Modifications and enhancements to the application continue.

Fisheries Data Specialist Jessica Marx prepares to collect logbook information in Homer, AK, U.S.A. Photo by Lara Erikson.

In British Columbia, Canada, IPHC Fisheries Data Specialists were provided with a field version of the log entry program used by the IPHC's Secretariat staff in Seattle. The Specialists 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, IPHC Fisheries Data Specialists were supplied with Bluetooth-enabled tablets for collection of electronic logs from vessels using Archipelago Marine Research's FLOAT - Fishing Log Application for Android.

IPHC has been working towards electronic data collection of logbooks which helps to reduce the need for post-collection data entry.

Recreational fishery

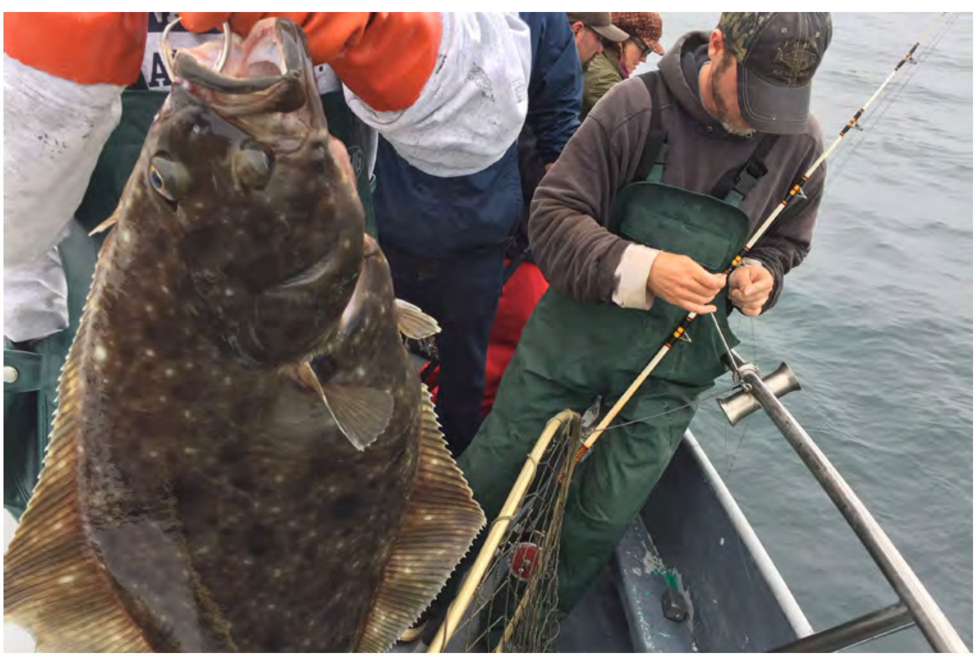
The 2019 recreational harvest of Pacific halibut, including discard mortality, was estimated at about 3,147 tonnes (6,938,000 pounds) by the IPHC, using information provided by state and federal agencies from each of the Contracting Parties. The regulations governing recreational fishing of Pacific halibut were specifically geared to each IPHC Regulatory Area. Table 4 provides a brief summary of overall removals and more detailed tables providing a summary of seasons and retained catch can be found on the IPHC website: https://www.iphc.int.

Table 4. Summary of 2019 recreational Pacific halibut allocations and catch by IPHC Regulatory Area.

Area	Allocation		Retained catch		Percent of allocation
	tonnes	pounds	tonnes	pounds	
2A[1]	275	605,675	203	448,298	74%
2B[1]	381	840,000	372	819,085	98%
2C (charter)[2]	372	820,000	303	667,000	81%
3A (charter)[2]	857	1,890,000	916	2,019,000	107%
3B	no limit		-[n/a]		-
4	no limit		-[n/a]		-

[1] The associated discard mortality for IPHC Regulatory Area 2A is 3 tonnes or 5,700 pounds and for Area 2B is 19 tonnes or 42,600 pounds.
[2] There is no allocation limit for the non-charter recreational fishery in these Regulatory Areas.

Recreational harvest including discard mortality was estimated to be about 6.9 million pounds (3,147 tonnes) in 2019.



Sport fishing off the *F/V Windsong*. Photo by Edward Henry.

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 licence holder from 1 March to 1 April. On 1 April the maximum size limit was increased to 126 cm (49.6 inch) and one fish had to be less than 90 cm (35.4 inch) when attaining the two fish possession limit.

British Columbia, Canada and Alaska, USA both have programs that allow recreational harvesters to land fish that is leased from directed commercial fishery quota share holders for the current season. In Canada, an estimated 8 tonnes (18,000 pounds) were leased from the directed commercial quota fishery and landed as recreational harvest.

IPHC Regulatory Area 2A – California, Oregon and Washington (USA)

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 32 tonnes or 70,000 pounds were allocated to the incidental Pacific halibut catch in the commercial sablefish fishery in Washington. This subdivision resulted in 126 tonnes or 277,100 pounds being allocated to Washington subareas and 131 tonnes or 289,575 pounds to Oregon subareas. In addition, California received an allocation of 18 tonnes or 39,000 pounds. 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. The IPHC Regulatory Area 2A recreational harvest totaled 203 tonnes (448,298 pounds), 26% under the recreational allocation (Table 4).

Both British Columbia and Alaska have programs whereby commercial quota can be leased for recreational harvest. In 2019, this amounted to 103,691 pounds (47 tonnes).

IPHC Regulatory Areas 2C, 3A, 3B, and 4 – Alaska (USA)

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 ≤ 97 cm or 38 inches or ≥ 203 cm or 80 inches in total length. In IPHC Regulatory Area 3A, charter anglers were allowed to retain two fish, but only one could exceed 71 cm or 28 inches 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 9 July, 16 July, 23 July, 30 July, 6 August, and 13 August.

Similar to British Columbia (Canada), Alaska (USA) 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 34 tonnes or 75,039 pounds and 5 tonnes or 10,652 pounds (4.1 t), respectively, were leased from the directed commercial quota fisheries in those areas and landed as recreational harvest.

Discard mortality of Pacific halibut in the directed fishery

In the directed 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 or in this case, directed commercial discard mortality.

Estimates of directed commercial discard mortality in 2019 amounted to 445 tonnes (982,000 pounds; net weight) (Table 5). Data in this chapter are as of 31 December 2019. There are three main sources of directed commercial 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 compliance reasons, such as a vessel reaching its trip, catch or quota share limit.

Table 5. Directed commercial discard mortality of Pacific halibut (net weight) by IPHC Regulatory Area, 2019.

IPHC Regulatory Area	Discard Mortality	
	tonnes	pounds
2A	13	29,000
2B	64	140,000
2C[1]	36	80,000
3A	160	353,000
3B	74	163,000
4A	47	104,000
4B	17	38,000
4CDE	34	75,000
Total	445	982,000

[1]Includes the Metlakatla fishery.

Pacific halibut are discarded during the directed fishery for a variety of reasons and a portion of those die. In 2019, this source of mortality was estimated at 982,000 pounds (445 t).

Directed commercial 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 advent of quota-share fishery management in these areas has greatly reduced the mortality from lost or abandoned gear.

IPHC Setline Survey Specialist Danielle Bennett displays a Pacific halibut skeleton affected by severe sand flea predation during the FISS. Photo by Jessica Miller.

A mortality rate of 16 percent was applied to all Pacific halibut discards from the quota fisheries.

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.

Directed commercial 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) uses similar fishing gear, FISS data have been used as a proxy for the expected encounter rates by area and year. Results are filtered to use FISS 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 USA). 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 the directed commercial fishery is estimated by multiplying the ratio of U32 to O32 Pacific halibut by the landed commercial catch and then by the estimated mortality rate for that fishery.

Directed commercial discard mortality for regulatory compliance reasons

In the derby fishery of 2A, a mortality limit of 25% is applied to discarded Pacific halibut.

In IPHC Regulatory Area 2A, the directed 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 directed commercial fisheries was not included in these numbers, however, as they were accounted for under non-directed commercial discard mortality estimates. In 2019, quota share fisheries in British Columbia and Alaska were included in these numbers.

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 removals. Subsistence harvest is barred from resale, so by nature does not make up a part of the commercial landings. 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, USA; 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 (USA) 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 6 provides a summary of subsistence removals followed by more detail for each area.

The subsistence classification is used for fish caught by those who have traditionally relied on Pacific halibut for food or customary purposes.

Table 6. Subsistence Pacific halibut fisheries removals (net weight) by IPHC Regulatory Area, 2019.

IPHC Regulatory Area	Subsistence Removals	
	tonnes	pounds
2A	12.70	28,000
2B	183.70	405,000
2C	166.11	366,214
3A	85.14	187,698
3B	7.55	16,644
4A	6.00	13,237
4B	0.76	1,684
4C	2.34	5,152
4D	0.00	0
4E	11.41	25,160
4D/4E[1] (CDQ U32)	3.29	7,252
Total	**530.39**	**1,056,041**

[1] 2018 Alaska estimates were carried over for the 2019 estimates, 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.

USA (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.

USA (IPHC Regulatory Areas 2C, 3, and 4; Alaska)

After the Alaska subsistence program began in 2003, the Alaska subsistence catch declined until 2013, after which it rose until 2015. A new 2018 estimate was used for 2018 and 2019. The Alaska estimates for the subsistence Pacific halibut harvest typically lag by a year, so the 2019 estimates are not yet complete.

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.

Photo by Allan Hicks.

Regulations surrounding this fishery require registration to participate in the program and include gear specifications.

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 2019, retention of U32 Pacific halibut in the CDQ fishery was 3.3 tonnes or 7,252 pounds, a decrease from the 4.5 tonnes of Pacific halibut retained in 2018. 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 2019, twenty-five harvesters brought in a catch of 317 U32 Pacific halibut, weighing 1.5 tonnes or 3,349 pounds. Pacific halibut were landed by BBEDC vessels equally at Togiak and Dillingham, with a small amount landed in Naknek and a minor amount landed in Egegik.

A portion of commercial Pacific halibut vessels in Bering Sea Areas 4D and 4E are authorized to retain U32 Pacific halibut for personal use.

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 2019, for the sixth year in a row, CVRF reported that their fishers landed zero Pacific halibut and no fish were received by their facilities.

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 2019, the area's only plant at Nome, received 390 U32 Pacific halibut, weighing 1.8 tonnes or 3,903 pounds.

Discard mortality of Pacific halibut in non-directed commercial fisheries

Discard mortality described in this section includes those Pacific halibut caught and discarded in fisheries where they are not the target.

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

In 2019, there were an estimated 2,919 tonnes or 6,436,000 pounds of Pacific halibut non-directed commercial fisheries discard mortality, representing a five (5) percent increase from the 2,771 tonnes or 6,110,000 pounds recorded in 2018. Estimates for 2019 are preliminary and subject to change as new information becomes available. Current values are available on the IPHC website: https://www.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 USA for discard mortality in non-directed commercial 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.

In the USA, 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 commercial 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

Marina in Newport, OR, USA. Photo by Sarah Stephens.

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.

Discard mortality in non-directed commercial fisheries by IPHC Regulatory Area

A variety of methods are used to arrive at the best possible estimate of bycatch mortality for each fishery, including both direct observations and information extrapolated from similar fisheries if direct observations are not available.

This section describes the estimated non-directed commercial fisheries discard mortality from each IPHC Regulatory Area (Table 7).

Table 7. Non-directed commercial fisheries discard mortality estimates of Pacific halibut (net weight) by year, IPHC Regulatory Area, and fishery, for 2019. Estimates are preliminary.[1]

IPHC Regulatory Area and Gear Type	Non-directed commercial fisheries discard mortality	
2A	tonnes	pounds
Groundfish Trawl	N/A	N/A
IFQ Bottom Trawl	32	71,000
Other Groundfish Trawl	<1	1,000
Groundfish Pot	<1	1,000
Hook & Line	24	53,000
Shrimp Trawl	0	0
Total	57	126,000
2B		
Groundfish Bottom Trawl	108	239,000
Total	108	239,000
2C		
Crab Pot	<1	1,000
Groundfish Trawl	N/A	N/A
Hook & Line (non-IFQ)	2	5,000
Hook & Line (IFQ)	23	50,000
Chatham Str. Sablefish	4	8,000
Clarence Str. Sablefish	11	25,000
Total	40	89,000
3A		
Scallop Dredge	11	24,000
Groundfish Trawl	615	1,356,000
Hook & Line (non-IFQ)	20	45,000

Hook & Line (IFQ)	10	23,000
Groundfish Pot	0	0
Pr Wm Sd Sablefish	5	10,000
Total	661	1,458,000
3B		
Crab Pot	23	50,000
Scallop Dredge	6	14,000
Groundfish Trawl	131	288,000
Hook & Line (non-IFQ)	5	12,000
Hook & Line (IFQ)	42	93,000
Groundfish Pot	1	2,000
Total	208	459,000
4A		
Crab Pot	12	27,000
Scallop Dredge	0	0
Groundfish Trawl	118	260,000
Hook & Line (non-IFQ)	15	33,000
Hook & Line (IFQ)	3	7,000
Groundfish Pot	1	2,000
Total	149	329,000
4B		
Crab Pot	1	3,000
Groundfish Trawl	69	152,000
Hook & Line (non-IFQ)	5	12,000
Hook & Line (IFQ)	0	0
Groundfish Pot	1	2,000
Total	77	169,000
4CDE+CA		
Crab Pot	17	37,000
Scallop Dredge	0	0
Groundfish Trawl	1,545	3,406,000
Hook & Line (non-IFQ)	55	122,000
Hook & Line (IFQ)	0	0
Groundfish Pot	1	2,000
Total	1618	3,567,000
4 Subtotal		
Crab Pot	30	67,000
Scallop Dredge	0	0
Groundfish Trawl	1,732	3,818,000
Hook & Line (non-IFQ)	76	167,000
Hook & Line (IFQ)	3	7,000
Groundfish Pot	3	6,000
Total	1,844	4,065,000
GRAND TOTAL	2,919	6,436,000

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

In Area 2B, discard mortality in trawl fisheries is capped at 750,000 pounds.

Canada (IPHC Regulatory Area 2B; British Columbia)

In Canada, Pacific halibut non-directed commercial discard mortality in trawl fisheries is capped at 454 tonnes round weight or 750,000 pounds net weight by DFO. Non-directed commercial discard mortality is handled under the quota system within the directed Pacific halibut fishery cap. The reported non-directed commercial discard mortality data were complete through September.

Projections for the full calendar year 2019 were made by extrapolating to the full 12 months.

USA (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 non-directed commercial discard mortality in IPHC Regulatory Area 2A. Groundfish fisheries in IPHC Regulatory Area 2A are managed by NOAA Fisheries, following advice and recommendations developed by the Pacific Fishery Management Council (PFMC). Pacific halibut non-directed commercial discard mortality in the trawl IFQ fishery (also called trawl catch shares) in this area is capped at 45 tonnes or 100,000 pounds of O32 (> 32 inches fork length; 81.3 cm) Pacific halibut.

USA (IPHC Regulatory Area 2C; Southeast Alaska)

NOAA Fisheries reported non-directed commercial discard mortality by hook-and-line vessels fishing in the outside (federal) waters of IPHC Regulatory Area 2C in 2019. 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 contribute to the amount of non-directed commercial discard mortality 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 2019.

USA (IPHC Regulatory Area 3; Eastern, Central, and Western Gulf of Alaska)

Trawl fisheries are responsible for the majority of the non-directed commercial discard mortality 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 non-directed commercial discard mortality, but at low levels. IPHC Regulatory Area 3 remains the area where non-directed commercial discard 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 result in observed trips not being representative of all trips.

In Regulatory Area 4, the majority of discard mortality is from the Pacific cod fishery where there is nearly 100 percent observer coverage.

USA (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 contributing to the amount of Pacific halibut non-directed commercial discard mortality. 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, non-directed commercial discard mortality estimates for IPHC Regulatory Area 4 fisheries are considered reliable. Pots are used to fish for Pacific cod and sablefish and fish very selectively. Non-directed commercial discard mortality rates are quite low and survival is relatively high. Within the Bering Sea, the non-directed commercial discard mortality has typically been the highest in IPHC Regulatory Area 4CDE due to the groundfish fishery in the area.

Fishery-independent survey activities

IPHC uses information from its own fishery-independent setline survey as well as from surveys conducted by other agencies.

Every year the International Pacific Halibut Commission (IPHC) conducts a fishery-independent setline survey (FISS or setline survey), participates in NOAA Fisheries (National Oceanic and Atmospheric Administration 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)

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.

IPHC Setline Survey Specialist Noelle Rucinski collects hook-by-hook data during the FISS aboard the chartered *F/V Free to Wander*. Photo by Chris Noren.

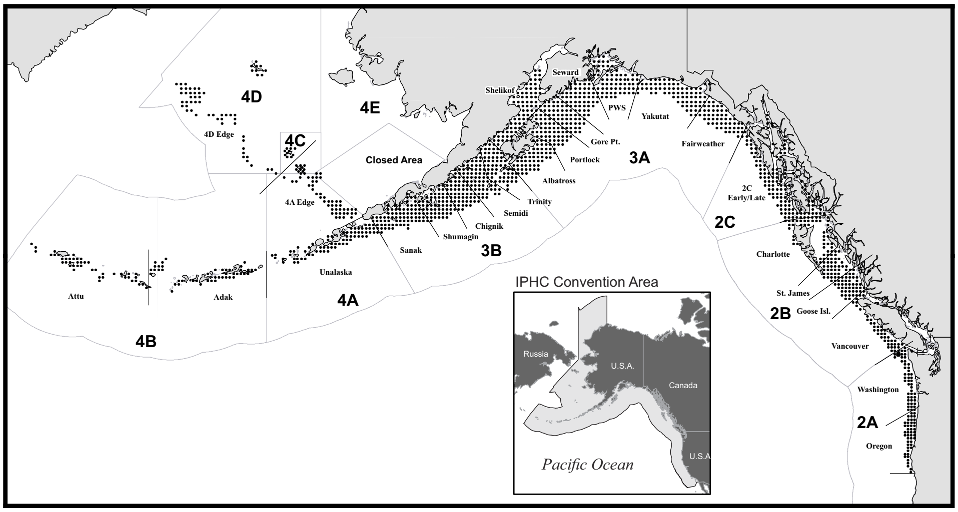


Figure 1. Charter regions and stations fished during the 2019 IPHC fishery-independent setline survey.

Design and procedures

The 2019 IPHC fishery-independent setline survey (FISS) covered both nearshore and offshore waters of Oregon, and Washington, USA, British Columbia, Canada, and Alaska, USA, including southeast Alaska, the central and western Gulf of Alaska, Aleutian Islands, and the Bering Sea continental shelf (Figure 1). The IPHC chartered 18 commercial longline vessels for FISS operations. During a combined 97 trips and 870 charter days, these vessels fished 27 charter regions. Each region required between 17 and 57 days to complete.

Standardized fishing practices have been in place since the IPHC FISS began, to ensure that direct comparisons can be made across years and among areas.

The FISS was conducted via stations arranged in a grid of 10x10 nautical miles with a depth range of 36 to 503 metres or 20-275 fathoms in most areas. In 2019, an additional 89 stations were added to IPHC Regulatory Area 3A and 66 stations to Regulatory Area 3B 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 from 10-400 fathoms. IPHC Regulatory Area 2A included eight extra stations in a densified grid for rockfish sampling with Washington Department of Fish and Wildlife. Each FISS station in IPHC Regulatory Area 2C was fished twice for a gear-comparison study (once with fixed gear and once with snap gear in random order). Of the 1,546 FISS stations planned for 2019, a total of 1,494 (97%) 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 FISS station in all charter regions. Each vessel conducting FISS work set 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 results, as were sets for which predetermined limits for lost gear, snarls, depredation, or displacement were exceeded. Other than the vessels using snap gear for the gear comparison work, FISS gear consisted of fixed-hook, 549 metre (1,800-foot) skates with 100 circle hooks of size 16/0 spaced 5.5 metres (18 feet) apart. The length of the gangions ranged from 61 to 122 centimetres (24 to 48 inches). Each hook was baited with 0.11 to 0.15 kilograms (1/4 to 1/3 pounds) of chum salmon.

Chartered survey vessel *Free to Wander*. Photo by Chris Noren.

Sampling protocols

Following protocols set out in the 2019 Fishery-Independent Setline Survey Manual, shipboard Setline Survey Specialists 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 Setline Survey Specialists recorded hook status (hook occupancy data to species or whether the hook was pulled up empty) for the first 20 consecutive hooks of each skate.

All O32 Pacific halibut and a subsample of U32 fish were processed for a variety of data including otoliths, sex, maturity, and previous injury.

Setline Survey Specialists recorded lengths and weights 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 FISS has always been No. 2 semi-bright (Alaska Seafood Marketing Institute grades A through E), headed and gutted, and individually quick-frozen chum salmon. In August 2018, the IPHC Secretariat began arranging bait purchases for the 2019 FISS. Approximately 185 tonnes (400,000 pounds) of chum salmon were utilized from three suppliers. Bait usage was based on 0.17 kilograms (0.37 pounds) per hook, resulting in approximately 117 kilograms (259 pounds) per seven-skate station. Bait quality was monitored and documented throughout the season and found to have met the standard as described above.

Fish sales

O32 (fork length ≥ 32 inches or 81.3 cm) Pacific halibut caught during the FISS have historically been kept and sold as a way to offset the cost of the work. In 2019, most vessel contracts contained a lump sum payment along with a 10 percent share of the Pacific halibut proceeds. Rockfish and Pacific cod landed incidentally during the FISS were also kept, because they rarely survive the trauma of capture and release. Proceeds from retained catch captured in USA waters were 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 of the non-Pacific halibut retained catch proceeds, but paid a processing fee to those vessels. The IPHC did not keep any proceeds from the sale of these species.

During the 2019 FISS, IPHC's chartered vessels delivered a total of 388 tonnes (854,948 pounds) of Pacific halibut to 23 different ports. The coastwide average price per kilogram was $12.33 USD or $5.59 USD per pound, amounting to sales totaling $4.8 million USD.

IPHC survey deliveries totalled just under 855 thousand pounds (388 t) in 2019.

Field personnel

The 2019 FISS vessels were staffed by 27 Setline Survey Specialists, who worked a total of 1,954 person-days, including travel days, sea days, and debriefing days. Typically, two setline survey specialists were aboard each FISS vessel. At a given time, one specialist handled fish, collected data, and sampled on deck, while the other setline survey specialist, in a portable shelter, recorded data and observations and stored samples collected by the specialist on deck. Three setline survey specialists were deployed on some vessels in some areas

Typical FISS sampling station set-up. Photo by Chris Noren.

to support additional data collection or special research projects. The IPHC also deployed four specialists on the NOAA Fisheries (AFSC) trawl survey—two on the *F/V Ocean Explorer* for four 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.

Additional research projects

In addition to core operations, the FISS provides 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.

In addition to the core data collection, there are a number of special projects carried out during the survey. Some of these are internal to the IPHC and some are collaborative projects with other entities.

IPHC Fishery-Independent Setline Survey (FISS) results

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

Weight and number per unit effort (WPUE)

As a result of including both commercial and non-commercial fishing grounds, the FISS results show an average weight per unit effort (WPUE) for all IPHC Regulatory Areas below that of the directed commercial Pacific halibut fleet (Table 8).

Table 8. The average total raw WPUE for each of the IPHC Regulatory Areas during the FISS 2019.

Regulatory Area	kg/skate	lb/skate	Station Count
2A	10	22	104
2B	34	74	165
2C	73	161	249
3A	42	92	426
3B	29	64	278
4A	20	45	104
4B	22	49	89
4CDE and Closed	15	34	79

Non-Pacific halibut catch

Around 115 species of fish and invertebrates were captured as bycatch by the IPHC FISS. The predominant incidental catches in IPHC Regulatory Areas 2A, 2B, 2C, and 3A were sharks, primarily spiny dogfish (*Squalus suckleyi*). The most frequent incidental catch in IPHC Regulatory Areas 3B, 4A, and 4CDE was Pacific cod (*Gadus microcephalus*). 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 46 percent of Pacific halibut caught during the IPHC FISS were smaller than the current commercial legal size limit (U32) with a median fork length of 74 cm (29 inches). In 2019, median length decreased in IPHC Regulatory Areas 2A, 2B, 2C, 3A, 4A, 4B, and 4CDE and was unchanged in 3B. No IPHC Regulatory Area saw an increase in median length. IPHC Regulatory Areas 3A, 3B, and 4A had median lengths below the legal-size limit. The largest median length was in IPHC Regulatory Area 2C (92 cm or 36.2 inches).

The sex composition of FISS-caught O32 Pacific halibut varied widely among IPHC Regulatory Areas, ranging from 41 (4B) percent to 82 (2C and 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 Areas 2C and 4CDE 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.

Fishery-Independent Setline Survey expansions in 2019

In 2019, 89 expansion stations were surveyed in IPHC Regulatory Area 3A and 66 in Area 3B. This marked the end of the IPHC's 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, moved the FISS into deep (275-400 fathoms; 503-731 m) and shallow (10-20 fathoms; 18-37 m) waters, and into spatial gaps in the 20-275 fathom (37-503 m) depth range not covered by the previous standard 10-nautical-mile station grid. Observations showed that there was significant commercial harvest in deep waters, particularly in IPHC Regulatory Area 4A, and in shallow waters in some areas. It was apparent that the previous FISS range did not cover the entirety of Pacific halibut habitat. Other gaps within the 20-275 fathom (37-503 m) range were at times substantial, particularly in IPHC Regulatory Areas 2B and 4.

This was the final year of the 6-year effort to expand the stations fished to include areas previously not covered by the FISS.

NOAA Fisheries groundfish bottom trawl surveys

Annual Bering Sea shelf and northern Bering Sea extension

The IPHC has participated in the National Oceanic and Atmospheric Administration (NOAA) Fisheries groundfish bottom trawl survey on the eastern Bering Sea shelf annually since 1998. Bottom trawl surveys tend to capture Pacific halibut smaller than those caught during either the commercial fishery or the IPHC fishery-independent setline survey, and the data serves as an additional data source, verification tool, and forecasting tool for Pacific halibut stock analysis. Northern extension stations have been added periodically to assess the abundance and extent of species in the northern Bering Sea. Prior northern extensions took place in 2010, 2017, and a modified grid was employed in 2018 in the north in response to reports of significant northward movement of some species. The 2018 results are not included in the time series results reported here due to data comparability issues.

Sorting the catch on the *F/V Vesteraalen*. Photo by Zach Kelleher.

Two vessels conducted the standard and northern surveys: *F/V Vesteraalen*, and *F/V Alaska Knight*. The IPHC Setline Specialist was aboard the *F/V Vesteraalen* for the standard survey and the *F/V Alaska Knight* for the northern extension. A total of 546 otoliths were collected for aging during the standard survey along with assessments for sex, maturity, and prior hooking injuries. A total of 481 fish that were < 82 cm fork length were wire tagged and released. The IPHC Setline Survey Specialist transferred to the *F/V Alaska Knight* for the northern Bering Sea portion of the survey and sampled 54 Pacific halibut for otoltihs, and tagged and released 49 others. Additionally, during the standard survey, NOAA personnel aboard the *F/V Alaska Knight* wire tagged and released 410 Pacific halibut. The NOAA food habits laboratory collects diet samples from Pacific halibut during each survey and in 2019, IPHC coordinated with them for the IPHC sampler to also collect weights and livers from these fish to assess condition. This sample included approximately 163 fish; 24 from the northern extension and the remainder from the standard survey.

In 2019, the IPHC partnered with the NOAA food habits laboratory to coordinate biological sampling efforts and the collection of additional data such as fish weight and liver samples.

The swept-area abundance estimate for 2019 was 74.46 million fish, which reflected a substantial increase from the 50.50 million fish estimated in 2018. The majority of the increase was realized in the smaller fish < 66 cm fork length. Total biomass was estimated at 251 million pounds, which represented the continuation of an overall decrease in biomass which began in the early 2010s.

In the north, the 2019 abundance estimate of 7.99 million fish represented a 58% increase over the 2017 estimate of 5.06 million fish and a 10% increase over the 2010 estimate of 7.29 million fish. Biomass in 2019 was estimated at 56.7 million pounds which represented an increase of 42% from 2017 and 10% from 2010. The average fork length was 57.9 cm, which was larger than the 50.4 cm average fork length observed during the standard survey. Similar results were also observed in 2010 and 2017.

Biennial Gulf of Alaska survey

The NOAA Fisheries Gulf of Alaska Bottom Trawl Survey has taken place every two years since 1999 and every three years prior to that. The IPHC has participated in this survey routinely since 1996. 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. This year, two survey vessels (*F/V Ocean Explorer* and *F/V Sea Storm*) sampled the area from Islands of Four Mountains to Dixon Entrance. The IPHC sampler was deployed on the *F/V Ocean Explorer* for the duration of the survey.

A total of 1,076 otoliths were collected for aging, along with assessments for sex, maturity, and prior hooking injuries. Additionally, 821 Pacific halibut that were < 82 cm fork length were wire tagged and released. The NOAA food habits laboratory collects diet samples from Pacific halibut during each survey and in 2019, IPHC coordinated with them for the IPHC sampler to also collect weights and livers from these fish to assess condition. This sample included approximately 350 fish.

Setline survey specialist Thomas Esson sampling aboard the Gulf of Alaska NOAA Fisheries bottom trawl survey vessel *Ocean Explorer*. Photo by Steven Wang.

On the Gulf of Alaska trawl survey, which spans from Islands of Four Mountains to Dixon Entrance, IPHC Survey Specialists collected 1,076 otoliths and tagged 821 U32 Pacific halibut, among other things.

Swept-area abundance was estimated at 122.9 million Pacific halibut, which represented a slight increase from 2017. Biomass in 2019 was estimated at 659 million pounds, which was essentially unchanged from 2017. Mean fork length of caught fish for the survey was 53 cm with predominantly smaller fish caught in the west compared to the east.

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 2019, the IPHC conducted 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.

Data sources

The data for the stock assessment is based on fishery-dependent 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 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.

The stock assessment includes modern-day data sources such as fishery-dependent and fishery-indpendent data as well as historical information.

Historical data

Known Pacific halibut removals (mortality) consist of target fishery landings and discard mortality (including research), recreational fisheries, subsistence,

The schooner *F/V Polaris* arriving at the dock. Photo by Lara Erikson.

and non-targeted discard mortality (bycatch) mortality in fisheries targeting other species (where Pacific halibut retention is prohibited). Over the period 1918-2019 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, and have averaged 41 million pounds (~19,500 t) from 2016-19.

2019 fishery-dependent and fishery-independent survey data

Fishery-dependent data includes information from commercial, recreational, personal use, and non-directed commercial 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-dependent 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.

Fishery independent data includes surveys from both IPHC and other agencies.

Coastwide commercial Pacific halibut fishery landings in 2019 were approximately 24.3 million pounds (~11,000 t), up 3% from 2018[1]. NOAA Fisheries and DFO estimate discard mortality 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 non-directed discard mortality occurred in 1992, with over 20 million pounds (~9,070 t), and has mostly declined since then, with an estimated 6.4 million pounds (~2,920 t) in 2019 (a 5% increase from 2018). The total recreational removals were estimated to be 6.9 million pounds (~3,140 t), unchanged from 2018. Mortality from all sources in 2019 was estimated to be 39.7 million pounds (~18,000 t).

In 2019, new information on the sex-ratio of the commercial landings was available from the 2017 and 2018 seasons. These data represent the first comprehensive direct observations in the history of the fishery, and indicated that in the current fishery females comprise the great majority of the landings (80-82% by number).

The 2019 FISS detailed a coastwide aggregate NPUE (modelled via the space-time methodology) which showed a third consecutive year of decrease, down 4% from 2018, with individual Biological Regions ranging from a 10% decrease (Region 3) to a 5% increase (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 2018 estimate at the coastwide level, constituting the lowest value in the time series. Individual IPHC Regulatory Areas varied from a 17% decrease (Regulatory Area 3A) to a 26%

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[1] Mortality estimates reported in this section reflect information available at the end of October 2019, and used for the assessment analysis.

increase (Regulatory Area 3B). The FISS sampling associated with the expansion in Region 3 (Regulatory Areas 3A and 3B) reduced bias and improved precision in the estimated Region 3 and coastwide WPUE and NPUE time series.

Fisheries Data Specialist Binget Nilsson samples a commercial offload in Seward, AK, USA. Photo by Lara Erikson.

Commercial fishery WPUE (based on extensive, but still incomplete logbook records available for this assessment) increased 4% at the coastwide level, with mixed trends across fisheries, gears, and IPHC Regulatory Areas. A bias correction for each Regulatory Area based on the last six years of data resulting from additional logbooks available after the assessment deadline in early November resulted in an estimate of a 1% increase coastwide. 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 31 October 2019 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 2019 mortality estimates for all fisheries still operating. All preliminary data series in this analysis will be fully updated as part of the 2020 stock assessment.

Some information is treated as data in the assessment, but actually represents products of analyses themselves.

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. Due to the direct sampling of individual Pacific halibut weights in the port sampling program (beginning in 2015) and the

FISS (beginning in 2019), the weight-length relationship is used only for other sources and is currently under review.

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 a higher average recruitment of younger fish. The PDO's longest "negative" phase since the late 1970s occurred from 2006 through 2013. Positive values were observed over 2014-19; however, it is unclear if this represents a change of phase or a different set of environmental conditions altogether.

The age at which female Pacific halibut are considered mature has been stable over time. An estimated half of the fish are mature by 11.6 years old and nearly all are mature by 17 years old.

Stock distribution estimation

This is achieved using the modelled FISS WPUE index of Pacific halibut density, weighted by the geographical extent of each IPHC Regulatory Area. To account for factors that are known to affect FISS catch rates, two adjustments to the raw WPUE prior to modelling are made for FISS 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, and are applied at the station level.

Stock distribution

Modelled survey WPUE (a proxy for density of all sizes of Pacific halibut captured by the FISS), 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 since 2004 indicate that population distribution has been decreasing in Biological Region 3, and increasing in Biological Regions 2 and 4. It is unknown to what degree current stock distribution corresponds to historical distributions from the mid-1900s or to the average distribution likely to occur in the absence of fishing mortality, as modelled survey estimates are only available beginning in 1993. From the modelled 2019 FISS, the stock distribution for Pacific halibut was estimated as shown in Table 9.

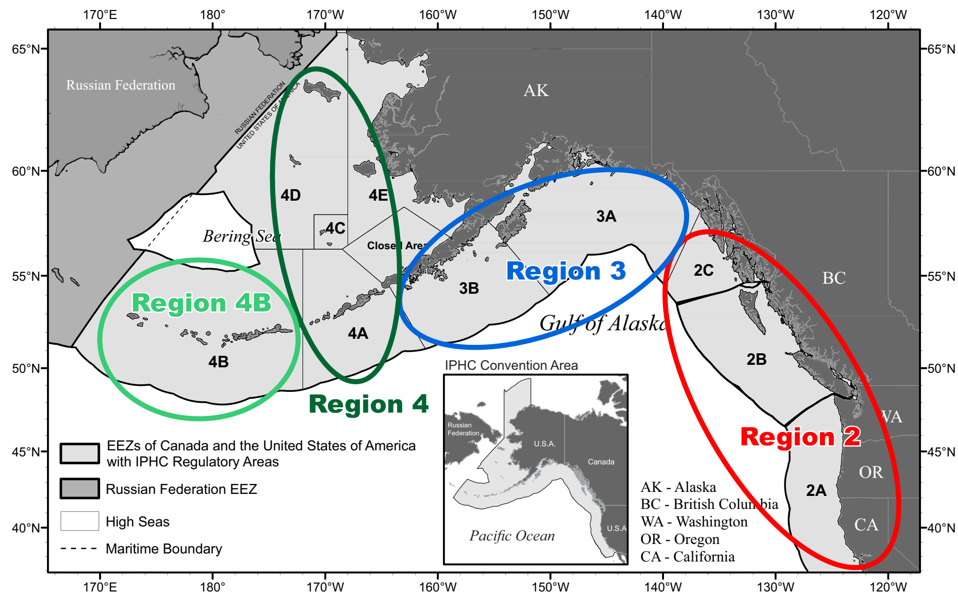


Figure 2. IPHC Regulatory Areas can be divided into four biological regions that are more meaningful for population studies.

Table 9. Recent stock distribution estimates by Biological Region based on modelling of all Pacific halibut captured by the FISS.

Year	Region 2 (2A, 2B, 2C)	Region 3 (3A, 3B)	Region 4 (4A, 4CDE)	Region 4B
2015	24.6%	51.3%	20.1%	4.0%
2016	24.7%	52.5%	18.7%	4.1%
2017	25.0%	49.2%	21.3%	4.5%
2018	24.4%	48.9%	21.5%	5.2%
2019	25.8%	46.5%	22.8%	4.8%

The ensemble approach has been used in recent assessments to better estimate the variability of the assessments, and provide flexibility into the future.

Population assessment at the end of 2019

Stock assessment

The methods for undertaking the population assessment for Pacific halibut have been improved many times over the last 30 years with the development of better model assumptions and analytical approaches. For the last eight 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).

For 2019, the stock assessment data and modelling approach was fully evaluated via an external peer review and semi-annual Scientific Board Review. Model improvements included decoupling of fishery and FISS selectivity assumptions to make use of the newly available sex-ratio from the commercial landings. Despite the new data and review, the basic assessment approach used in 2019 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. The four assessment models are 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

IPHC Quantitative Scientist Dr. Piera Carpi extracts a Pacific halibut otolith during the FISS. Photo by Al Pazar.

There are currently four models used in the ensemble, and all are equally weighted.

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 2019 stock assessment indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2012. 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) stabilised near 200 million pounds (~90,700 t), the stock is estimated to have increased gradually to 2016. The SB at the beginning of 2020 is estimated to be 194 million pounds (~87,850 t), with an approximate 95 percent confidence interval ranging from 133 to 248 million pounds (~60,500-112,500 t) (Figures 3 and 4). Comparison with previous stock assessments indicates that the 2019 results are very close to estimates from the 2012 through 2018 assessments, all of which lie very close to the median estimate.

Based on the two long time-series models, average Pacific halibut recruitment is estimated to be higher (69 and 76 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 2019 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.

Recruitment in 2005 represented a level above the recent average, and that year class has been the most numerically abundant in both the FISS and directed fisheries in recent years. From 2006-10 recruitments are estimated to have been much lower, well-below the 30-year average and will contribute to decreasing fishery yields and spawning biomass in the near future as they replace the 2005 year class. Based on observations from 2018-19, slightly better recruitment is estimated to have occurred in 2011-12, but still below the 2005 level.

Reference points

As part of the full assessment and review process for 2019, the IPHC updated the basis for its relative spawning biomass reference points from a fixed historical value to a 'dynamic' calculation that incorporates the biology and recruitment history in the current stock. A comparison of the median 2020 ensemble SB to reference levels specified by the interim management procedure suggests that the stock is currently at 32 percent (approximate 95 percent credible range = 22-46 percent) of levels likely to occur in the absence of fishing mortality. The probability that the stock is below the SB30 percent level is estimated to be 46 percent, with less than a 1 percent chance that the stock is below SB20 percent.

The 2005 year class of Pacific halibut represented above average abundance, but as they age and move out of the commercial fishery, they will be replaced by year classes that are estimated to be significantly lower.

The two long time-series models (coastwide and areas-as-fleets) show different results when comparing the current stock size to that estimated at the historical low in the 1970s. The AAF model estimates that recent stock sizes are below those levels, and the coastwide model above. The relative differences among models reflect both the uncertainty in historical dynamics as well as the importance of spatial patterns in the data and population processes, for which all of the models represent only simple approximations.

The recent time-series shows that the 2019 estimate corresponds to slightly lower fishing intensity (F42%) than the average 2014-2016 (now estimated at F41%).

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. Although this is an improvement over the use of a single assessment model, there are important sources of uncertainty that are not included.

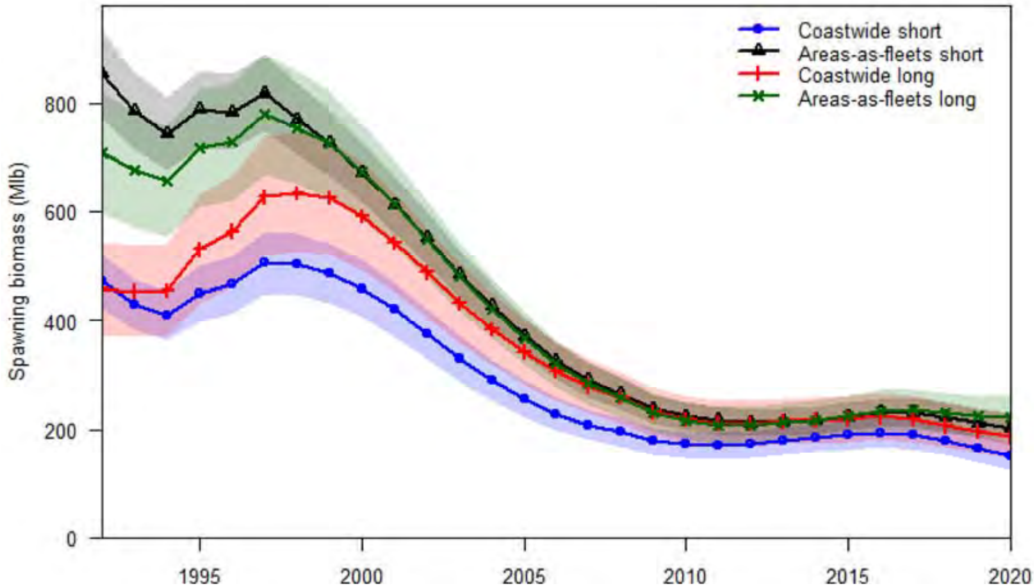


Figure 3. Estimated spawning biomass trends (1992-2020) based on the four individual models included in the 2019 stock assessment ensemble. Series indicate the maximum likelihood estimates; shaded intervals indicate approximate 95% credible intervals.

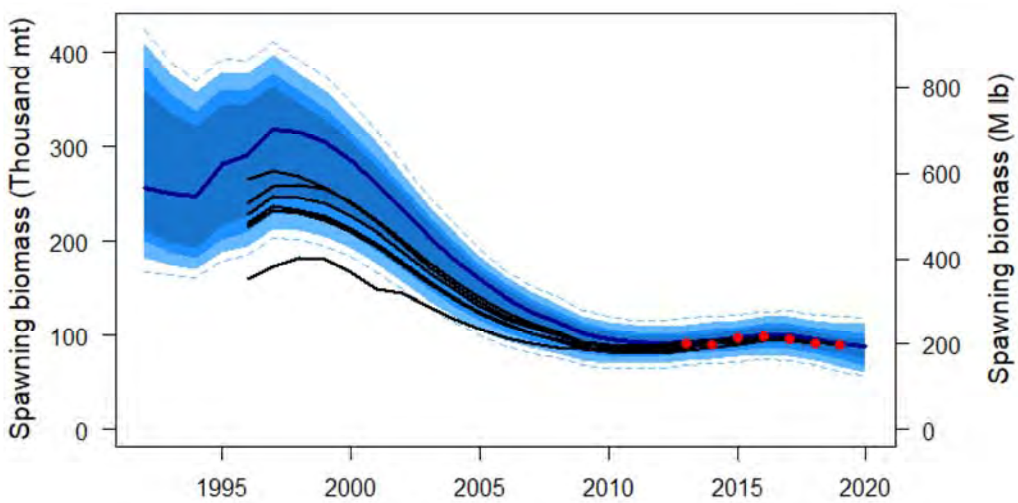


Figure 4. Retrospective comparison among recent IPHC stock assessments. Black lines indicate estimates of spawning biomass estimated by assessments conducted from 2012-2018 with the terminal estimate shown as a point, the shaded distribution denotes the 2019 ensemble: the dark blue line indicates the median (or "50:50 line") with an equal probability of the estimate falling above or below that level; colored bands moving away from the median indicate the intervals containing 50/100, 75/100, and 95/100 estimates; dashed lines indicate the 99/100 interval.

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.

Two primary uncertainties continue to hinder our current understanding of the Pacific halibut resource: 1) the sex-ratio of the commercial catch (not sampled historically 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. The 2019 assessment utilizes two years (2017-18) of sex-ratio information from the directed commercial fishery landings. However, uncertainty in historical ratios, and the degree of variability likely present in those and future fisheries remains unknown. Additional years of data are likely to further inform selectivity parameters and cumulatively reduce uncertainty in stock size in the future. The treatment of spatial dynamics and movement rates among Biological Regions, which are represented via the coastwide and AAF approaches, has large implications for the current stock trend, as evidenced by the different results among the four models comprising the stock assessment ensemble.

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. This assessment also does not include mortality, trends or explicit demographic linkages with Russian waters, although such linkages may be increasingly important as warming waters in the Bering Sea allow for potentially important exchange across the international border.

Maturation schedules are currently under renewed investigation by the IPHC. Currently used historical values are based on visual field assessments, and the simple assumption that fecundity is proportional to spawning biomass and that Pacific halibut do not experience appreciable skip-spawning (physiologically mature fish which do not actually spawn due to environmental or other conditions). To the degree that maturity, fecundity or skip spawning may be temporally variable, the current approach could result in bias in the stock assessment trends and reference points. New information will be incorporated as it becomes available; however, it may take years to better understand these biological processes.

Due to the many remaining uncertainties in Pacific halibut biology and population dynamics, a high degree of uncertainty in both stock scale and trend will continue to be an integral part of an annual management process. Potential solutions include management procedures that utilize multi-year management approaches, which are being tested with the MSE framework.

Outlook

Stock projections were conducted using the integrated results from the stock assessment ensemble in tandem with summaries of the 2019 directed fisheries and other sources of mortality. The stock is projected to decrease with at least a 51% chance over the period from 2021-23 for all TCEYs greater than the "3-year surplus" of 18.4 million pounds (~8,350 t). The decision table (Table 10) includes a range of harvest levels and risk assessments, including the 'reference' Spawning Potential Ratio (SPR=46%). The TCEY corresponding to the reference SPR (31.9 million pounds, ~14,470 t, total removals) corresponds to a 89/100 (89 percent) chance of stock decline in 2021 and a 46 percent chance of at least a five percent decline through 2021. There is up to a one-half chance (<50/100; 50 percent) that the stock will decline below the trigger reference point ($SB_{30\%}$) in projections for all the levels of TCEY up to the status quo of 38.6 million pounds (~17,509 t) evaluated over three years; for TCEYs exceeding that level, the probability begins to increase rapidly.

Scientific advice

Current female spawning biomass, which is estimated to have been declining overall since 2016, is currently estimated to be 194 million pounds.

Sources of mortality

In 2019, total Pacific mortality due to fishing was up slightly to 39.67 million pounds (17,996 t) from 38.5 million pounds (17,461 t) in 2018 (updated for this assessment). Of that total, 81% comprised the retained catch, down from 82% in 2018.

Fishing intensity

The 2019 mortality corresponded to a point estimate of SPR = 42%; there is a 59% chance that fishing intensity exceeded the IPHC's reference level of 46%. The Commission does not currently have a coastwide fishing intensity limit 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 relative female spawning biomass estimated to be above and not approaching SB20%, the stock is classified as '**not subject to overfishing**'.

Stock status (spawning biomass)

Current female spawning biomass is estimated to be 194 million pounds (87,856 t), which corresponds to an 46% chance of being below the IPHC trigger reference point of $SB_{30\%}$, and less than a 1% chance of being below the IPHC limit reference point of $SB_{20\%}$. The stock is estimated to have been declining since 2016 and is currently at 32% of the unfished state. Therefore, the stock is considered to be '**not overfished**'. Projections indicate that mortality consistent with the interim management procedure reference fishing intensity ($F_{46\%}$) is likely to result in further declining biomass levels in the near future.

Stock distribution

The proportion of the coastwide stock represented by Biological Region 3 has been decreasing since 2004, with Biological Regions 2 and 4 increasing.

Table 10. Harvest decision table for 2020 mortality limits. 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.

2020 Alternative					3-Year Surplus				*Reference SPR=46%*						Status quo		
		Total mortality (M lb)	0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
		TCEY (M lb)	0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
		2020 fishing intensity	$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
		Fishing intensity interval	–	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Stock Trend (spawning biomass)	In 2021	Is less than 2020	1	29	61	71	79	87	89	91	93	94	95	96	97	>99	a
		Is 5% less than 2020	<1	<1	11	23	30	42	46	50	54	58	61	64	67	98	b
	In 2022	Is less than 2020	<1	16	50	60	68	77	79	81	83	85	87	89	90	>99	c
		Is 5% less than 2020	<1	1	23	33	45	59	61	64	66	68	69	71	74	99	d
	In 2023	Is less than 2020	1	22	50	58	65	73	75	77	79	81	83	85	87	>99	e
		Is 5% less than 2020	<1	6	33	43	53	62	64	66	67	69	71	73	75	99	f
Stock Status (Spawning biomass)	In 2021	Is less than 30%	35	39	43	44	46	47	48	48	48	48	48	49	49	51	g
		Is less than 20%	<1	<1	<1	<1	<1	1	1	1	2	2	2	3	3	16	h
	In 2022	Is less than 30%	26	31	40	43	46	48	48	49	49	49	49	50	50	54	i
		Is less than 20%	<1	<1	<1	1	2	6	7	8	9	11	12	14	15	27	j
	In 2023	Is less than 30%	18	27	37	41	45	48	49	49	49	49	50	50	50	60	k
		Is less than 20%	<1	<1	<1	2	6	13	15	17	18	20	21	22	23	40	l
Fishery Trend (TCEY)	In 2021	Is less than 2020	0	<1	11	24	36	50	51	52	54	57	59	63	67	>99	m
		Is 10% less than 2020	0	<1	1	12	25	40	44	46	48	50	51	52	53	>99	n
	In 2022	Is less than 2020	0	<1	11	25	39	50	51	52	54	56	59	62	66	>99	o
		Is 10% less than 2020	0	<1	2	14	27	43	46	48	49	50	51	52	54	>99	p
	In 2023	Is less than 2020	0	<1	13	27	41	50	51	52	54	56	58	61	65	>99	q
		Is 10% less than 2020	0	<1	4	16	30	45	47	48	49	50	51	52	54	>99	r
Fishery Status (Fishing intensity)	In 2020	Is above $F_{46\%}$	0	<1	7	22	31	48	50	51	53	55	57	60	64	>99	s

Although comprising 46.5% of the coastwide surveyed biomass in 2019, the decreasing trend suggests that surplus production has likely been exceeded in Biological Region 3 over the last 15 years to a greater degree than in other Biological Regions.

Future research in support of the stock assessment

Research priorities for the stock assessment and related analyses have been consolidated with those for the IPHC's MSE and the Biological Research program. These ranked and categorized priorities will soon be available on the IPHC's website (https://www.iphc.int).

IPHC is working to coordinate research priorities throughout the organization.

Kodiak-based Fisheries Data Specialist Dave Jackson and Quantitative Scientist Dr. Ian Stewart take in the display at ComFish Alaska in Kodiak, AK, USA. Photo by Lara Erikson.

Harvest strategy policy

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 IPHC Convention Area. The policy uses a management procedure that incorporates science and policy 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.

The IPHC harvest strategy includes separating the coastwide fishing intensity, or scale, and the distribution of fishing mortality which allows Commissioners to separate the decision of coastwide fishing intensity from distributing the catch.

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 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.

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 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 2019, the MSAB proposed primary coastwide and area-specific objectives, defined management procedures for testing in 2020, and further 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) and to update the reference fishing intensity in the interim management procedure to 43%. The MSAB also recommended that future work continue to examine 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 reporting final MSE results and recommendations on a coastwide fishing intensity and the distribution of the TCEY to the Commission in January 2021, for potential adoption and implementation.

The MSE process at IPHC includes input from stakeholders and managers from varying interests in order to provide the best advice possible to Commissioners on how to achieve objectives defined by all involved parties.

The Management Strategy Advisory Board met twice in 2019, once in Sitka, AK and once at IPHC Headquarters in Seattle, WA, USA. Photo by Edward Henry.

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 the IPHC are guided by a 5-year research plan that addresses core IPHC 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 11).

Table 11. 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

Photo by Piera Carpi.

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.

A total of 1,760 U32 Pacific halibut were wire tagged and released in 2019.

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 2019, a total of 1,760 small Pacific halibut (< 82 cm fork length or "U32") were tagged and released (Figure 5). Of this total, 54 U32 Pacific halibut were tagged during the FISS and 1,706 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 in the northeast Bering Sea

The IPHC has conducted a series of pop-up archival transmitting (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,

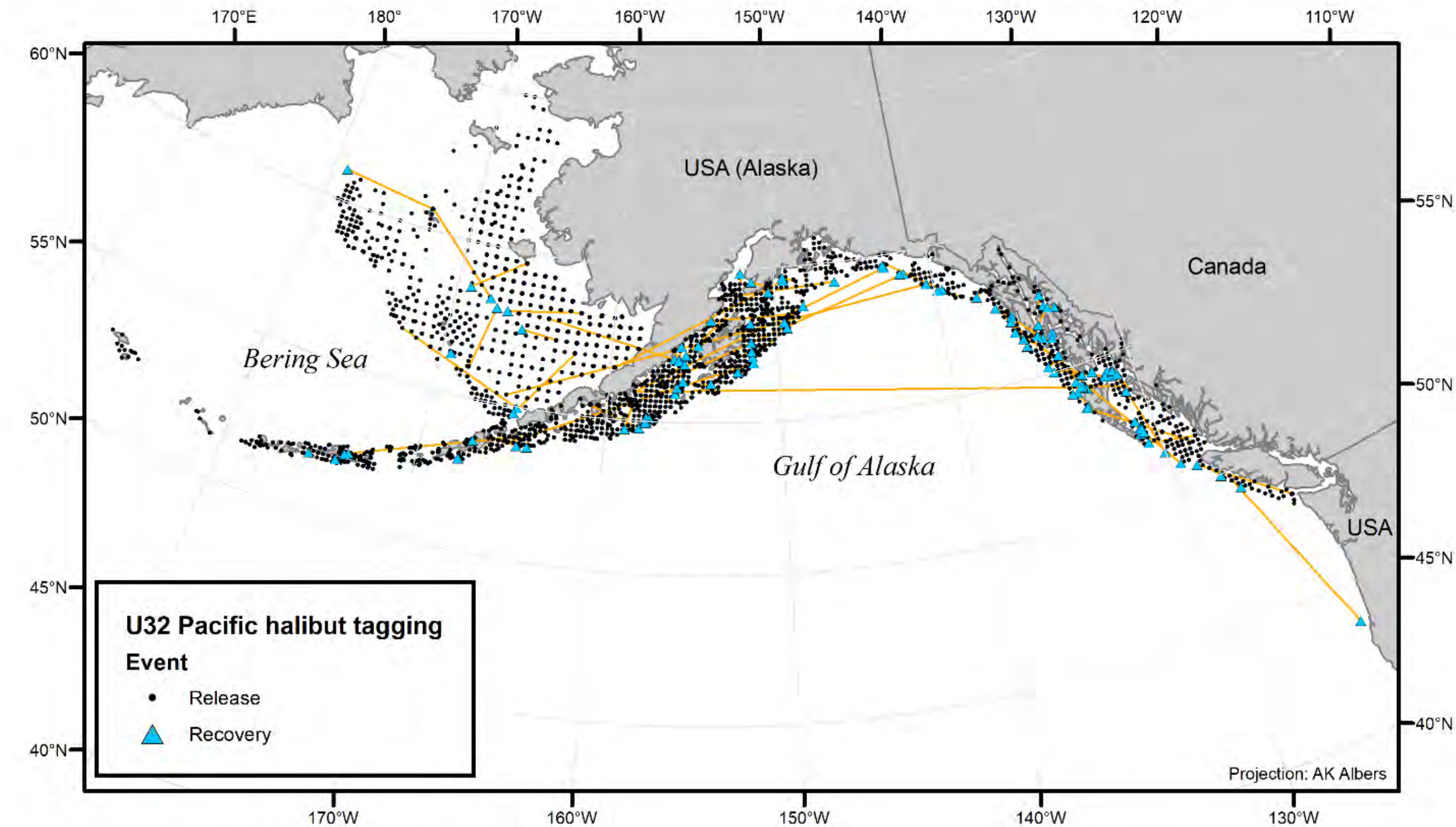


Figure 5. Tag releases and recoveries from the most recent wire tagging project at IPHC that began in 2015 to study U32 Pacific halibut migration.

and investigate mixing within the BSAI and between the Bering Sea and Gulf of Alaska. In 2019, the IPHC entered into collaboration with Norton Sound Economic Development Corporation (NSEDC) and the University of Alaska Fairbanks (UAF) to expand PAT tagging into IPHC Regulatory Area 4E, with attention to local dispersal, potential connectivity between US and Russian waters, and the effects of climate forcing on recruitment and migration patterns. Pacific halibut were tagged in the Norton Sound and St. Lawrence Island regions (n = 41); with the IPHC providing (27) tags and NSEDC providing the remaining tags and funding for vessel charters and deployment logistics. The PAT tags were programmed to release from their host fish and report their location and archived data during three periods: January 2020 (representing the spawning season); summer of 2020 (investigating site fidelity versus emigration); and summer of 2021 (examining longer-term dispersal). Tags provided by the IPHC were used to tag relative small fish (i.e., 70-90 cm forklength) and were accompanied by tagging of larger (>100 cm forklength) Pacific halibut using the tags that were purchased by NSEDC. The releases were designed to produce data that will be comparable to the IPHC's prior BSAI PAT-tagging research, while expanding the work to examine a considerably broader stock demographic than any prior electronic tagging experiment. Funding has also been secured to support a project-dedicated graduate student (MSc) through UAF.

IPHC collaborated with NSEDC and the University of Alaska Fairbanks to gain a better understanding of local dispersal in Area 4E.

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. In 2019, a total of 50 additional archival tags were deployed on Pacific halibut captured in specific regions during the NMFS Bering Sea trawl survey.

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 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.

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

Throughout the fishery's history, the sex ratio of commercially-caught Pacific halibut has remained unknown as landed individuals are eviscerated at sea and otherwise sexually indistinguishable. Historically, the sex ratio from the IPHC's fishery independent setline survey (FISS) has been the only direct source of sex-ratio information, but differences in size between individuals landed commercially and on the FISS suggested a greater proportion of females in the fishery.

To obtain accurate sex information, the IPHC collaborated with geneticists at the University of Washington to develop a genetic protocol to determine sex from small tissue samples taken from commercially caught fish. Two genetic markers were identified to be good indicators and the molecular assays developed for them were applied to over 20,000 random commercial samples from 2017 and 2018.

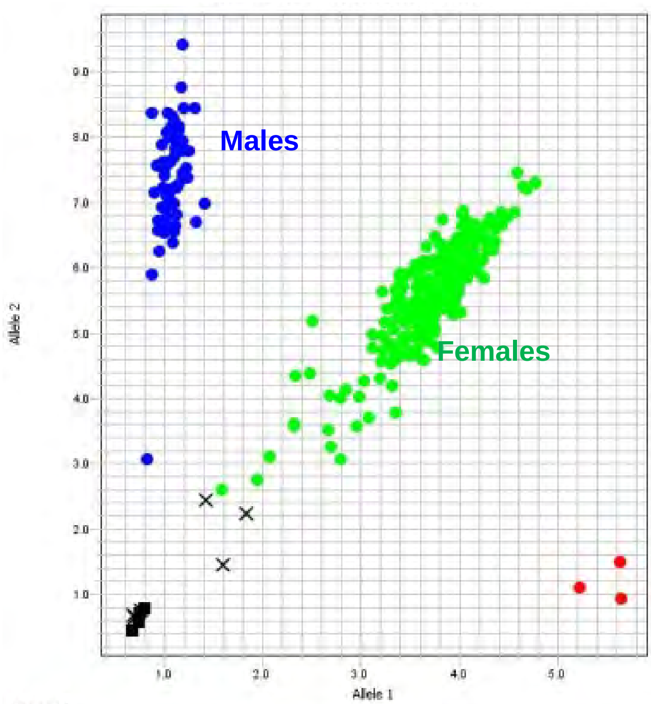


Figure 6. Sex ratio of the commercial catch is now determined genetically using fin clips. This figure shows the output of all samples taken during the commercial fishery in 2017 and 2018. Legend: Blue dots - Males; Green dots - Females; Black and red - outliers/undetermined

Genetic sampling of the 2017 commercial catch found that between 65-97% were female depending on Regulatory Area. Results from the 2018 catch were similar.

The results of the study indicate the commercial catch of Pacific halibut in 2017 was 81% female, varying from 65% female in region 4B to 97% female in region 4CDE. Similar values were found for the 2018 commercial catch with only minor variations (Figure 6). This genotyping project will be continued with the samples from 2019 and future years, with all data incorporated into future stock assessments.

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 may introduce an unknown 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 describing the entire range of oocyte stages and 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.

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, including gonadal samples for histological assessment of maturity. The biological information collected in this project will allow us to conduct a revision of maturity schedules and to compare macroscopic and microscopic (i.e. histological) ovarian staging. To date, we have completed the analysis of the temporal progression of the four maturity classification stages (macroscopic) used for staging females in the IPHC FISS and of the gonadosomatic index

The results of a physiological characterization of the Pacific halibut reproductive cycle will allow IPHC to revise maturity schedules that have been historically used and are based on macroscopic observations only.

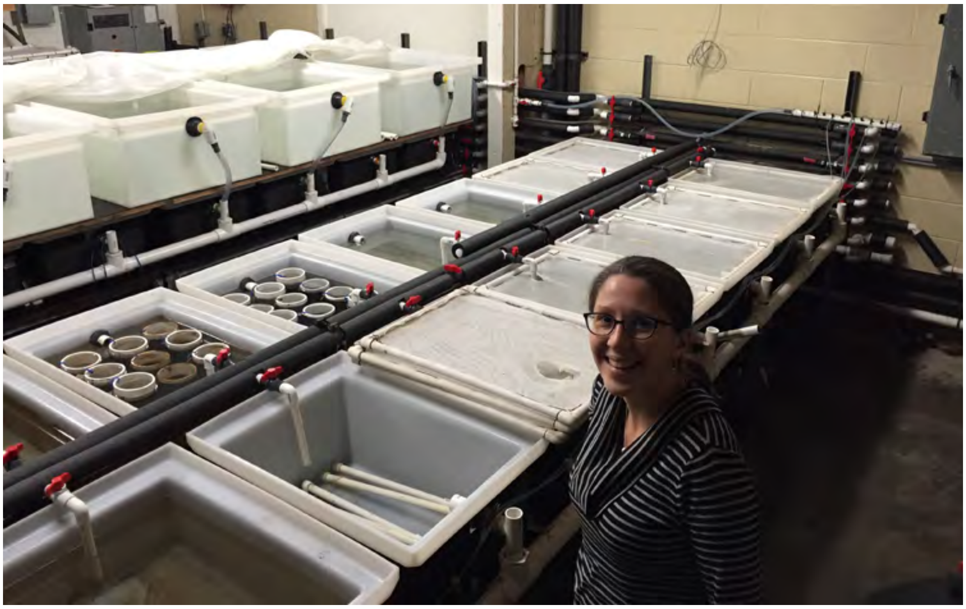
Reproductive tissue samples. Photo by Lara Erikson.

(gonad weight/round weight x 100; GSI) as well as the hepatosomatic index (liver weight/round weight x 100; HSI) for both females and males. The results obtained indicate that macroscopic maturity classification captures changes in the maturity status of female Pacific halibut during an entire reproductive cycle, with females being increasingly classified as maturing from July onwards and with ripe females only present in January and February, consistent with the expected peak in spawning during this period. The GSI in females increases gradually from July until just prior to the spawning time, when the highest GSI levels are highest (close to 10%), and changes in GSI reflect the increase in ovarian size during ovarian development. In contrast, the highest levels of HSI are found in September and October, coinciding with the peak of vitellogenesis. Current efforts are devoted to complete the microscopic staging of females throughout an entire reproductive cycle based on the histological assessment of ovarian samples and to compare it with the results of the macroscopic staging. Future efforts involve the analysis of additional reproductive markers to assist with ovarian staging. 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, and will result in improved estimates of the actual spawning biomass.

Growth studies are taking place at IPHC that look at age-specific growth patterns over time, space, and under different environmental conditions.

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 aims at identifying key 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. In summary, temperature acclimation laboratory studies were conducted at the Hatfield Marine Science Center in Newport, OR in collaboration with scientists from the Alaska Fisheries Science Center under the framework of a research grant funded by the North Pacific Research Board to the IPHC. These studies resulted in the successful manipulation of growth patterns: growth suppression by acclimation to low water temperature and growth stimulation by temperature-induced growth compensation in juvenile Pacific halibut. White skeletal muscle samples from the control and treatment groups resulting from the two types of growth manipulations were collected and processed for transcriptomic (i. e. RNAseq) and proteomic analyses. Temperature induced growth suppression resulted in a



IPHC Age Lab Technician Dana Rudy prepares to process growth study samples at the Hatfield Marine Science Laboratory in Newport, OR, USA. Photo by Josep Planas.

significantly decrease in the mRNA expression levels of 676 annotated genes and in a significantly decrease in the abundance of 150 annotated proteins. In contrast, temperature-induced growth stimulation resulted in a significant increase in the mRNA expression levels of 202 annotated genes and a significant increase in the abundance of 149 annotated proteins. Based on the transcriptomic results, a set of potential growth marker genes has been selected for validation by qPCR as well as a set of potential housekeeping genes for normalization of expression levels. The identified growth marker genes will be tested using muscle samples from wild-caught Pacific halibut in order to validate the use of these markers to monitor growth patterns in the wild.

IPHC is researching the role of temperature, density, and stress as possible influencers of growth.

Other studies that the Secretariat is conducting with regards to the study of factors that may result in growth alterations involve investigating the effects of density and handling stress on somatic growth. In particular, additional laboratory experiments were conducted in which juvenile Pacific halibut were held in groups of 8 fish per tank (with 4 replicate tanks), 4 fish per tank (with 4 replicate tanks) and also individually (with 10 replicate tanks) under restricted feeding (at 50% of maximal feeding rate) for a period of 6 weeks. White skeletal muscle samples and liver samples were collected from fish at different densities and target gene expression analyses by qPCR are currently being conducted. Our studies evaluating the effects of handling stress on somatic growth involved air exposure of juvenile Pacific halibut and white muscle samples from fish exposed or not to air were collected for analysis of growth marker gene expression. These studies will allow (1) the identification of genes whose expression is indicative of growth changes and (2) the identification of common or unique responses to the different growth manipulations (i.e. temperature- versus density- or stress-induced).

Discard mortality and survival

Discard mortality rates in the directed Pacific halibut fishery

In order to better estimate post-release survival of Pacific halibut caught incidentally in the directed longline fishery, the IPHC Secretariat is conducting investigations to understand the relationship between fish handling practices and fish physical and physiological condition and survival post-capture as assessed by tagging. We initially evaluated the effects of different release techniques (i.e. careful shake, gangion cutting, hook stripper) on injury levels and the results indicate that a majority (more than 70%) of Pacific halibut released by careful shake and by gangion cutting are classified in the excellent injury category. In contrast, Pacific halibut that encounter the hook stripper are primarily classified in the medium and poor injury categories. In addition, the physiological condition of Pacific halibut subjected to the different hook release techniques is currently being assessed by relating the injury category assigned to each fish with the condition factor, fat levels and levels of stress indicators in the blood (e.g. glucose, lactate and cortisol). We also conducted biotelemetric monitoring of released fish with the use of satellite-transmitting electronic archival tags equipped with accelerometers in order to estimate survival. The results obtained from 79 Pacific halibut allowed us to estimate that the discard mortality rate of Pacific halibut that were categorized as being in excellent-condition at the time of their release was approximately 4%.

Accelerometer tags allowed the estimation of a discard mortality rate associated with an "excellent" condition rating upon release.

IPHC Research Biologist Claude Dykstra and researchers at Alaska Pacific University investigate the effects of discard stress in Pacific halibut. Photo by Teresa Fish.

Discard mortality rates of Pacific halibut in the recreational fishery

The IPHC initiated a research project in 2019 aimed at experimentally deriving discard mortality rates from the charter recreational fishery for the first time. As an initial step in this project, information from the charter fleet on types of gear and fish handling practices was collected through stakeholder meetings and on dock interviews with charter captains and operators. This information will inform the design of the experimental test fishing that will take place in 2020 and in which mortality of discarded Pacific halibut will be estimated with the use of accelerometer satellite-transmitting tags.

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 embarked in the sequencing of the Pacific halibut genome through a combination of short and long read sequencing followed by Hi-C sequencing. Continuation of this work will result in the generation of an annotated, chromosome-level assembly of the Pacific halibut genome that will be available in 2020. These genomic tools will be instrumental for generating management-relevant information on population structure, connectivity, adaptation and response to environmental conditions, fisheries effects, among others.

Environmental monitoring

Oceanographic monitoring

This year marked the eleventh 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 Sea-Bird Scientific that collected pressure (depth), conductivity (salinity), temperature, dissolved oxygen, pH, and fluorescence (chlorophyll *a* concentration) throughout the water column. A total of 1,109 successful casts were made during the survey.

Routine post-cast maintenance on the water column profiler. Photo by Niallan O'Brien.

The coldest bottom temperature detected during the FISS in 2019 was near St. Matthew Island as seen in previous surveys, but was notably warmer at 2.5°C compared to temperatures around 0°C in years prior to 2018.

The coldest bottom temperatures are routinely found in the Bering Sea around St. Matthew Island and in past years those temperatures have typically been as low as 0°C and sometimes lower. In 2019, the coldest bottom temperature was again recorded off of St. Matthew Island, but was 2.5°C. Although this was substantially warmer than in most past years, it was colder than in 2018, when the coldest temperature around St. Matthew was 5.5°C. The Bering Sea has experienced temperatures much higher than normal in the past two summers due to lack of sea ice in the winter that typically creates a very cold pool of water as it melts. Although there was some hypoxia (very low dissolved oxygen) at deep stations, there was no hypoxia encountered at shallow stations off of the USA west coast as in some previous years.

Contaminant 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 2019, twenty nine samples from a variety of sizes were collected in the Portlock FISS charter region, 89 samples were collected in the Seward charter region, and 89 samples were collected in the Yakutat charter region. 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.

Age data collection

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

The most commonly occuring year class of Pacific halibut in the FISS otolith sample, were the 14 year olds born in 2005.

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, 15,716 were successfully aged (note, this total reflects sampled fish caught on the standard fixed hook gear and does not include 2,003 otoliths collected on snap gear). The most commonly occurring year class for both males and females was 2005 (14-year-olds), with 1,933 caught. Next most common were the year classes 2006 (13-year-olds), with 1,690 caught, and 2004 (15-year-olds), with 1,499 caught.

In 2019, the youngest and oldest Pacific halibut contained in the FISS samples were three and 50 years old, respectively. There were two fish determined to be three years old: a female from Regulatory Area 2B and a male from Area 3B, both measuring 41 cm fork length (16 inches). The 50-year-old was a male captured in Regulatory Area 4B with a fork length of 121 cm (48 inches). The maximum fork length recorded for FISS-caught Pacific halibut in 2019 was 191 cm (75 inches): a male from Regulatory Area 3B aged at 39 years. The smallest Pacific halibut sampled in the 2019 setline survey were the two previously mentioned 41-cm (16 inches) fish.

Age distribution of fish caught in the commercial fishery

In 2019, the age distribution of Pacific halibut sampled from commercial landings is based on 10,574 otoliths aged at the time of writing. The 14-year-olds from the 2005 year class were the most abundant (1,604 fish, or 15% of the total). The next most abundant year classes for all IPHC Regulatory Areas combined were 2004 and 2006, accounting for 13 and 12 percent of the sampled catch, respectively.

Average fork length of sampled Pacific halibut increased in IPHC Regulatory Areas 2A, 2B, 2C, 3A, and 4D in 2019, but decreased in all other areas. Average fork length for all areas combined decreased by 0.4 cm in 2019. The average age from all areas combined in 2019 (13.9 years) was slightly higher than it was in 2018. The youngest and oldest Pacific halibut in the 2019 commercial samples were determined to be five and 39 years old, respectively.

In the commercial ageing sample, average fork length decreased slightly overall while average age increased slightly compared to 2018.

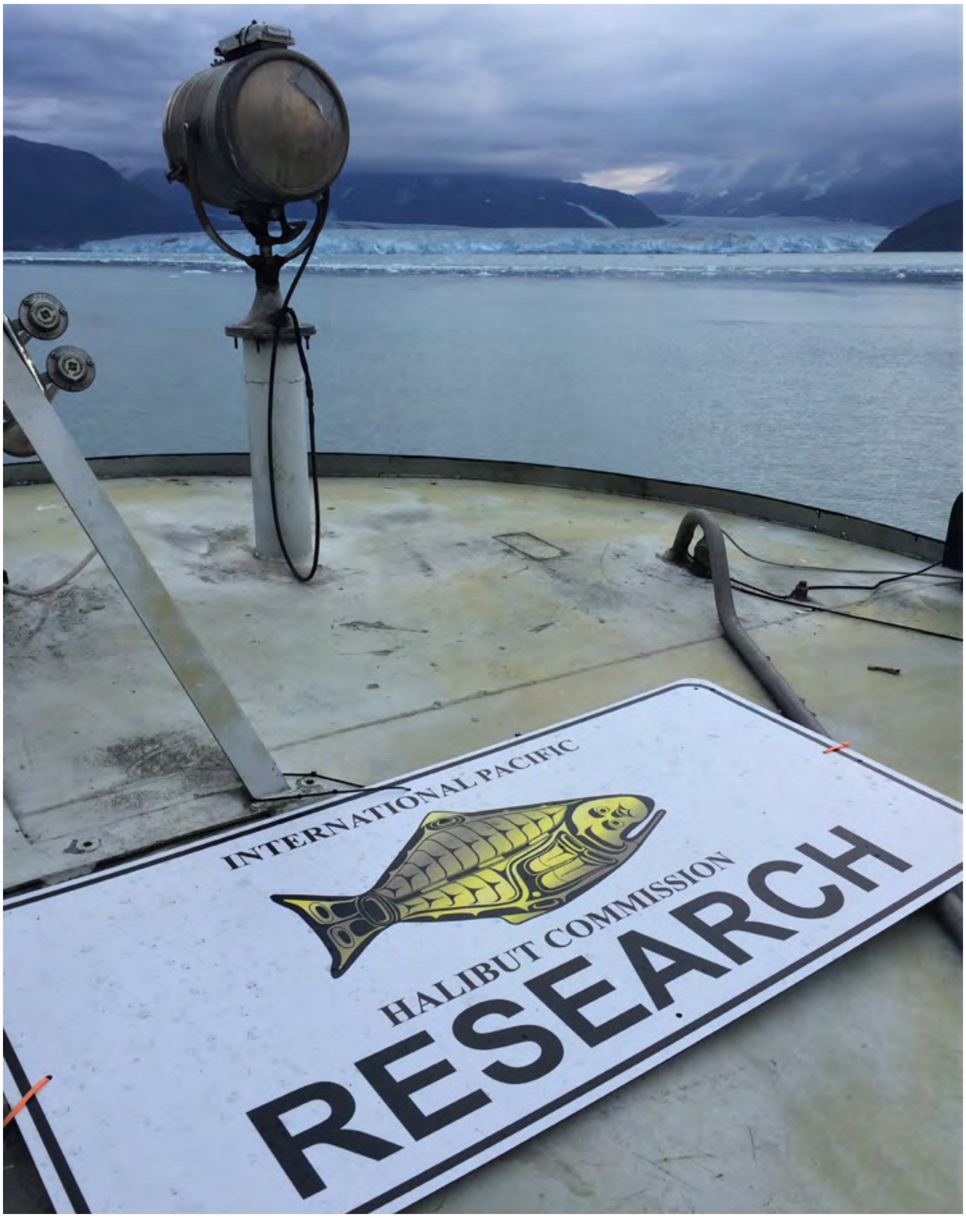


Photo by Zach Kelleher.

Looking forward

This section summarises the major decisions made at the 96th Session of the IPHC Annual Meeting (AM096), held 3-7 February 2020 in Anchorage, Alaska, USA. 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 annual meeting webpage (https://www.iphc.int).

Mortality limits

The Commission adopted mortality limits (described as Total Constant Exploitation Yield, TCEY limits) for 2020 as provided in Table 12. These mortality limits include a variety of estimated sources of mortality which are detailed in Table 13.

Table 12. Adopted TCEY limits for 2020.

IPHC Regulatory Area	TCEY limits (net weight)	
	Tonnes	Million Pounds
Area 2A (California, Oregon, and Washington)	748.43	1.65
Area 2B (British Columbia)	3,098.04	6.83
Area 2C (southeastern Alaska)	2,653.51	5.85
Area 3A (central Gulf of Alaska)	5,533.83	12.20
Area 3B (western Gulf of Alaska)	1,415.21	3.12
Area 4A (eastern Aleutians)	793.79	1.75
Area 4B (central/western Aleutians)	594.21	1.31
Areas 4CDE (Bering Sea)	1,769.01	3.90
Total (IPHC Convention Area)	**16,601.48**	**36.60**

The 2020 Annual Meeting (AM096) took place in Anchorage, AK, USA.

Commissioners deliberate at the IPHC Annual Meeting (AM096). Photo by Edward Henry.

Table 13. Mortality table projected for the 2020 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	0.03	0.13	NA	NA	0.16	0.09	0.04	0.08	**0.52**
O26 non-directed discard mortality	0.12	0.24	0.07	1.29	0.53	0.22	0.16	2.06	**4.69**
Non-CSP recreational (+ discards)	NA	0.05	1.15	1.66	0.00	0.01	0.00	0.00	**2.88**
Subsistence	NA	0.41	0.37	0.19	0.02	0.01	0.00	0.04	**1.03**
Total non-FCEY	0.15	0.82	1.59	3.14	0.71	0.34	0.20	2.17	**9.12**
Commercial discard mortality	NA	NA	0.07	0.29	NA	NA	NA	NA	**0.36**
CSP recreational (+ discards)	0.61	0.88	0.78	1.71	NA	NA	NA	NA	**3.98**
Subsistence	0.03	NA	NA	NA	NA	NA	NA	NA	**0.03**
Commercial landings	0.87	5.12	3.41	7.05	2.41	1.41	1.10	1.73	**23.11**
Total FCEY	**1.50**	**6.00**	**4.26**	**9.06**	**2.41**	**1.41**	**1.10**	**1.73**	**27.48**
TCEY	**1.65**	**6.83**	**5.85**	**12.20**	**3.12**	**1.75**	**1.31**	**3.90**	**36.60**
U26 non-directed discard mortality	0.00	0.02	0.00	0.29	0.12	0.14	0.01	1.02	**1.60**
Total Mortality	**1.65**	**6.85**	**5.85**	**12.49**	**3.24**	**1.89**	**1.32**	**4.92**	**38.19**

Fishing periods (season dates)

The Commission approved a fishing period 14 March to 15 November 2020 for all commercial Pacific halibut fisheries in Canada and United States of America. All commercial fishing for Pacific halibut in all IPHC Regulatory Areas may begin no earlier than noon local time on 14 March and must cease by noon local time on 15 November 2020.

In Regulatory Area 2A, the Commission adopted three-day (58-hour) fishing periods for the non-tribal directed commercial fishery in place of the previous 10-hour fishing periods. The first fishing period will begin at 0800 on 22 June 2020 and end at 1800 on 24 June 2020. Additional openings will take place at two-week intervals as allocation allows, to be determined and communicated by the IPHC Secretariat.

Recommendations

For 2020, the FISS will be modified to an enhanced randomized design which will allow variation in spatial coverage while maintaining scientific sampling targets.

The Commission made two additional recommendations at AM096, both concerning the IPHC's 2020 Fishery-Independent Setline Survey (FISS):

- The IPHC Secretariat shall employ the proposed subarea design for Regulatory Areas 2A, 4A, 4B, 4CDE, and an enhanced randomized subsampling FISS design in Regulatory Areas 2B, 2C, 3A, and 3B to meet the primary design objective, while also considering secondary and tertiary objectives. The IPHC Secretariat shall determine the number of skates at each FISS station with the secondary objective in mind.
- The IPHC Secretariat shall make the following specific additions to the new 2020 FISS design, on the basis of the tertiary objective, on a cost-recovery basis. Any other tertiary sampling objective shall be at the discretion of the IPHC Secretariat unless specifically directed by the Commission:
  - Regulatory Area 2A: Washington Department of Fish and Wildlife - rockfish sampling;
  - Regulatory Area 2B: DFO-Canada - rockfish sampling.

Upcoming IPHC meetings

Meeting	Date	Location
Interim Meeting (IM096)	18-19 November 2020	Seattle, WA, USA
Annual Meeting (AM097)	25-29 January 2021	Victoria, BC, Canada
Annual Meeting (AM098)	24-28 January 2022	Seattle, WA USA

Commission officers

The Commission elected Mr Paul Ryall (Canada) as Chairperson of the IPHC, and Mr Chris Oliver (USA) as Vice-Chairperson of the IPHC, until the close of the 97th Session of the IPHC Annual Meeting in 2021.

IPHC Secretariat update

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

Committees and Organization appointments

- Bering Sea Fishery Ecosystem Plan Team - Dr. Ian Stewart
- North Pacific Research Board Science Panel - Dr. Josep Planas
- NPFMC Bering Sea/Aleutian Island Groundfish Plan Team - Dr. Allan Hicks
- NOAA-Alaska Observer Science Committee - Dr. Ray Webster
- NPFMC Scientific and Statistical Committee - Dr. Ian Stewart
- American Fisheries Society Science Communication Section organizer - Ed Henry
- Canadian Science Advisory Secretariat Regional Peer Review Meeting for the Widow Rockfish Stock Assessment - Dr. Allan Hicks
- Interagency electronic reporting system for commercial fishery landings in Alaska (eLandings) - Lara Erikson (Steering committee), Huyen Tran (Steering committee), Afshin Taheri (IT Steering committee)
- Technical Subcommittee of the Canada-United States Groundfish Committee - Dr. Josep Planas, Lara Erikson
- NPFMC Trawl Electronic Monitoring Committee - Claude Dykstra, Huyen Tran
- International Flatfish Symposium Steering Committee - Dr. Timothy Loher

Conferences and Meetings (chronological order)

- Science Talk '19, 4-5 April, Portland, OR, USA - Ed Henry
- 2019 Committee of Age Reading Experts (CARE) workshop, 9-11 April, Seattle, WA, USA - Joan Forsberg (presenter), Chris Johnston, Dana Rudy, Robert Tobin
- Bevan Symposium and SAFS Centennial, 16-18 April, Seattle, WA, USA - Lauri Sadorus, Stephen Keith
- 2019 Wakefield Symposium, 6-9 May, Anchorage, AK, USA - Dr. Josep Planas (presenter)
- AFSC workshop on Integrating ecosystem and socioeconomic information into the groundfish/crab stock assessments Ecosystem and Socioeconomic Profiles, 29-31 May, Seattle, WA, USA - Dr. Ian Stewart
- 54th European Marine Biology Symposium, 25-29 August, Dublin, Ireland - Dr. Timothy Loher (presenter)
- American Fisheries Society & The Wildlife Society 2019 Joint Annual Conference, 29 September - 2 October, Reno, NV, USA - Ed Henry (presenter)
- North Pacific Marine Science Organization (PICES) Annual Meeting and Pacific halibut Workshop, 18-25 October, Victoria, B.C., Canada - Dr. Josep Planas (convenor, presenter), Dr. David Wilson (invited speaker), Dr. Ian Stewart (presenter), Lauri Sadorus (presenter), Dr. Timothy Loher (presenter), Claude Dykstra (presenter), Dr. Allan Hicks (presenter), Joan Forsberg (presenter), Dana Rudy (presenter), Anna Simeon, Andy Jasonowicz
- CAPAM workshop on the creation of frameworks for the next generation general stock assessment models, 4-8 November, Wellington, New Zealand - Dr. Allan Hicks, Dr. Piera Carpi
- The Dynamics of Disputes over Illegal, Unreported, and Unregulated Fishing, 28-29 November, Luxembourg - Dr. Barbara Hutniczak (invited panelist)

Outreach

- Booth at Pacific Northwest Sportmen's Show, 5-10 February, Portland, OR, USA - Caroline Robinson (organizer), Ed Henry, Lauri Sadorus, Stephen Keith, Collin Winkowski, Dr. Ian Stewart
- Seafood Expo North America (Boston Seafood Show), 17-19 March, Boston, MA, USA - Colin Jones, Ed Henry
- ComFish Alaska, 28-30 March, Kodiak, AK, USA - Dr. Ian Stewart, Lara Erikson
- Two booths at Fishermen's Fall Festival, 21 September, Seattle, WA, USA - Caroline Robinson, Dr. Piera Carpi, Lara Erikson, Collin Winkowski, Abby Carrigan, Huyen Tran, Kamala Carroll, Kimberly Sawyer, Jay Walker, Chris Johnston, Keith Jernigan, Tamara Briggie, Dana Rudy, Ed Henry, Dr. David Wilson
- Booth at Pacific Marine Expo, 21-23 November, Seattle, WA, USA - Colin Jones, Collin Winkowski, Stephen Keith, Ed Henry, Caroline Robinson, Dr. Josep Planas, Kimberly Sawyer, Claude Dykstra, Kamala Carroll

IPHC Secretariat Staff help raise funds for the Fishermen's Memorial during the Fall Fishermen's Festival in Seattle, WA, USA. Photo by Edward Henry.

Academic activities

- Alaska Pacific University affiliate faculty, Anchorage, AK, USA - Dr. Josep Planas
- University of Washington affiliate faculty, Seattle, WA, USA - Dr. Ian Stewart, Dr. Allan Hicks
- University of Alaska Fairbanks student committee member, Juneau, AK, USA - Dr. Timothy Loher
- University of Washington student committee member, Seattle, WA, USA - Dr. Allan Hicks, Dr. Ian Stewart
- Alaska Pacific University student committee member, Anchorage, AK, USA - Dr. Josep Planas, Dr. Ian Stewart
- University of Massachusetts Dartmouth student committee member, Dartmouth, MA, USA - Dr. Allan Hicks
- University of Washington guest course lecturer: *Age structured models in fisheries stock assessment*, Seattle, WA, USA - Dr. Allan Hicks
- Editorial board member for journals: *PLoS One, Frontiers in Physiology, Scientific Reports, Fishes* - Dr. Josep Planas

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 (FISS) by storing and staging equipment and supplies.
- The Bering Sea and Gulf of Alaska 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.
- The NOAA Resource Ecology and Ecosystem Modeling group for coordination with IPHC FISS specialists aboard the trawl surveys to ensure stomach content data and other biological data are able to be paired together post season.
- 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.
- Norton Sound Economic Development Corporation for their logistical and financial support of our tagging research in the Norton Sound and St Matthew Island region.
- 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 FISS 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 FISS.
- 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.
- The stakeholders and agency personnel that are members of the MSAB and the city of Sitka for hosting the 13th MSAB meeting in May.
- Wes Erikson for volunteering his time and culinary expertise to our fundraising efforts during the Fishermen's Fall Festival.

2019 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 2019 and authored by the Commission and Secretariat staff are shown below.

International Pacific Halibut Commission. 2019. 2018 Annual Report. 68 p.

Monnahan, C. C., Branch, T. A., Thorson, J. T., **Stewart, I. J.**, and Szuwalski, C. 2019. Overcoming long Bayesian run times in integrated fisheries stock assessments. ICES J. Mar. Sci., 76(6):1477-1488. doi:10.1093/icesjms/fsz059/5475859

Nielsen, J. K., Mueter, F. J., Adkinson, M. D., **Loher, T.**, McDermott, S. F., and Seitz, A. C. 2019. Effect of study area bathymetric heterogeneity on parameterization and performance of a depth-based geolocation model for demersal fish. Ecological Modelling, 402(C):18-34. doi: 10.1016/ecolmodel.2019.03.023

Rose, C. S., Nielsen, J. K., Gauvin, J., **Loher, T.**, Sethi, S., Seitz, A. C., Courtney, M. B., and Drobny, P. 2019. Survival outcome patterns revealed by deploying advanced tags in quantity: Pacific halibut (*Hippoglossus stenolepis*) survivals after release from trawl catches through expedited sorting. Can. J. Fish. Aquat. Sci., 76(12):2215-2224.

van Helmond, A. T. M., Mortensen, L. O., Plet-Hansen, K. S., Ulrich, C., Needle, C. L., Oesterwind, D., Kindt-Larsen, L., Catchpole, T., Mangi, S., Zimmermann, C., Olesen, H. J., Bailey, N., Bergsson, H., Dalskov, J., Elson, J., Hosken, M, Peterson, L., McElderry, H., Ruiz, J., Pierre, J. P., **Dykstra, C.**, and Poos, J. J. 2019. Electronic monitoring in fisheries: Lessons from global experiences and future opportunities. Fish & Fisheries (advance online publication) https://www.onlinelibrary.wiley.com/doi/10.1111/faf.12425. Print publication: Vol. 21(1):162-189 (2020).

Reward offered for every IPHC tag returned

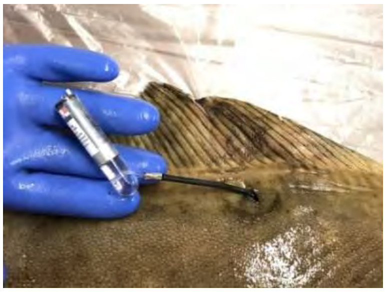
IPHC regulations allow Pacific halibut of any size bearing an IPHC tag to be landed regardless of gear type, fishery, or time of year.

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**

INTERNATIONAL PACIFIC HALIBUT COMMISSION

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Steven Pennoyer	1989-2000
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Donald Lane	2014-2015
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Bruce M. Leaman	1997-2016
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Stephen Keith, M.A.	Executive	Assistant Director
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Tamara Briggie	Administrative Services	Administrative Specialist
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Ian Stewart, Ph.D.	Quantitative Sciences	Quantitative Scientist
Raymond Webster, Ph.D.	Quantitative Sciences	Biometrician
Steven J. Berukoff, Ph.D.	Quantitative Sciences	Programmer (Management Strategy Evaluation)
Piera Carpi, Ph.D.	Quantitative Sciences	Researcher (Management Strategy Evaluation)
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Andy Jasonowicz, M.Sc.	Biological & Ecosystem Sciences	Research Biologist
Christopher Johnston	Biological & Ecosystem Sciences	Age Lab Technician
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Dana Rudy	Biological & Ecosystem Sciences	Age Lab Technician
Lauri Sadorus, M.Sc.	Biological & Ecosystem Sciences	Research Biologist
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Lara Erikson	Fisheries Statistics & Services	Branch Manager
Huyen Tran	Fisheries Statistics & Services	Fisheries Data Manager
Abby Carrigan	Fisheries Statistics & Services	Fisheries Data Entry Specialist
Kamala Carroll	Fisheries Statistics & Services	Fisheries Data Specialist
Edward Henry	Fisheries Statistics & Services	Fisheries Data Specialist
Thomas Kong	Fisheries Statistics & Services	Fisheries Data Specialist
Caroline Robinson	Fisheries Statistics & Services	Fisheries Data Specialist
Kimberly Sawyer	Fisheries Statistics & Services	Fisheries Data Specialist
Aregash Tesfatsion	Fisheries Statistics & Services	Fisheries Data Specialist
Kayla Ualesi	Fisheries Statistics & Services	Setline Survey Coordinator
Colin Jones, M.Sc.	Fisheries Statistics & Services	Setline Survey Specialist
Monica Mocaer	Fisheries Statistics & Services	Setline Survey Specialist
Eric Soderlund	Fisheries Statistics & Services	Setline Survey Specialist
Collin Winkowski	Fisheries Statistics & Services	Setline Survey Specialist
Jason Taylor	Fisheries Statistics & Services	Setline Survey Gear Assistant

Fisheries Data Specialists Field Staff Fisheries Statistics & Services Branch	
Name (Official)	Location
Levy Boitor	Petersburg, AK
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Chelsea Hutton	Port Hardy, B. C.
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Setline Survey Specialists Field Staff Fisheries Statistics & Services Branch	
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INTERNATIONAL PACIFIC HALIBUT COMMISSION
2320 WEST COMMODORE WAY, SUITE 300
SEATTLE, WA 98199-1287