ISSN: 0074-7238

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Annual Report
2016

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

Commissioners

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2017

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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 for the preservation of the Pacific halibut (*Hippoglossus stenolepis*) fishery of the north Pacific Ocean and the Bering Sea. The Convention was the first international agreement providing for the joint management of a marine resource. The Commission's authority was expanded by several subsequent conventions, the most recent being signed in 1953 and amended by the Protocol of 1979.

Three IPHC Commissioners are appointed by the Governor General of Canada and three by the President of the United States 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 staff, government agencies and by industry (specifically the Conference Board and the Processor's Advisory Board). The measures recommended by the Commission are submitted to the two governments for approval. Upon approval the regulations are enforced by the appropriate agencies of both governments and published in the U.S. Federal Register and Canadian Gazette.

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

How to interpret this report

Data in this report has been updated using all information received by IPHC through the 2017 Annual Meeting. Some data may have been subsequently updated. 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

Pacific Northwest artist Kostan Lagace is located in Prince Rupert, British Columbia where he and his partner Florbela Cunha run their locally owned small business, Coastal Fusion Art — a gallery/store that retails a collection of fine art prints and silkscreen clothing. Find out more about Coastal Fusion Art on Facebook at www.fb.com/coastalfusionart or email them directly at coastalfusionart@gmail.com.

Co-producer

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

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
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
SSA - Standardized Stock Assessment
WDFW - Washington Department of Fish and Wildlife
WPUE - Weight-Per-Unit-Effort
XRQ - Experimental Recreational Halibut

Executive Director's Message

Throughout the course of 2016, the IPHC has seen tremendous change, both within the Secretariat, and for the resource itself. As the new IPHC Executive Director, I'd like to start this message by acknowledging the outstanding service, commitment and performance of the former Executive Director, Dr. Bruce Leaman, who led the organisation through tough times over the course of his 19-year tenure, to the point where the stock is now experiencing steady or increasing biomass. During his tenure, Dr. Leaman built an organization who's global reputation is considered the 'Gold Standard' among Regional Fisheries Management Bodies. It will be very difficult to fill the very large shoes he has left behind, though I will certainly do my utmost to ensure his legacy is retained, enhanced and built upon.

As for myself, I hail from Australia originally, though I've spent the majority of my professional working life abroad. Much of this time has been spent being involved in fisheries science institutional management and in developing and implementing multilateral arrangements for the conservation and management of highly migratory fish stocks, and shared fish stocks in the Pacific Ocean, Indian Ocean and Caribbean. My experience was largely gained while working at the Indian Ocean Tuna Commission (Deputy and Acting Executive Secretary); Australian Government International Fisheries Science Head (Department of Agriculture, Forestry and Fisheries – Australian Bureau of Agricultural and Resource Economics and Sciences); Northern Fisheries Senior Manager at the Australian Fisheries Management Authority; Director of the Center for Marine Resource Studies in the Turks and Caicos Islands, and Fisheries Biologist with the Department of Marine and Wildlife Resources in American Samoa. I obtained my doctorate from James Cook University, Australia, in tandem with the Australian Institute of Marine Science, and the Smithsonian Tropical Research Institute in Panama.

Over the coming year, it is my intention to enhance the IPHC's scientific processes and the communication of scientific advice emanating from our core functions. This will occur in tandem with an evaluation of the supporting governance procedures of the organization, including how stakeholder input is incorporated into the decision making framework, to ensure that all points of view are being adequately considered.

While the resource faces continued threats from unresolved issues such as the decline in size at age, incidental catch levels, and climatic variation, I'm confident that we have the staff, stakeholders and fishery managers to meet these challenges and enhance the resource and the lives of those who fish it.

In closing, I am honored to have been given the privilege of leading the IPHC Secretariat and I look forward to meeting with all of you over the coming year, either through the Commission's subsidiary bodies, or in person at our landing ports and communities that so heavily rely on Pacific halibut as a source of income, food, and cultural identity.

David T. Wilson, Ph.D.
Executive Director

Activities of the Commission

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

Annual Meeting 2016

The IPHC held its 92nd Annual Meeting in Juneau, Alaska, U.S.A., from 25-29 January 2016. The Commission is composed of six members (Commissioners) and for 2016, Mr. Paul Ryall of Canada presided as the Chairperson and Dr. James Balsiger of the U.S.A. presided as Vice-Chairperson. The Commission heard reports from the Secretariat staff about the health of the Pacific halibut population, reviewed finance and administration, discussed bycatch issues and minimum size limits, considered the suggestions of its subsidiary bodies, and solicited public comments before passing regulations and setting catch limits for 2016.

At the 92nd Annual Meeting, the Commission decided to recommend to the governments that the total coastwide catch limit be set at 29.89 million pounds (~13,558 t) net weight.

Final public session of the 2016 Annual Meeting. Photo by Tracee Geernaert.

Catch limits and fishing periods for 2016

The Commission recommended to the governments of Canada and the United States of America that the total catch limit for 2016 should be 29,890,000 pounds net weight (13,557.88 t), a 2.3 percent increase from the 2015 catch limit of 29,223,000 pounds (13,255.33 t). Note that for Regulatory Areas 2-3A, the number shown includes some portions of the recreational catch. The limit was divided among Regulatory Areas as follows:

Area 2A - California, Oregon, and Washington: 1,140,000 pounds (517.10 t)
Area 2B - British Columbia, including sport catch allocation: 7,300,000 pounds (3,311.22 t)
Area 2C - Southeastern Alaska, combined commercial/guided sport: 4,950,000 pounds (2,245.28 t)

Area 3A - Central Gulf of Alaska, combined commercial/guided sport: 9,600,000 pounds (4,354.49 t)
Area 3B - Western Gulf of Alaska: 2,710,000 pounds (1,229.24 t)
Area 4A - Eastern Aleutians: 1,390,000 pounds (630.49 t)
Area 4B - Central/western Aleutians: 1,140,000 pounds (517.10 t)
Area 4C - Pribilof Islands: 733,600 pounds (332.76 t)
Area 4D - Northwestern Bering Sea: 733,600 pounds (332.76 t)
Area 4E - Bering Sea flats: 192,800 pounds (87.45 t)

The Commission subdivides the coastwide stock by IPHC Regulatory Area, except in Regulatory Area 4CDE where the Commission recommends a single catch limit. Catch sharing plans developed and implemented by the domestic governments allocate the catch further in some areas, which the Commission applies. The Commission applied the North Pacific Fishery Management Council's (NPFMC's) catch-sharing plan for Area 4CDE and the Pacific Fishery Management Council's (PFMC's) catch-sharing plan that allocates the Regulatory Area 2A catch among the treaty and non-treaty commercial fisheries, the sport fisheries, and the treaty ceremonial and subsistence fishery.

In Regulatory Area 2B, the Department of Fisheries and Oceans Canada's (DFO's) allocation plan for First Nation, sport, and commercial fisheries was also approved. The NPFMC catch-sharing plan allocating the catch for Regulatory Areas 2C and 3A between commercial and charter sport sectors contains specific charter management measures (see below). More in-depth information on all of these subjects can be found in the applicable sections of this report.

The individual quota fishery season was set to open on 19 March and close on 7 November.

The 2016 season for all Alaska and British Columbia quota share commercial fisheries was designated to open on 19 March and to close 7 November. Both treaty and non-treaty commercial fishing in Washington, Oregon, California, and the Annette Islands Reserve in Alaska utilize shorter open periods, also within the period designated for the quota fisheries.

Other decisions made at the meeting

The Commission made a range of decisions at the 2016 Annual Meeting, including:

- Approval of the legal use of longline pot gear in Alaska's commercial Pacific halibut fishery per National Marine Fisheries Service (NMFS) regulations of this gear in the individual fishing quota (IFQ) sablefish fishery. The Commission will review this decision in three years.
- Approval of the exemption of Pacific halibut with external IPHC tags from sport daily bag or possession limits, size limits, and season restrictions, and from personal use and subsistence daily bag or catch limits.
- Approval of the electronic version of the NMFS Groundfish/IFQ Daily Fishing Longline and Pot Gear logbook as acceptable for use in the Alaskan commercial Pacific halibut fishery.
- IPHC Secretariat staff were tasked with a re-examination of the appropriateness of the 16% discard mortality rate (DMR) currently assigned to Pacific halibut released in the U.S.A. and Canadian directed Pacific halibut fisheries.

Dr. Bruce Leaman was recognized by the Halibut Association of North America during the Annual Meeting for his outstanding achievements and dedication to the management of the Pacific halibut fishery. This was Dr. Leaman's final Annual Meeting as IPHC Executive Director before retirement at 19 years of service. Photo by Tracee Geernaert.

Dr. Bruce Leaman was recognized by Commissioners and stakeholders for his years of exceptional service as the IPHC Executive Director.

- The Commission invited fishers in the area around Nunivak Island to participate in the IPHC logbook program, and asked the IPHC Secretariat staff to continue its outreach to the communities there to try and obtain better data for abundance and distribution analyses in Area 4E.
- Approval of the next in a series of expansions to the Commission's fishery-independent setline survey, this one in the Area 4D Edge. The purpose of the expansion series is to reduce potential biases in the surveys among Regulatory Areas and to keep up with the increasing depth reached by the commercial fishery.
- Awarding of the IPHC Merit Scholarship to its 14th recipient, Ms. Shalie Dahl of Petersburg, Alaska, U.S.A.
- Arranging for the 2018 Annual Meeting to be held 22-26 January 2018 in Portland, Oregon, U.S.A.
- Electing Canadian Government Commissioner Mr. Paul Ryall of Vancouver, British Columbia, as Chairperson for the coming year, and United States Government Commissioner Dr. James W. Balsiger of Juneau, Alaska, U.S.A. as Vice-Chairperson. The Commission also announced the selection of Dr. David Wilson to succeed Dr. Bruce Leaman as its Executive Director.

Charter Pacific halibut sector management in Areas 2C and 3A

The Commission approved NPFMC-proposed charter Pacific halibut sector management measures for Regulatory Areas 2C and 3A. In Area 2C, these measures amount to a one-fish daily bag limit and a "reverse slot" size limit (42 inches and 80 inches) restriction. In Area 3A, the requirements are: a two-fish

daily bag limit, with a 28-inch size limit for the second fish caught; a four-fish annual limit; a vessel limit and charter permit limit of one trip per calendar day; and the closure of Pacific halibut charter fishing on Wednesdays all year.

An IPHC regulation to require vessels to retain filleted carcasses on board until they are offloaded was dropped since it appears in the NMFS regulations.

Interim Meeting (IM092)

The 92nd Session of the IPHC Interim Meeting (IM092), held on 29-30 November 2016 in Seattle, U.S.A., was an occasion to prepare for the 2017 Annual Meeting in January. The Commissioners and the public were able to hear IPHC Secretariat staff presentations and discuss topics including a review of the 2016 fisheries and preliminary stock assessment results, and the 2017 harvest decision table. There was also discussion about the reduction in bycatch, changes in the spatial distribution of the stock, proposed sport regulation changes, a proposal for Pacific halibut retention in sablefish pot fisheries, budgeting and staffing issues, and various regulatory proposals.

Commissioners meet each year to prepare for the decisions and issues that need consideration at the IPHC Annual Meeting in January.

Commissioners discuss topics of interest to the fishery at the Interim Meeting in Seattle. Photo by Ed Henry.

Other topics covered included the progress of the Management Strategy Advisory Board, the Scientific Review Board report, and a summary of related meetings with the NPFMC, PFMC, and DFO.

IPHC Budget

The IPHC is funded jointly by the governments of Canada and the U.S.A. For fiscal year 2016, the U.S.A. appropriated $4.15 million to the IPHC which included funding designated for pension deficits and the IPHC headquarters leases. Canada provided $878,720 and an additional payment of $95,508 to cover pension deficits.

IPHC Regulatory Areas for 2016

On its formation in 1923, IPHC established four regulatory areas, covering California northward through the Bering Sea. They have changed in their numbering and their geographic boundaries over the years, but the current boundary lines have remained the same since 1990. Convention waters extend further north than the designated regulatory areas, but to date, no Pacific halibut have been found north of the Bering Strait so this area is unassigned. For an illustration of the boundaries, refer to the map on the inside front cover of this report.

Area 2A—waters off the coasts of California, Oregon, and Washington.

Area 2B—waters off the coast of British Columbia.

Area 2C—waters off the coast of Southeast Alaska, south and east of Cape Spencer.

Area 3A—Central Gulf of Alaska. Waters off South Central Alaska, between Cape Spencer and the southernmost tip of Kodiak Island (Cape Trinity).

Area 3B—Western Gulf of Alaska. Waters south of the Alaska Peninsula, from west of Cape Trinity (Kodiak Island) to a line extending southeast from Cape Lutke (Unimak Island).

Area 4A—Waters surrounding the Eastern Aleutian Islands. The specific boundaries are "all waters in the Gulf of Alaska west of Area 3B and in the Bering Sea west of the Closed Area (defined below) that are east of 172°00'00" W. longitude and south of 56°20'00" N. latitude."

Area 4B—Waters surrounding the Western Aleutian Islands. This includes "all waters in the Bering Sea and Gulf of Alaska west of Area 4A and south of 56°20'00" N. latitude."

Area 4C—A 'square' of water surrounding the Pribilof Islands in the Bering Sea. It is measured as "all waters in the Bering Sea north of Area 4A and north of the Closed Area defined in section 10 which are east of 171°00'00" W. longitude, south of 58°00'00" N. latitude, and west of 168°00'00" W. longitude."

Area 4D—Northwestern Bering Sea, including "all waters in the Bering Sea north of Areas 4A and 4B [56°20'00" N. latitude], north and west of Area 4C, and west of 168°00'00" W. longitude."

Area 4E—Northeastern Bering Sea, including "all waters in the Bering Sea north and east of the Closed Area, east of 168°00'00" W. longitude, and south of 65°34'00" N. latitude."

Closed Area—This trapezoid-shaped body of water in Bristol Bay is closed to commercial halibut fishing. This relatively shallow body of water serves as a nursery for juvenile Pacific halibut. The area is more precisely described as "all waters in the Bering Sea north of 55°00'00" N. latitude in Isanotski Strait that are enclosed by a line from Cape Sarichef Light (54°36'00" N. latitude, 164°55'42" W. longitude) to a point at 56°20'00" N. latitude, 168°30'00" W. longitude; thence to a point at 58°21'25" N. latitude, 163°00'00" W. longitude; thence to Strogonof Point (56°53'18" N. latitude, 158°50'37" W. longitude); and then along the northern coasts of the Alaska Peninsula and Unimak Island to the point of origin at Cape Sarichef Light. Furthermore, all waters in Isanotski Strait between 55°00'00" N. latitude and 54°49'00" N. latitude."

The Commission uses an equidistant line for the division between Areas 2A/2B and 2B/2C, attributing catch by each nation in the boundary area to that nation's allocation, in the absence of a boundary agreement between the two countries.

The Commission manages Regulatory Area 4CDE as a single area, and has defined Areas 4C, 4D, and 4E specifically, at the request of the North Pacific Fishery Management Council for its Catch Sharing Plan (catch allocation framework).

COMMERCIAL FISHERY

The commercial Pacific halibut landings in 2016 along with the Pacific halibut landed on the IPHC fishery-independent setline survey were 25,026,000 pounds (11,351.60 t), up 1.5 percent from the 24,673,000 pounds (11,191.48 t) landed in 2015. 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 report reflects data received as of the 2017 Annual Meeting in January.

Fishing periods

At the 2016 Annual Meeting, the Commission continued its discussions on season length, including recommendations to open the fishery on a Saturday to facilitate marketing. Accordingly, the Canadian Individual Vessel Quota (IVQ) fishery in Regulatory Area 2B and the United States Individual Fishing Quota (IFQ) and Community Development Quota (CDQ) fisheries in Regulatory Areas 2C, 3A, 3B, 4A, 4B, and 4CDE commenced at 12 noon local time on 19 March (a Saturday) and closed at 12 noon local time on 7 November (a Monday). The Regulatory Area 2A commercial fisheries, including the treaty Indian commercial fisheries, were required to occur during the same calendar period (19 March to 7 November).

Area 2A non-treaty directed commercial fishing periods were set to begin 22 June with several more to follow until the catch limit was reached.

For Regulatory Area 2A, eight potential 10-hour fishing periods for the non-treaty directed commercial fishery were adopted: 22 June, 6 July, 20 July, 3 August, 17 August, 31 August, 14 September, and 28 September. All fishing periods were to begin at 08:00 hrs and end at 18:00 hrs local time, and were further restricted by fishing period and specific vessel-length catch limits Each

The crew of the *F/V Seymour* pull a large Pacific halibut over the rail. Photo by Chris Noren.

opening was scheduled only after determining the estimated amount of available commercial allocation and only until the commercial allocation was estimated to have been reached.

Licensing, catch limits, and landings

The 2016 coastwide commercial landings amounted to 24,344,000 pounds (11,042.25 t), which is 657,300 pounds (298.15 t) below the 25,001,300 pound (11,340.40 t) limit for the year. Catch limits are set by the Commission for all individual Regulatory Areas and for Area 4CDE combined. Domestic Catch Sharing Plans (CSPs) allocate catch limits by user groups in Regulatory Areas 2A, 2B, 2C, and 3A and among sub-areas for Area 4CDE.

Domestically run catch sharing plans are used to allocate the catch among user groups and, in the case of Area 4, among subareas.

A variety of fisheries with unique catch limits comprise Regulatory Area 2A. There are two treaty Indian fisheries: a ceremonial and subsistence use (C&S) fishery, which had a 2016 catch limit of 33,900 pounds (15.38 t); and a commercial fishery, with a limit of 365,100 pounds (165.61 t). There were three non-treaty commercial fisheries: the directed fishery, with a limit of 193,364 pounds (87.71 t); the incidental Pacific halibut fishery during the salmon troll season, with a limit of 34,123 pounds (15.48 t); and the incidental Pacific halibut fishery during the limited entry sablefish (*Anoplopoma fimbria*) fishery, with a limit of 49,686 pounds (22.54 t). The area's three sport fishery catch limits (Washington, Oregon, and California) totaled 463,827 pounds (210.39 t). The total Regulatory Area 2A landings (not including IPHC fishery-independent setline surveys) were 1,154,300 pounds (523.58 t) in 2016, which were one percent above the catch limit.

Licensing regulations for Regulatory Area 2A non-treaty fisheries were unchanged in 2016: 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. To accommodate earlier opening dates, 15 March was the deadline for license applications for the incidental Pacific halibut in the salmon troll and the sablefish fisheries. The deadline date for the directed commercial fishery was 30 April.

In Regulatory Area 2B, IPHC stipulated a catch limit of 7,300,000 pounds (3,311.22 t) for the combined sport and commercial fisheries for 2016. The Department of Fisheries and Oceans Canada (DFO) further refined this limit by requiring a ratio of 85 percent commercial to 15 percent sport. The total 2016 Regulatory Area 2B combined commercial and sport landings was 7,135,000 million pounds (3,236.38 t), falling short of the catch limit by two percent.

For the third year, the North Pacific Fishery Management Council (NPFMC) recommended including the commercial and sport charter fisheries in a CSP for Regulatory Areas 2C and 3A. Consequently, IPHC's adopted catch limits for Regulatory Areas 2C (4,950,000 pounds; 2,245.28 t) and 3A (9,600,000 pounds; 4,354.49 t) included the commercial and charter fishery catch limits, plus discard and lost gear mortality estimates. Regulatory Area 2C came close to the catch limit at 4,895,000 landed pounds (2,220.34 t), while Regulatory Area 3C slightly exceeded the catch limit at 9,632,000 landed pounds (4,369.01 t). The individual catch limits adopted for Regulatory Areas 4C (733,600 pounds; 332.76 t), 4D (733,600 pounds; 332.76 t), and 4E (192,800 pounds; 87.45 t) are determined by a NPFMC CSP, and increased from the previous year. The NPFMC CSP and

IPHC regulations allowed Regulatory Area 4D CDQ to be harvested in Regulatory Areas 4D or 4E, and Regulatory Area 4C IFQ and CDQ to be harvested in Regulatory Areas 4C or 4D. Collectively, the Regulatory Area 4CDE fisheries came in under the combined Regulatory Area 4 CDE catch limit.

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, National Marine Fisheries Service (NMFS), DFO, Metlakatla Indian Community, Washington treaty 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 landings data comes from a number of different federal and state agencies as well as the Metlakatla Indian Community and Washington treaty Indian tribal fisheries management departments.

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

The Regulatory Area 2A directed commercial fishery south of Point Chehalis, Washington, closed after three 10-hour openings with fishing period vessel-length specific limits in 2016, during which time harvesters landed 198,000 pounds (89.81 t) (two percent over the catch limit of 193,364 pounds (87.71 t)). Each H-class vessel (56 feet (17.1 m) or longer) was allowed to bring in 9,000 pounds (4.08 t) on 22 June and 6 July, and 2,500 pounds (1.13 t) on 20 July.

Bellingham, WA port sampler Bryna Mills (left) learning the routine from her predecessor Linda Gibbs (right). Photo by Lara Erikson.

Smaller vessel classes were limited to less poundage according to their length. Vessel licenses for Regulatory Area 2A decreased in 2016 from the prior year, with IPHC issuing 597 total licenses. The directed commercial Pacific halibut fishery and the sablefish fishery accounted for 167 licenses (one more than in 2015). In addition, 310 (54 fewer than in 2015) licenses went to the salmon troll fishery for retaining incidentally caught Pacific halibut, and 120 licenses (five fewer than in 2015) went to sport charter vessels. There were 10 vessels that received two licenses: one for the directed commercial and one for incidental Pacific halibut during the sablefish fishery.

The period of incidental Pacific halibut retention during the salmon troll fishery ran from 1 April to 7 November, with a total catch of 26,000 pounds (11.79 t), which was 24 percent under the 34,123-pound (15.48 t) catch limit. As in 2015, at the start of the season on 1 April, the allowable incidental catch ratio of Pacific halibut during the salmon troll fishery was one Pacific halibut per four Chinook salmon (*Oncorhyhus tshawytscha*), plus an "extra" Pacific halibut per landing, and a vessel trip limit of 12 fish. On 1 May, the landing restrictions changed to one Pacific halibut per three Chinook salmon, plus an "extra" Pacific halibut per landing, and a vessel trip limit of 20 fish.

Incidental Pacific halibut retention during the limited-entry sablefish fishery, from 1 April to 7 November, resulted in a total catch of 30,000 pounds (13.61 t) (40 percent under the catch limit of 49,686 pounds (22.54 t)). The allowable landing ratio was 110 pounds (49.9 kg) of Pacific halibut to 1,000 pounds (453.6 kg) (net weight) of sablefish, and up to two additional Pacific halibut in excess of the ratio limit (a greater landing restriction than in recent years).

In 2016, the total treaty Indian commercial catch for Regulatory Area 2A-1 (north of Point Chehalis) was 361,000 pounds (163.75 t), one percent under the catch limit (365,100 pounds; 165.61 t). The treaty Indian tribes allocated 75 percent of the commercial catch limit to an open-access fishery, and the remaining 25 percent to a restricted fishery with daily and vessel catch limits. There were three unrestricted, open-access fisheries from 19-23 March; and one restricted fishery, with a vessel per-day limit of 500 pounds (226.8 kg) during the 1-2 April opening. Finally, there were several late fishery openers between 1 May and 7 November.

Area 2B (British Columbia; Canada)

Pacific halibut was landed from a total of 230 active licenses in Area 2B in 2016, with 74 of those licenses from other fisheries.

During the 2016 season, the Individual Vessel Quota (IVQ) fisheries of British Columbia landed 6,049,000 pounds (2,743.78 t), which was two percent below the commercial catch limit of 6,199,000 pounds (2,811.82 t). As part of the groundfish Integrated Fisheries Management Plan, IVQ fisheries include quota shares for all hook-and-line and trap groundfish fisheries, transferability with limits among license holders, 100 percent at-sea and dockside monitoring, and vessel accountability for all catch, both landed and discarded. There is 100 percent monitoring through logbook records, video camera coverage, and dockside monitoring.

DFO allocates each Pacific halibut vessel a fixed poundage limit for the season and designates each with either an "L" or "FL" license. L commercial licenses are limited and vessel-based. FL communal licenses are reserved for First Nations. The number of active Pacific halibut licenses, both L and FL, decreased from a 1999 high of 257 to a 2014 low of 146, then came up to 156 in 2016. In addition, Pacific halibut can be landed as incidental catch in other licensed groundfish fisheries. Therefore, Pacific halibut was landed from a total of 230 active licenses in 2016, with 74 of these licenses from other fisheries. This is a decrease from 240 active licenses in 2015.

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

In 2016, the total landings by the IFQ andCDQ Pacific halibut fisheries in the waters off Alaska, was 17,677,000 pounds (8,018.15 t), less than three percent under the catch limit. The total commercial Quota Share (QS) landings was one

Port sampler Darlene Haugen and port sampler supervisor Tom Kong collect a Pacific halibut sample in Prince Rupert, B.C. Photo by Ed Henry.

percent below the catch limit in Regulatory Areas 3A and 2C, three percent below in Regulatory Areas 3B and 4A, and four percent below in Regulatory Area 4B. As mentioned previously, the NPFMC CSP allowed Regulatory Area 4D CDQ to be harvested in Regulatory Areas 4D or 4E and Regulatory Area 4C IFQ and CDQ to be fished in Regulatory Areas 4C or 4D. These two regulations were the reason the catches in Regulatory Area 4D exceeded the catch limit. However, the total Regulatory Area 4CDE commercial catch of 1,461,000 pounds (662.70 t) was 12 percent under the Regulatory Area 4CDE catch limit (1,660,000 pounds; 752.96 t).

Regulatory Area 2C includes the Annette Islands Reserve (just south of the city of Ketchikan), home to the Metlakatla Indian Community, which the U.S. Bureau of Indian Affairs has authorized to conduct a commercial Pacific halibut fishery within the Reserve. In 2016, there were 13 two-day openings between 15 April and 2 October, resulting in a total catch of 79,358 pounds (36.0 t). This was 12,000 pounds (5.44 t) higher than the 2015 catch, and within the historical catch range that has varied over time from a low of 12,000 pounds (5.44 t) in 1998 to a high of 126,000 pounds (57.15 t) in 1996.

Kodiak received the largest proportion of Alaskan commercial catch and Port Hardy received the most Canadian catch of Pacific halibut.

Landing patterns

The landed catch in Alaska, weighing in at 17,677,000 pounds (8,018.15 t), accounted for the majority of the total commercial landings (71%). Regulatory Area 3A again had the highest catch limit and landed catch level in 2016, with 40% of the Alaskan commercial catch landed in the ports of Homer, Kodiak, and Seward. As in 2015, Kodiak received the largest portion of the Alaskan commercial catch, with 2,666,000 pounds (1,209.28 t) (15%). In 2016, Homer received 2,572,000 pounds (1,166.64 t) (14%) of catch, and 1,915,000 pounds (868.63 t) (11%) were landed in Seward. In Southeast Alaska (Regulatory Area 2C), Petersburg, Sitka, and Juneau, in that order, received the three largest commercial landed pounds.

In Regulatory Area 2B, as in 2015, two ports among the 12 on the British Columbia coast received 90 percent of the area's landed catch: Port Hardy and Prince Rupert/Port Edward. Port Hardy received 46 percent of the area's commercial landed catch (2,718,000 pounds; 1,232.86 t), and Prince Rupert received 44 percent (2,646,000 pounds; 1,200.21 t). Ucluelet and Vancouver combined received seven percent of the Regulatory Area 2B commercial landed catch.

In Alaska, the quota share (QS) landings were highest in May, with 22 percent of poundage from Alaska landed in that month, as in 2015. October was the busiest month in British Columbia, accounting for 15 percent of total poundage from Regulatory Area 2B. The 2016 landing of live Pacific halibut from Regulatory Area 2B (allowed by the DFO since 1999 as a means to get Pacific halibut to certain markets in a fresher state) resulted in a total landed weight far lower than in 2015 (exact pounds not reported due to confidentiality). It was also the lowest landed since 1999, when these landings were at a high of 103,000 pounds (46.72 t).

May was the busiest landing month in Alaska, and October was the busiest in British Columbia.

Sampling commercial landings

Sampling commercial landings is a key component to collecting data on Pacific halibut for the stock assessment. Port samplers collect otoliths,—fish ear bones (stones) that, when read under a microscope, give the animal's age in years—associated fork lengths, and fish weights, as well as logbook information, final landing weights, and any IPHC tags caught during fishing. Lengths of sampled Pacific halibut allow estimates of mean weight and, in combination with age data, size-at-age information. Actual fish weights are also available. Mean

Seward port sampler Jaelee Vanidestine shows the ropes to IPHC newcomer Keith Jernigan. Photo by Lara Erikson.

weights are combined with final landing weights to estimate 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 times and places, and percentage of fish sampled are based on landing patterns and are reviewed annually. The protocols can vary slightly from port to port to achieve the appropriate sampling representation.

Considering that vessels travel to multiple regulatory areas and are not limited in where they may land their catch, IPHC samplers were stationed in Pacific halibut ports coastwide. In Regulatory Area 2A, IPHC samplers were present in Newport (Oregon) and Bellingham (Washington). In addition, samples were taken in several treaty Indian ports in Washington by biologists from the treaty Indian fishery management offices. In Canada, IPHC samplers staffed Port Hardy, Prince Rupert, and Vancouver. In Alaska, the ports of Dutch Harbor, Kodiak, Homer, Seward, Juneau, Sitka, Petersburg, and St. Paul were staffed. Bellingham (Washington) and the listed Canadian and Alaskan ports were staffed from 19 March through 7 November apart from St. Paul which was staffed from 6 July through 19 August, during the height of the Area 4C CDQ and IFQ fisheries.

Otoliths

IPHC port samplers collected 12,111 otoliths from 36 percent of the landed catch.

As in 2015, samplers aimed to collect 11,500 total Pacific halibut otoliths in 2016, with the target for each of Regulatory Areas 2B through 4B and Area 4CD (combined) set at 1,500 (±500). The target for Regulatory Area 2A was set at 1,000; subdivided into a target of 650 for Regulatory Area 2A-1 treaty Indian fisheries and 350 for Regulatory Area 2A directed commercial fishery. Samplers collected 12,111 otoliths by sampling from 36 percent of the landed catch in the 763 landings sampled. Otolith targets were met in all areas with the exception of Regulatory Area 2A.

Prior to the 2016 season, a review of landings to assess if any statistical areas were being under-represented, revealed that there were statistical areas in Regulatory Area 3B where the proportion of landings with catch from these statistical areas into sampled ports was lower than their total contribution to the Regulatory Area 3B harvest. Despite this underrepresentation, Sand Point, AK was removed from the list of staffed ports due to logistical and budget considerations.

Samplers also collected specimens for the Clean Otolith Archive Collection (COAC), which comprises structures gathered from all IPHC otolith collection programs and other research opportunities; these are not used for age determination, but are cleaned, dried, and stored whole in climate-controlled conditions for future analysis. The COAC samples are supplied primarily by the fishery-independent setline survey. However, where there is a danger of falling short of the target of 100 otolith pairs on the fishery-independent setline survey, otoliths were also collected from the commercial landings. A total of 100 otolith pairs per area were targeted for collection in Regulatory Areas 2A, 4B, and 4CD, and this number was exceeded in 2A and 4B, but not in 4CD. Samplers collected a total of 178 COAC otoliths in Regulatory Area 2A, 145 in Area 4B, and 88 in Area 4CD.

Port program manager Lara Erikson trains new Dutch Harbor port sampler Jennifer Rogge how to collect vessel logbook information that will later be used for the stock assessment. Photo by Huyen Tran.

Logbooks

Alongside otolith samples, IPHC port samplers collected logbook information from harvesters. In total, 2,895 logs were collected in 2016. A total of 2,445 (84 percent by count) were collected from U.S. landings and 450 (16 percent by count) were collected from Canadian landings.

Recovered tags

In 2016, samplers collected 25 tags from tagged Pacific halibut, 18 of which originated in the 2013 tagging project that involved single- and double-tagging fish. One of the 18 tagged in 2013 was recovered in Sitka, three in Seward, seven in Homer, and seven in Kodiak. Additionally, four tags from the 2010 Aleutian wire tagging study were recovered (one in Kodiak and three in Dutch Harbor), and three tags applied during the 2015 NMFS trawl survey were recovered: two in Homer and one in Kodiak. See tagging studies under the Research section of this report for more details.

Electronic data collection

IPHC is digitizing data collection to eliminate or reduce the need for post-collection data entry and increase the efficiency of data editing. In 2016, each IPHC port sampler in Alaska and Bellingham, Washington, used an electronic tablet to input data from paper logbooks into a remote data entry (RDE) application. In 2017, RDE of log data will continue to be a regular part of the port sampling program log collection protocol.

Port samplers enter logbook information into a remote data entry application in an effort to streamline the data entry and editing processes.

Length-weight

Length-weight ratios vary by region and season so collection of these data by port samplers allow the examination of variability over space and time.

In 2016, IPHC port samplers weighed Pacific halibut in all staffed ports as part of standard random sampling procedures. These data can be used to estimate the relationship between fork length and net weight, including the estimation of adjustments necessary to convert head-on weight to net weight and adjust for the presence of ice and slime. Length-weight ratios vary by region and seasonally, so the collections allow IPHC Secretariat staff to review the patterns and degree of variability among Regulatory Areas or seasons.

In 2016, IPHC samplers in all ports collected Pacific halibut weight data throughout the fishing season, with the weighing of Pacific halibut integrated into the sampling of length and age data. This was the first year fish were weighed in St. Paul, AK and the first year weight sampling was part of the standard length and age data collection in Dutch Harbor, AK allowing for the collection of representative samples of fish harvested in Regulatory Areas 4A, 4B, and 4CDE. In Regulatory Area 2A, Pacific halibut landed in Bellingham were weighed, along with tribal landings in La Push. Pacific halibut sampled in these fisheries, and during derby openings in Newport, OR, for length and age collection will consistently be weighed in 2017. The results of the sampling showed strong evidence that in Regulatory Areas 2B, 2C, and 3A, the standard IPHC relationship overestimates expected weight. There will likely be positive biases in the 2016 mean net weight of a Pacific halibut calculated from the standard relationship ranging from two percent (Area 3B) to 11 percent (Area 4B). For the four areas with high sample sizes in 2015, estimates of bias in 2016 were similar (for Areas 2B and 2C) or higher (for Areas 3A and 3B) than in 2015.

The proportion of the total Pacific halibut weight comprised by the head varies across the coast, with Pacific halibut having mean head proportions close to 0.13, larger than the assumed value of 0.10 used in net weight calculations for Pacific halibut landings. Values in Regulatory Area 2B are closest to the assumed value.

Each year port samplers gather at IPHC headquarters in Seattle for training. Photo by Chris Johnston.

Age distribution of commercial fishery

In 2016, age distribution of Pacific halibut sampled from commercial landings is based on 10,938 otoliths aged as of publication time. Of the 11,431 otoliths received thus far (out of 12,108 otoliths collected), ages could not be determined for 493 of them because they were crystallized, right-sided, or badly broken. The 12-year-olds from the 2004 year class were the most abundant (2,086 fish, or 18% of the total). Sixty-seven percent (7,742 fish) were 10- to 14-year-olds.

Average fork length of sampled Pacific halibut increased in Regulatory Areas 2A, 3B, 4A, and 4CD in 2016, but decreased in all other areas. Average fork length for all areas combined increased by 1.0 cm in 2016. The average age from all areas combined in 2016 (13.4 years) was slightly higher than it was in 2015. The youngest and oldest Pacific halibut in the 2016 commercial samples were determined to be five and 43 years old, respectively.

Voluntary at-sea sex marking

Uncertainty regarding the sex ratio of commercial Pacific halibut landings represents one of the largest sensitivities within the current Pacific halibut stock assessment, in particular generating considerable variability around estimates of total female spawning biomass. A decades-long trend in which the average size of Pacific halibut landed in the commercial longline fishery declined (falling from 40 to 20 pounds (18-9 kg) between the mid-1970s and 2010) has caused concern regarding sex-specific mortality within the commercial fishery. Female Pacific halibut grow faster than males and are therefore viable targets for the fishery at a younger age. The behavior and seasonal characteristics of Pacific halibut also likely allow fishers to selectively target one sex over the other, resulting in the potential for large amounts of catch to come from times and places in which the population's underlying sex ratio is highly skewed.

The IPHC began a voluntary at-sea sex marking project in Area 2B in 2016. Over the course of the season, 28 sex marked deliveries were sampled by IPHC port samplers.

The sex ratio of the commercial landings cannot be determined using direct observations because commercially harvested Pacific halibut are dressed (eviscerated) at sea. To allow assessment, IPHC formally launched its five-year at-sea sex marking and validation program in 2014. The program is designed to culminate in the incorporation of sex-mark data collection into routine port sampling for commercial size and age data beginning during the 2019 commercial Pacific halibut fishing season.

The 2016 fishing season saw the initiation of voluntary at-sea marking by the commercial fleet within Regulatory Area 2B. IPHC and the Pacific Halibut Management Association of British Columbia (PHMA) created a laminated informational flyer to assist crew members in distinguishing between male and female Pacific halibut, and to describe the sex-marking procedure. PHMA included the flyer in their pre-season mailing to all Regulatory Area 2B commercial license holders, totaling 435 vessels. Subsequently, the IPHC's port samplers in Prince Rupert, Port Hardy, and Vancouver served as project liaisons and information points for crews operating out of those ports and sampled fish from trips where the sex was marked. Over the course of the season, 28 sex-marked landings were sampled representing just over 16 percent of the total number of landings and individual Pacific halibut sampled area-wide, and around 13 percent of total landings by weight. Those samples are scheduled for evaluation during 2017.

Recreational fishery

The 2016 sport harvest of Pacific halibut was estimated at 7.4 million pounds (3,347.5 t), as estimated by the IPHC with help from state and federal agencies. The 2016 take was similar to 2015, continuing below the historic levels seen in 2004-08 (when harvest averaged 10.7 million pounds; 4,853.5 t). The regulations governing sport fishing of Pacific halibut were specifically geared to each Regulatory Area.

The estimated recreational harvest of Pacific halibut was 7.4 million pounds (~3,348 t) in 2016.

IPHC Regulatory Area 2A (U.S.A. West Coast)

Regulatory Area 2A's sport fishers landed an estimated 502,202 pounds (227.79 t) of Pacific halibut in 2016, exceeding the 463,826 pound (210.39 t) allocation by 38,376 pounds (17.41 t).

The allocation was subdivided into seven subareas through the Pacific Fishery Management Council (PFMC) catch sharing plan: Washington Inside Waters (57,393 pounds; 26.03 t), Washington North Coast (108,030 pounds; 49.00 t), Washington South Coast (42,739 pounds; 19.39 t), Columbia River (11,009 pounds; 4.99 t), Oregon Central Coast (206,410 pounds; 93.63 t), Oregon South Coast (8,605 pounds; 3.90 t), and California (29,640 pounds; 13.44 t). California was a full partner in the Area 2A catch sharing plan and conducted in-season management for the first time.

In 2016, as in previous years, sport-fishing harvest timing remained dependent on the availability of salmon or albacore tuna. Each subarea was open between six and 184 days, depending on conditions. The Washington North Coast fishery was open for six days, twice as long as in 2015, during which time 99.4 percent of the subarea's allocation was caught.

Catch exceeded the allocation in Washington Inside Waters by 45,306 pounds (20.55 t; 78.9%) and came in on target or within a few percentage points in three others (Washington North Coast, with catch at 99.4 percent of allocation; Oregon Central Coast, with 98.2 percent; and California, with 99.8%).

IPHC scientist Claude Dykstra, sport fishing off the U.S. West Coast. Photo by Ed Henry.

IPHC Regulatory Area 2B (British Columbia; Canada)

In 2016, the sport harvest in Regulatory Area 2B was estimated by Fisheries and Oceans Canada (DFO) to total 1,012,844 pounds (459.42 t), an increase of two percent (19,024 pounds; 8.63 t) from the 993,820 harvest in 2015. The 1,101,000-pound (499.41 t) allocation for 2016 represented 15 percent of the total catch limit for the area. DFO kept in place several restrictions in 2016 to pace the harvest and lengthen the season within the constraints of the allocation. A maximum length restriction of 133 cm was in place, with a daily bag limit of one fish, and a possession limit of two fish, of which one Pacific halibut had to be smaller than 83 cm. DFO also continued an annual limit of six fish per angler.

The XRQ program in Area 2B allows the lease of commercial quota by sport fishers.

From 1 April to 31 December 2016, sport fishing also occurred under an experimental recreational Pacific halibut (XRQ) program under which commercial quota could be leased to sport fishers. As of September 18, 2016, a total of 8,851 pounds (4.01 t; comprised of 2,829 pounds—1.28 t—carried over from 2015, and 6,022—2.73 t—pounds transferred in 2016) were available in this program, and 5,217 pounds (2.37 t) of it had been utilized.

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

Management of the charter fishery in 2016 was conducted with a North Pacific Fishery Management Council (NPFMC) catch sharing plan for the charter sport and commercial fisheries for Pacific halibut in waters of Regulatory Areas 2C and 3A. IPHC implemented a reverse slot limit for managing the 2016 charter fishery in Area 2C, based on a recommendation by the NPFMC, which restricted harvest to Pacific halibut less than or equal to 43 inches (109 cm) fork length and Pacific halibut greater than or equal to 80 inches (203 cm). In Area 3A, charter anglers had a two fish daily bag limit but only one fish could be greater than 28 inches (71 cm).

The Guided Angler Fish (GAF) program initiated in 2014 was continued in 2016. The Pacific halibut catch sharing plan authorized annual transfers of commercial Pacific halibut Individual Fishing Quota (IFQ) as GAF fish to charter Pacific halibut permit holders in IPHC Areas 2C or 3A for the charter Pacific halibut fishery. Charter vessel operators participating in the program could offer their clients the opportunity to harvest up to two Pacific halibut of any size per day. Charter anglers using GAF were subject to the harvest limits in place for unguided sport anglers in that area. In 2016, there was a two-fish of any size daily bag limit for unguided sport anglers in Areas 2C and 3A.

In Area 2C, the sport harvest was estimated to have increased slightly this year, to 2,100,000 pounds (952.54 t) from 2,095,000 pounds (950.28 t) in 2015. Harvest by the charter fishery increased slightly, while the harvest by the non-charter sector dropped slightly. In Area 3A, the total estimated sport catch was 3,492,000 pounds (1,583.94 t), down slightly from 3,683,000 pounds (1,670.58 t) caught in 2015. Charter anglers caught fewer fish in 2016 (155,032) than 2015 (163,632), and those caught in 2016 had a slightly higher average net weight (12.67 pounds; 5.75 kg) than those caught the prior year (12.63 pounds; 5.73 kg).

In Area 3B and Area 4, sport fishing is less common than in other parts of Alaska, due to the relative remoteness of the ports. The estimated 2016 harvests for these areas remained relatively low—and reduced substantially from 2015—at 5,000 pounds (2.27 t) in Area 3B and 12,000 pounds (5.44 t) in Area 4A.

Incidental mortality of Pacific halibut in the commercial fishery (wastage)

The incidental mortality of Pacific halibut in the commercial fishery was estimated to have decreased by about eight percent from 2015.

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

Estimates of wastage in 2016 amounted to 1,178,000 pounds (534.33 t; net weight), which is a decrease of about eight percent from the estimated wastage in 2015. There are three main sources of wastage mortality accounted for by IPHC: (1) fish caught and never retrieved on lost or abandoned fishing gear; the discard of fish that measure below the legal size limit of 32 inches (U32; < 81.3 cm) and subsequently die; and (3) the discard of legal-sized Pacific halibut (O32; ≥32 inches or 81.3 cm) for regulatory reasons, such as a vessel reaching its trip or catch limit. How each of these is accounted for differs and is described below.

Wastage 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 frenzy resulted in a considerable quantity of lost fishing gear, which continued to kill fish. Estimates of the amount of missing gear were extrapolated to total catch values using available logbook catch and effort statistics.

The rate of O32 wastage from gear loss was calculated by first figuring out the ratio of effective skates lost to effective skates hauled aboard the vessels for

Retrieving the flag on the *F/V Vanisle*. Photo by Aaron Ranta.

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 included both snap gear and fixed-hook gear in all areas. U32 wastage from lost gear was calculated in a similar manner incorporating the U32:O32 ratio calculations for discarded U32 Pacific halibut as described below.

Wastage 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 British Columbia fishery (Regulatory Area 2B) 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 Areas, considering that the setline survey uses similar fishing gear, the survey data have been used as a proxy for the expected encounter rates by area and year. Results are filtered to use setline survey stations with a higher catch rate (by weight) of O32 Pacific halibut, similar to those observed in the commercial fishery. A universal mortality rate of 16% has been applied to all Pacific halibut discards from the individual quota fisheries (Canada and Alaska). For derby fisheries in previous years in British Columbia and Alaska, and for the Area 2A directed fishery, a mortality rate of 25% is applied. Accordingly, the amount of discarded U32 Pacific halibut in a commercial fishery is estimated by multiplying the ratio of U32 to O32 Pacific halibut by the landed commercial catch then by the mortality rate for that fishery.

A 16% mortality rate is applied to Pacific halibut discarded in the IQ fisheries and a 25% rate is applied to the directed Area 2A fishery.

Wastage from discard mortality for regulatory reasons

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

Personal use (subsistence) harvest

Pacific halibut that are caught by those that have traditionally relied on Pacific halibut as a food source or for customary purposes are classified as "personal use," as opposed to sport or commercial catch. Personal use harvest is barred from resale, so by nature does not make up a part of the commercial catch. The IPHC defines personal use harvest further as Pacific halibut taken in: 1) the federal subsistence fishery in Alaska; 2) the sanctioned First Nations Food, Social, and Ceremonial (FSC) fishery in British Columbia; 3) treaty Indian Ceremonial and Subsistence (C&S) fisheries in Washington state; and 4) U32 Pacific halibut (those under the legal size limit of 32 inches or 81.3 cm) retained by commercial fishers in Regulatory Areas 4D and 4E 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 catch and are not included in the estimates here.

The Alaska subsistence fishery, which was officially recognized in 2003, totaled an estimated 1.2 million pounds (~546 t) in 2016.

Estimated harvests by area

The 2016 coastwide personal use catch rose again after hitting its lowest point in 2013 since the Alaska subsistence program began in 2003. The 2016 estimate of 1,204,800 pounds (546.49 t) is up slightly from the 2015 estimate of

A rare sinistral (left side) Pacific halibut spotted among the catch. Photo by Rob Ames.

1,204,000 pounds (954.36 t). The estimates for the subsistence Pacific halibut harvest typically lag by a year, so the 2016 estimates are not yet complete.

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

The personal use allocation in Regulatory Area 2A consists of the C&S fishery that the Treaty tribes have subdivided from their catch limit. The 2015 final estimate of C&S was 33,900 pounds (15.38 t), and this catch estimate became the 2016 C&S allocation. In 2016, an estimated 33,900 pounds (15.38 t) were harvested.

Regulatory Area 2B (British Columbia; Canada)

The FSC fishery constituted British Columbia's personal use harvest. Fisheries and Oceans Canada (DFO) estimates 405,000 pounds (183.70 t) were harvested in the FSC fishery. DFO has estimated the same level of harvest for this fishery since 2007.

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

The 2016 personal use estimate for Alaska, carried over from the 2014 and 2015 harvest, was 765,900 pounds (347.41 t) of Pacific halibut, an increase from 697,000 pounds (316.15 t) in 2013 and 707,200 pounds (320.78 t) in 2012. Regulations on the personal use fishery in Alaska set by the National Marine Fisheries Service 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.

According to Alaska Department of Fish and Game's voluntary annual survey, conducted in 2014 and carried forward to apply to 2015 and 2016, Regulatory Area 2C pulled in the most Pacific halibut as personal use, at 428,200 pounds (194.23 t), followed closely by Area 3A, at 231,300 pounds (104.92 t). The remaining regulatory areas accounted for a small fraction of these two, with Area 3B claiming 18,300 pounds (8.30 t), while the combined Area 4 (non-CDQ) fishery pulled in an estimated 82,600 pounds (37.48 t).

Retention of U32 Pacific halibut in the CDQ fishery

U32 Pacific halibut are allowed to be retained in the CDQ fisheries taking place in Areas 4DE.

The IPHC allows commercial Pacific halibut vessels fishing for certain Community Development Quota (CDQ) organizations in 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 2016, retention of U32 Pacific halibut in the CDQ fishery was 5,457 pounds (2.48 t), an increase from the 4,666 pounds (2.12 t) of Pacific halibut retained in 2015. 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: 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 a catch of 3,456 pounds (1.57 t) of Pacific halibut in 2016, a 40 percent increase from 2015. The average weight of the 403 U32 Pacific halibut caught was 8.6 pounds (3.9 kg), and 94 percent of the fish measured at least 26 inches (66 cm) long. As in 2015, vessels out of Togiak landed the majority of Pacific halibut, followed by those at Dillingham.

Two of the three CDQ organizations reported a U32 catch totaling 5,457 pounds (~2.5 t) in 2016.

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 2016, for the second year in a row, CVRF reported that their fishers landed zero Pacific halibut and no fish were received by their facilities in Chefornak, Hooper Bay, Kipnuk, Mekoryuk, Toksook Bay, and Tununak.

Norton Sound Economic Development Corporation

The NSEDC is the northernmost of the three organizations, centered on Nome, Alaska. 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 2016, the area's only plant, at Nome, received 2,269 pounds (net; 1.03 t) of Pacific halibut, with an average weight per fish of 8.7 pounds (3.9 kg). The amount retained in 2016 was a decrease of nine percent from 2015.

Incidental mortality of Pacific halibut (bycatch)

Incidental catch, or "bycatch" refers to the unintended capture of Pacific halibut by other fisheries. Regulations require such fish be returned to the ocean but many perish from injuries sustained during capture. This section summarizes the estimated mortality across fisheries where Pacific halibut are caught, within the IPHC Convention Area.

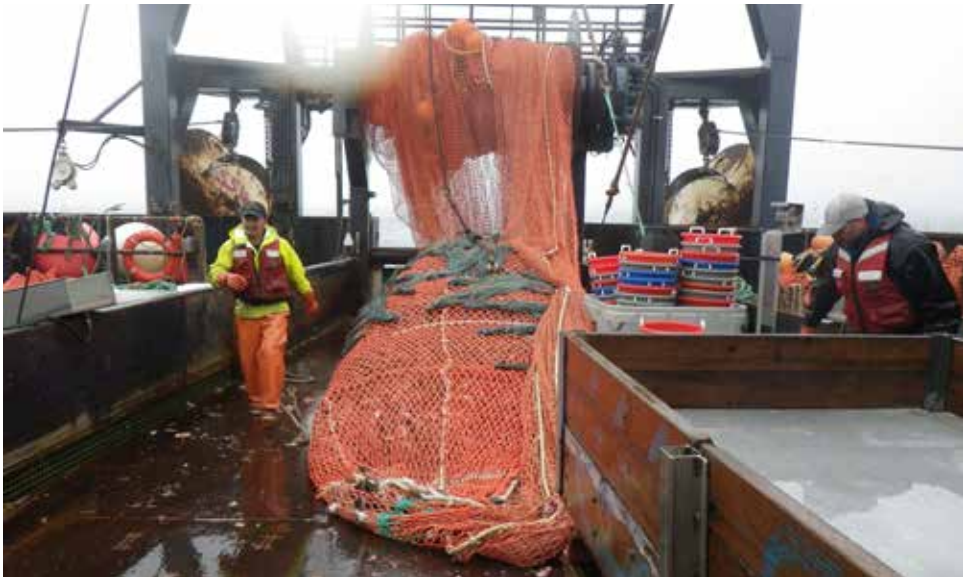
There has been a declining trend in bycatch mortality over the last few decades, with 2016 representing the lowest level in 25 years. According to NMFS estimates, in 2016 there were 7,095,000 pounds (3,218.24 t) of Pacific halibut bycatch mortality, representing a five percent decrease from the 7,488,000 pounds (3,396.50 t) lost in 2015. Today's level is almost down to one-third of the high of 20,293,000 pounds (9,204.75 t) recorded in 1992. Estimates for 2016 are preliminary and subject to change as new information becomes available.

The incidental mortality of Pacific halibut in 2016 was estimated to be the lowest it's been in 25 years.

Sources of bycatch information

The IPHC relies on observer programs run by government agencies from Canada and the U.S.A. for bycatch information. National Marine Fisheries Service (NMFS) monitors trawl fisheries off the coast of Alaska (Regulatory Areas 2C-4) and the U.S. west coast (Area 2A), while Fisheries and Oceans Canada (DFO) monitors fisheries off British Columbia (Area 2B).

Off the U.S. west coast, 100 percent fishery monitoring coverage for the IFQ trawl fishery is mandatory, so all vessels must carry an observer. The varied methods used for recovering bycatch information for British Columbia include



Incidental catch of Pacific halibut can occur with any gear including trawl, longline, and pot. Pictured here is a trawl codend which has just been pulled aboard the survey vessel. Photo by Paul Logan.

catch sampling and 100 percent at-sea monitoring.Estimates of bycatch off Alaska for 2016 in federally managed fisheries were provided by the NMFS Alaska Region. Several fishery programs have a mandatory 100 percent monitoring requirement, including the Central GOA Rockfish Program, the Bering Sea/Aleutian Islands (BSAI) Community Development Quota (CDQ) fisheries, the American Fisheries Act pollock cooperatives, and the BSAI Ammendment 80 fishery cooperatives. An annual deployment plan (ADP) provides the scientific guidelines, which 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. Estimates of bycatch mortality off Alaska for 2016 were based on reports filed through 1 November from the NMFS Alaska Region website and projected through the remainder of the year.

Discard mortality rate is the percentage of Pacific halibut that die as a result of capture and this value varies by fishery and area.

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 from pre-set criteria. For fisheries without observers, assumed DMRs are used, which are based on similar fisheries in other areas where data are available.

Bycatch mortality by Regulatory Area

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

Reporting for this area lags by one year, so the numbers for 2016 are not yet available. The results from 2015 are reported here as projections for 2016, and will be updated when final estimates become available. Regulatory Area 2A bycatch mortality in 2015 was 98,000 pounds (44.45 t), almost identical to the 2011-14 average for this fishery. Bycatch in the area remains substantially below levels seen in the pre-IFQ fishery period. As in prior years, the bottom trawl fishery and hook-and-line fishery for sablefish were responsible for the bulk of the bycatch.

Bycatch mortality in the 2015 hook-and-line fisheries was estimated at 41,000 pounds (18.60 t), which was a decrease from the 2014 estimate of 49,000 pounds (22.23 t). Groundfish fisheries in Area 2A are managed by NMFS, following advice and recommendations developed by the Pacific Fishery Management Council (PFMC). Pacific halibut bycatch in trawl fisheries in this area are capped at 100,000 pounds (45.36 t, net weight) of O32 ($\geq$ 32 inches or 81.3 cm fork length) Pacific halibut.

Regulatory Area 2B (British Columbia, Canada)

DFO staff at the Pacific Biological Station estimated bycatch mortality for the bottom trawl fishery in Regulatory Area 2B to be 258,000 pounds (117.03 t), down 21 percent from 2015. In contrast to prior years, the amount of Pacific halibut bycatch was relatively constant throughout the first nine months of 2016. In previous years, the highest bycatch occurred during the summer months.

The results of a trawl tow aboard the NMFS trawl survey. Photo by Paul Logan.

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

NMFS reported bycatch by hook-and-line vessels fishing in the outside (federal) waters of Regulatory Area 2C in 2016. The vessels in this area were mostly targeting Pacific cod and rockfish in open access fisheries, and sablefish in the IFQ fishery. In the aggregate, these fisheries resulted in roughly 30,000 pounds (13.61 t) of bycatch mortality in 2016.

Fisheries in this area that take bycatch include pot fisheries for red and golden king crab, and tanner crab. Bycatch in these fisheries has been fairly low, with most (typically 90 percent) of the mortality from pot fisheries occurring in the tanner crab fishery. Since 2011, however, the tanner crab fishery has accounted for only about 60 percent of bycatch due to the growth of the red king crab fishery. Since 1995, annual estimates of bycatch in the crab pot fisheries have been less than 35,000 pounds (15.88 t), and frequently lower than 21,000 pounds (9.53 t), especially since 2004.

In SE Alaska, bycatch takes place in hook-and-line fisheries targeting Pacific cod, rockfish, and sablefish, and pot fisheries targeting red king and tanner crab.

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

A preliminary estimate of Pacific halibut bycatch mortality for Regulatory Area 3 in 2016 amounts to 3,019,000 pounds (1,369.40 t; including 2,536,000 pounds—1,150.31 t--from the groundfish trawl fishery), a 12 percent increase from 2015's level of 2,258,000 pounds (1,024.21 t).

Bycatch mortality decreased in 2016 in Area 3A, from 2,098,000 pounds (951.64 t) in 2015 to 1,967,000 pounds (892.22 t) in 2016. In Area 3B, however, bycatch mortality increased in 2016 from 658,000 pounds (298.46 t) to 979,000 pounds (444.07 t). In Area 3A, the hook-and-line fishery (both IFQ and non-IFQ) and the groundfish pot fishery saw increases in bycatch, but bycatch decreased for all fisheries in Area 3B. Notably, there was a large uptick in trawl fishery bycatch mortality in Area 3B, to 800,000 pounds (362.87 t). This may have been related to the non-pollock, non-rockfish trawl fishery closure (Four deep water Pacific halibut PSC limit closures were triggered during 2016) from May through August.

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

Pacific halibut bycatch mortality in Regulatory Area 4 was estimated at 3,691,000 pounds (1,674. 21 t) in 2016, a 14 percent decrease from 4,290,000 pounds (1,945. 91 t) in 2015. This estimate for 2016 is the lowest since 2000, and is well below the 2005-2015 mean of 5,800,000 pounds (2,630.84 t). Trawl fishery bycatch was estimated at 3,200,000 pounds (1,451.50 t), a second consecutive annual decline, now 35 percent less than in 2015. Hook-and-line bycatch mortality in 2016 was estimated at 550,000 pounds (249.48 t), an eight percent decrease from the 600,000 pounds (272.16 t) estimated for 2015. Bycatch rates for pot fisheries are quite low, resulting in an estimated 8,000 pounds (3.63 t) for 2016. Within the Bering Sea, bycatch has typically been the highest in Area 4CDE due to the flatfish ground fishery in the area. In 2015, bycatch in Areas 4CDE combined accounted for 81 percent of the total Bering Sea bycatch.

Bycatch from the Prohibited Species Donation program

Pacific halibut donated through the Prohibited Species Donation program were distributed to food banks in three states in 2016 including Alaska, Washington, and California.

Through the Prohibited Species Donation program managed by SeaShare, an organization based on Bainbridge Island, Washington, U.S.A., Pacific halibut unintentionally landed by trawl vessels in the Bering Sea/Aleutian Islands and the Gulf of Alaska, are processed into steaks and donated to food banks throughout the United States. The amount of landed Pacific halibut bycatch handled in the program has totaled 581,974 pounds (263.98 t; net weight) since program inception, representing over 1.75 million meals, based on a 1/3rd pound serving size.

After a variety of cooperating cold-storage companies weigh, inspect, steak, and repack the fish, SeaShare sends it out to hunger relief programs. Food banks receiving this fish in 2016 were The Glory Hole (Juneau), Kenai Peninsula Food Bank (Soldotna), Brother Francis Shelter (Kodiak), Kodiak Baptist Mission (Kodiak), Nana Corp. (Kotzebue), Kawerak, Inc. (Nome), Food Bank of Alaska (Anchorage), St. Herman's Seminary (Kodiak), and San Francisco Food Bank (California). Additionally, new recipients in 2016 included Millionair Club (Seattle), 2nd Harvest (Spokane), and the city of Palmer, AK.

The 45,665 pounds (20.71 t) of Pacific halibut bycatch landed by vessels fishing groundfish off Alaska in 2016 (through 30 September) came from both the Bering Sea (mostly from Akutan) and Gulf of Alaska (mostly Kodiak). Processors in Bering Sea ports received 20,999 pounds (9.53 t), and processors in Gulf of Alaska ports received 24,666 pounds (11.19 t). The preliminary figures showed a lower proportion of Pacific halibut coming from Gulf of Alaska processors in 2016 (54 percent, down from 74 percent in 2015). SeaShare expects a significant amount from the port of Dutch Harbor, AK from the pollock "B" season, which has yet to be tallied, and final 2016 figures could prove to be composed of a higher proportion of donations from the Bering Sea, as opposed to the Gulf of Alaska.

Survey activities

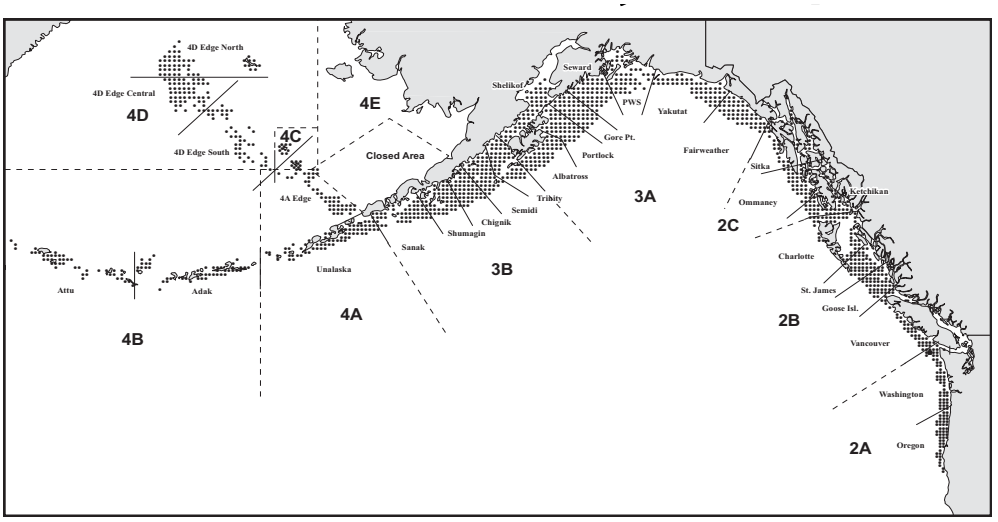
Every year the International Pacific Halibut Commission (IPHC) conducts a fishery-independent setline survey and participates in National Marine Fisheries Service (NMFS) trawl surveys. Activities during these cruises include collection of biological and oceanographic data, tagging and release of fish, and other projects. Fishing activities are summarized here and other projects are described in more detail in the Research section of this report.

The IPHC fishery-independent setline survey provides a view of the Pacific halibut population independent of the commercial fishery and results are a critical component to the stock assessment process.

IPHC fishery-independent setline survey

The IPHC fishery-independent setline survey (a.k.a. the "setline survey") gathers catch-rate information and biological data such as the size, age, and sex-composition of Pacific halibut, and is used to monitor changes in biomass, growth, and mortality in adult and sub-adult components of the Pacific halibut population. The setline survey uses standardized methods, bait, and gear during summer months to gain a balanced picture that can be compared over a large area and from year to year. When other species are caught, their presence provides data about bait competition and the rate of bait attacks. Other species data can also provide an indication of abundance over time, making them valuable to the assessment, management, and avoidance of bycatch species. The setline survey data are standardized (including fishing locations) which means they are independent of the common changes in gear, bait and set location seen in the commercial fisheries. The two data sets together, from the setline survey and the commercial fishery, provide a complete picture of the Pacific halibut population in convention waters.

Crewman Conner McLellan, Captain Russell Cameron, IPHC sea sampler Nathan Willse, and crewman Josep McKay (left to right) getting ready to go ashore from the *F/V Free to Wander* during the 2016 fishery-independent setline survey. Photo by Jason Taylor.



Stations fished during the IPHC fishery-independent setline survey in 2016.

Thank you to the captains and crews of the fishing vessels that carried out the 2016 IPHC setline survey. The 14 fishing vessels were:

Allstar
Bold Pursuit
Clyde
Free to Wander
Kema Sue
Norcoaster
Pacific Surveyor
Pender Isle
Polaris
Saint Peter
Seymour
St. Nicholas
Sunward
Vanisle

Design and procedures

The 2016 setline survey covered both nearshore and offshore waters of southern Oregon and Washington, U.S.A., British Columbia, Canada, and Alaska, U.S.A. including southeast Alaska, the central and western Gulf of Alaska, Aleutian Islands, and the Bering Sea continental shelf. The IPHC chartered 14 commercial longline vessels for setline survey operations. During a combined 77 trips and 698 charter days, these vessels fished 29 charter regions. Each region required between 16 and 39 days to complete.

The setline survey was conducted via stations arranged in a grid reflecting the depth range occupied by Pacific halibut during summer months (20-275 fathoms or 37-503 m in most areas). In 2016, the IPHC conducted a standardized grid setline survey in the northern part of Regulatory Area 4D as a continuation of the multi-year coastwide effort to expand the setline survey depth profile and update calibration with other surveys. An additional 83 stations were added to Regulatory Area 4D, including stations as shallow as 50 fathoms (91 m) and as deep as 400 fathoms (732 m). Six skates of baited gear were set at each setline survey station in all charter regions. Setline survey sampling work involved each vessel setting from one to four stations every day, with boats setting gear as early as 5:00 a.m. 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, as were sets for which predetermined limits for lost gear, snarls, predation, or displacement were exceeded. Setline survey gear consisted of fixed-hook, 1,800-foot (549 m) skates with 100 circle hooks of size 16/0 spaced 18 feet (5.5 m) apart. The length of the gangions ranged from 24 to 48 inches (61 to 122 cm). Each hook was baited with 1/4 to 1/3 pounds (0.11 to 0.15 kg) of chum salmon.

Sampling protocols

Following protocols set out in the 2016 Standardized Stock Assessment Survey Manual, shipboard biologists (also known as sea samplers) assessed the functionality of bird avoidance devices during setting of the gear, and also

recorded the number of hooks set and baits lost per skate. During gear retrieval, the biologists recorded hook status (whether hooks were pulled up empty or what species were captured) for the first 20 consecutive hooks of each skate. However, processing needs for fish from previous skates, particularly in areas with high catch rates, occasionally affected where in the 100-hook sequence of the skate the sample was taken. In northern stations of Regulatory Area 2A, and all of Area 2B, samplers recorded the status of all hooks in the order in which they were hauled, in lieu of 20-hook subsample counts.

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

The male fish were deemed to be either mature or immature, and the females were categorized as immature, ripening, spawning, or spent/resting. The sex and maturity level of U32 (forklength < 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.

Special setline survey projects

The setline survey includes a number of special projects that are not directly associated with the Pacific halibut stock assessment. The following is a brief summary of those projects in 2016, and more information can be found on several of them in the Research section of this report where indicated.

The survey in 2016 included 14 special projects in addition to the standard sampling. Some, but not all projects were carried out coastwide.

Seabird occurrence

At the end of each setline survey haul, samplers recorded the number of seabirds present within a 50-meter radius of the vessel's stern so as to judge where and when they gather in most abundance. Tracking seabird occurrence is important because fisheries can be shut down due to overly high mortality of endangered seabirds, such as the short- tailed albatross. More information on this project can be found in the Research section of this report.

Rockfish sampling in Regulatory Area 2A

IPHC sea samplers recorded where and at what depth all rockfish were captured in Regulatory Area 2A. They individually marked and brought them all to port, recording the station and skate of capture. Biologists from Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) then collected additional data, such as sex, weight, length, and maturity, as well as otoliths and fin clips for genetic analysis of each fish. In 2016, state biologists sampled 245 rockfish that were captured in Area 2A.

In 2016, as in 2015, eight rockfish index stations were added to the standard setline survey stations at the request of WDFW. Only three skates were set at these locations in order to reduce pressure on the rockfish population. Pacific halibut that were caught on these rockfish skates were measured and released alive and without removing otoliths, and none of those data were used in the Pacific halibut stock assessment.

Rockfish sampling in Regulatory Area 2B

The sampling of rockfish has occurred annually since 2003 (with the exception of 2013) in Regulatory Area 2B, and is expected to continue indefinitely. IPHC samplers analyzed and recorded the round weight, length, sex, and maturity, and collected otoliths from all rockfish caught on the setline survey, according to the sampling criteria in the 2016 Protocols for Rockfish Data Collection in British Colombia. Samplers collected biological data from 2,180 rockfish (representing 14 different species), and collected otoliths from 2,085 rockfish. IPHC shared these data and otoliths with Fisheries and Oceans Canada (DFO).

Crewman Ivan Mametieff ("Johnny") and IPHC sea sampler Greg Riepma on the *F/V St. Nicholas*. Photo by Zach Kelleher.

Yelloweye rockfish enumeration in Alaska

At the request of the Commercial Fisheries Division of the Alaska Department of Fish and Game (ADF&G), IPHC samplers enumerated all yelloweye rockfish (*Sebastes ruberrimus*) pulled in by setline survey vessels in Regulatory Area 2C and in the Fairweather charter region of Area 3A. In 2016 this involved collecting data for a total of 1,162 yelloweye rockfish, which were sent to ADF&G for analysis.

For several years, IPHC has participated in a study to look at environmental contaminants in Pacific halibut.

Oceanography

IPHC deployed water column profilers at every setline survey station for the eighth consecutive year in 2016 unless prevented by weather or tide conditions. The goal is to measure depth, temperature, salinity, dissolved oxygen, pH, and chlorophyll *a* concentration throughout the water column and on the Pacific halibut grounds. More information about this project can be found in the Research section of this report.

Environmental contaminant sampling

IPHC samplers contributed to an ongoing study on environmental contaminants in Pacific halibut, undertaken in conjunction with the Alaska Department of Environmental Conservation (ADEC). Flesh samples from Pacific halibut caught by setline survey vessels were collected from a range of sizes at stations that corresponded to areas of high commercial catch. In 2016, a total of 66 samples were collected in the Attu charter region, 85 in the Sitka region, and 68 in the 4D Edge North region. Samples were subsequently tested for a range of environmental contaminants, including organochlorine pesticides, dioxins, furans, polybrominated diphenyl ethers, polychlorinated biphenyl congeners, methyl mercury, and heavy metals (arsenic, selenium, lead, cadmium, nickel, and chromium). Additional small muscle and liver tissue samples were collected to be examined for genetic expression of genes that are responsive to contaminant load.

Icthyophonus sampling

In 2016, the IPHC continued its research into how widespread the microscopic protozoan parasite called *Ichthyophonus* is in the Pacific halibut population. *Ichthyophonus* are from the class Mesomycetozoea, a highly diverse group of organisms with characteristics of both animals and fungi, and has been identified in many marine fish. The 2016 project resampled the three geographically distinct areas that have been sampled since 2011: Oregon, Prince William Sound, and Bering Sea charter regions. Samples were collected for both the traditional grow-out test, as well as for a similar test using a genetic probe for *Ichthyophonus*. Genetic and histology results for these samples are still pending, and traditional grow-out results are similar to previous years.

At-sea weights pilot study

As a fundamental concept that the IPHC uses for stock assessment, apportionment, and all facets of Pacific halibut management, net weight is a key metric, but the data are a result not only of natural variation but also of variable processing procedures that occur after the fish is caught. The at-sea weights pilot study collected data on the setline survey for use in estimating the relationship between fork length and net weight, complementing an ongoing project in which portions of commercial deliveries were measured and weighed at the dock. The study provided length-to-weight data that is not available at commercial offloads: from U32 Pacific halibut, round fish, and freshly eviscerated and dressed fish, allowing for measurements of shrinkage from the time of capture to final weighing at the offload.

The at-sea weights study compliments an ongoing project undertaken by the port sampling team to understand the relationship between fork length and net weight as the effects of variable processing procedures.

In 2016, building the 2015 pilot project, samplers used a motion-compensating scale to weigh Pacific halibut on nine trips in the Ommaney, Sitka, and Fairweather charter regions. These regions were selected because they have a high proportion of large Pacific halibut. Samplers weighed and measured 943 fish at sea in the round and immediately after being dressed. All the O32 fish (fork length $\geq$ 32 inches or 81.3 cm) were weighed again at the offload, except those from the final trip's offload, during which the scale malfunctioned and no weights were recorded. This project will be incorporated into the standard setline survey protocols.

Sea sampler Chris Clarke measures and weighs a Pacific halibut dockside in Sitka, AK as part of the at-sea weight study. Photo by Tracee Geernaert.

For the past few years, IPHC has collected samples of incidentally caught sixgill sharks to assist the Seattle Aquarium and NOAA with a population genetics study.

Spiny dogfish sampling

In 2016, IPHC samplers collected data on the sex and length of 2,728 spiny dogfish as part of a multi-year study requested by NOAA-Alaska Fisheries Science Center 's (AFSC) Auke Bay Laboratories. The study aims to compare IPHC's setline survey catch rates with those from the NOAA lab's sablefish (*Anoplopoma fimbria*) longline surveys. The results will shed light on species distribution and test the hypothesis that there may be two biological stocks of dogfish—one in southeast Alaska's inside waters, and one in coastal waters elsewhere. These data will be used to develop a length-based population dynamics model for the annual dogfish stock assessment.

Sixgill shark genetics

Since 2014, the IPHC has collected samples of broadnose sixgill sharks (*Hexanchus griseus*) caught on the setline survey to assist the Seattle Aquarium and NOAA-AFSC in the examination of the genetics of this population in the north Pacific Ocean. Little is known about these sharks outside of Puget Sound. Samplers took two samples in 2016 to add to the seven collected in 2015. Both samples were collected in British Columbia waters, one off Cape Scott and one in Queen Charlotte Sound. Samplers took simple morphometrics (greatest length) to determine maturity, and tissue samples (1-2 mm fin clips) to determine approximate age (subadult vs. adult).

Pacific cod length frequencies

The IPHC shared data with NOAA-AFSC on Pacific cod (*Gadus macrocephalus*) captured during the setline surveys on the Bering Sea continental

shelf edge in Regulatory Areas 4A and 4D, and in Area 4B. NOAA will use this information to bolster data currently used to assess the Bering Sea and Aleutian Islands Pacific cod stock. In 2016, length frequency data were collected by recording the total lengths of the first 15 Pacific cod from each skate on the setline survey vessels working these areas. Samplers collected 12,007 Pacific cod lengths aboard the *F/V Norcoaster* (2,294), *F/V St. Peter* (4,745), *F/V Sunward* (2,320), and the F*/V Vanisle* (2,648).

Pacific cod genetics

The University of Washington School of Aquatic and Fishery Sciences and NOAA-AFSC collaborated on a request to collect Pacific cod genetic samples during the 2016 setline survey. The data from this project will help establish a new method of estimating migration routes in marine fish, and will inform Pacific cod stock assessment by estimating the level of migration between statistical areas. More specifically, the study hopes to determine contributions of Aleutian Island and Eastern Bering Sea spawning populations to mixed summer fisheries. A total of 732 samples were collected; 97 from the Semidi charter region, 299 in the 4D Edge North region, 237 in the Attu and Adak regions, and 99 in the 4A Edge region.

The presence of marine mammals around the survey vessels while fishing were recorded again in 2016 as an effort to catalogue interactions with longline gear.

Depredation tracking

Pacific halibut, once hooked by the commercial fishery, are vulnerable to attack by marine mammals such as orca whales, sperm whales, seals, and sea lions. During gear retrieval, samplers on the setline survey recorded all damaged and missing hooks to establish a baseline rate of gear damage against which to compare stations with suspected interference from depredating species. Some of this type of interference can be difficult to detect and quantify. If sea samplers observed any toothed whales or pinnipeds within 100 meters of a setline survey vessel, they identified the individuals to species level, recorded the number

Orca whales have been known to eat the catch directly off the hooks as the strings of gear are being hauled. Photo by Paul Logan.

present, position (in relation to the vessel, the gear, and the offal discharge), and the hook number at first and last encounter. Samplers also noted all damaged Pacific halibut and damaged bycatch retrieved during these encounters. A station was considered ineffective due to whale depredation if the sum of damaged gear and damaged catch was greater than 10% of the hooks set.

In 2016, marine mammals approached charter vessels during gear retrieval on 71 sets (5.2% of total sets); of those, 51 encounters (or 72%) involved either sperm whales or killer whales. Though damaged Pacific halibut were observed on 23 of the stations where whales were present, no sets were deemed ineffective for Pacific halibut stock assessment because of depredation. These data will continue to be collected so that these interactions may be further evaluated.

Pop-up Archival Transmitting (PAT) and wire tagging

A total of 20 Pacific halibut were tagged with PAT tags aboard the *F/V Saint Peter*, 17 in the 4D Edge North charter region, and three in the 4D Edge Central region. A total of 169 Pacific halibut were tagged with wire tags during the 2016 setline survey, 48 aboard the *F/V Sunward* in the 4D Edge South charter region and 121 on the *F/V Saint Peter* in both the 4D Edge North and Central regions. More information about tagging projects can be found in the Research section of this report.

Bait purchases

To ensure consistency from year to year, the bait used for the setline survey is always No. 2 semi-bright (Alaska Seafood Marketing Institute grades A through E), headed and gutted, and individually quick-frozen chum salmon. In August 2015, staff began arranging bait purchases for 2016. Approximately 275,000 pounds (~124.8 t) of chum salmon were utilized from two suppliers in the U.S.A. An additional 36,000 pounds (~16.3 t) of chum salmon were purchased in-season from one U.S.A. salmon processor. Bait quality was monitored and documented throughout the season and found to meet the standard as described above.

O32 halibut caught on the setline survey is processed as it would be on a commercial vessel and sold to help offset the cost of the setline survey. In 2016, the total setline survey catch was 681,553 pounds (~309 t).

Fish sales

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

In 2016, IPHC's chartered setline survey vessels delivered a total of 681,553 pounds (~309 t) of Pacific halibut to 24 different ports. The coastwide average price per pound was $6.85 (U.S.), amounting to a sales totaling $4.7 million (U.S. dollars).

Field personnel

The 2016 setline survey vessels were crewed by a combination of seasonal hires and IPHC staff. Two samplers are typically aboard each setline survey vessel. At a given time, one biologist handles fish, collects data, and samples on deck, while the other sea sampler, in a portable shelter, records data and observations and stores samples collected by the deck sampler. Low catch rates in Regulatory Area 2A required only one sampler for all but the first trip in the northern portion of the Washington charter region (which was staffed by two samplers for 10 days). The IPHC also deployed four samplers on the NOAA-AFSC trawl survey—two on the *F/V Sea Storm* during the Aleutian Island survey and two on the F/*V Vesteraalen* during the Bering Sea survey.

The setline survey is routinely conducted during the summer months of June, July, and August.

IPHC sea samplers ready to start the survey season after successfully completing a week of intensive training at IPHC headquarters in Seattle, WA. Photo by Tom Kong.

IPHC fishery-independent setline survey results

As always, the IPHC targeted the summer months—June, July, and August—for setline survey fishing, and the vast majority (about 93%) of all stations were fished in those months. The early part of the setline survey season saw the greatest activity; coastwide activity declined early in August and was fully completed by mid-August.

Weight and number per unit effort (WPUE and NPUE)

As a result of including both commercial and non-commercial fishing grounds, the setline survey results have an average weight-per-unit-effort (WPUE) for all Regulatory Areas below that of the commercial fleet. The average total raw WPUE figures for the Regulatory Areas were:

Regulatory Area	lbs/skate	kg/skate
2A	30	14
2B	89	40
2C	177	80
3A	130	59

3B	82	37
4A	51	23
4B	56	25
4C	60	27
4D	19	9
4E	Only fished as part of the EBS expansion*	

*For details about expansion stations, see the section titled *Fishery-independent setline survey expansions in 2016*.

Compared to 2015 results, WPUE increased in Regulatory Areas 3A (+26%), 3B (+4%), 4A (+4%), and 4C (+36%). WPUE decreased in Regulatory Areas 2A (-3%), 2C (-14%), and 4D (-37%). There was no change in WPUE in Regulatory Areas 2B and 4B. Since 2011, Area 2C's WPUE has exceeded Area 3A's, and has been the highest WPUE of all the regions. Although weight is the primary unit of measure when studying population and removals, the number of Pacific halibut is also a critical measure. There was a 10 percent decrease in the relative numbers of U32 Pacific halibut caught and a four percent increase in catch rates of O32 Pacific halibut when compared to 2015.

About 112 different species of fish and invertebrates were encountered on the setline survey gear. At least 20% of the hooks were recorded in all areas and some areas recorded 100%.

Otolith collection

Collection of Pacific halibut otoliths for aging is a major activity of the setline survey. In 2016, the otolith collection goal was 2,000 per Regulatory Area (with a minimum target of 1,500 per area). Samplers removed a total of 15,505 otoliths from 80,200 Pacific halibut, a 19.3 percent sampling rate. Due to low catch rates and few setline survey stations, the minimum 1,500 otolith goal was not reached in three Regulatory Areas. Additional otoliths were collected in most Regulatory Areas for the clean otolith archive collection, which will be used in the future for projects not yet identified.

Bycatch

As a result of the setline survey, around 112 species of fish and invertebrates were captured as bycatch. Despite precautionary measures taken by skippers to avoid marine mammal and bird catch, one black-footed albatross (*Phoebastria nigripes*) was captured in Regulatory Area 3B and was provided to the Oikonos organization for genetic sampling. The most frequent incidental species groups consisted of a nearly equal distribution of sablefish, sharks, and rockfish. Dogfish were the most commonly caught shark species in Areas 2A, 2B, and 3A. Pacific cod was the most frequent bycatch in Areas 3B, 4A, and 4D. In Areas 2C, 4B, and 4E, a large range of "other species" were captured as bycatch, most commonly yellow Irish lord sculpins (*Hemilepidotus jordani*), unidentified starfish, grenadiers (*Macrouridae*), and arrowtooth flounder (*Atheresthes stomias*).

Pacific halibut distribution

Just upwards of 56 percent of Pacific halibut caught during the setline survey were smaller than the current commercial legal size limit (U32) with a median fork length of 79 cm. In 2016, median length increased in Regulatory Areas 3A and 4C; decreased in Areas 2A, 2C, 3B, 4B, and 4D; and did not change in Areas 2B and 4A. Most of the western regions (Areas 3A, 3B, 4A, and 4B) had U32 median lengths. The largest median length was in Area 2C (85 cm).

The sex composition of setline survey-caught O32 Pacific halibut varied widely among areas, ranging from 36 percent to 89 percent female. As in the prior year, 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. Also, as in previous years, Area 4C showed the highest concentration of females, and increasingly so over the last few years. Also of note, Area 3B had a 15 percent decrease in the recorded females as compared to last year. Most female Pacific halibut caught were in the ripening stage and expected to spawn in the upcoming winter season.

Age distribution

The otoliths collected on the setline survey give us an age distribution of Pacific halibut coastwide. Of the otoliths collected during the setline survey 15,113 were successfully aged. The most commonly occurring year class for both males and females was 2005 (11-year-olds), with 2,950 caught. Next most common were the year classes 2004 (12-year-olds), with 2,519 caught, and 2006 (10-year-olds), with 1,625 caught.

In 2016, the youngest and oldest Pacific halibut caught in the setline survey samples were three and 50 years old, respectively. There was one fish determined to be three years old: a female from Area 3A measuring 52 cm FL. The 50-year-old was a male captured in Area 4B with a fork length of 121 cm. The maximum fork length recorded for setline survey-caught Pacific halibut in 2016 was 187 cm. There were two fish measuring 187 cm, both female: a 26-year-old caught in Area 3A and a 31-year-old caught in Area 4B. The smallest Pacific halibut sampled in the 2016 setline survey measured 41 cm FL: a female from Area 3B aged at five years old.

The 2005 year class (11-year-olds) were the most commonly occurring Pacific halibut in the age sample, followed by the 12 and 10 year olds, respectively.

Fishery-independent setline survey expansions in 2016

The IPHC is in the middle of a six-year fishery-independent setline survey 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 Regulatory Areas 2A and 4A, and set to complete in 2019, moves the setline survey into deep (275-400 fathoms; 503-731 m) and shallow (10-20 fathoms; 18-37 m) waters, and into gaps in the 20-275 fathom (37-503 m) waters not covered by the standard 10 nautical mile station grid. Observations have shown there to be significant commercial harvest in deep waters, particularly in Area 4A, and in shallow waters in some areas. It is apparent that the current setline survey range does not cover the entirety of Pacific halibut habitat. Other gaps within the 20-275 fathom (37-503 m) range are at times substantial, particularly in Areas 2B and 4.

Area 4CDE edge setline survey expansion

The third year of the IPHC's fishery-independent setline survey expansion was carried out along the Regulatory Area 4CDE continental shelf edge, with 84 additional stations fished in 2016 in this region. The WPUE of O32 Pacific halibut at these new stations averaged 14.0 lb/skate (6.4 kg/skate), compared with 18.7 lb/skate (8.5 kg/skate) at the 51 standard stations successfully fished in 2016. Mean WPUE over all Regulatory Area 4CDE continental shelf edge

stations fished in 2016 was 84.5 percent of that computed from the standard stations that are fished annually, implying that previous estimates of WPUE in this region were positively biased. Several of the new stations close to the USA/Russia EEZ border had average or above average catch rate, indicating that Pacific halibut density does not strongly taper off as it approached the border.

Prior to 2016, the WPUE from the 52 stations on the 4CDE edge fished on an annual basis was assumed to also apply in parts of this region not covered by the setline survey. With the adoption of space-time modeling for estimation of WPUE, it is possible that WPUE can be predicted at any station not fished in a given year, with the model informed by years with setline survey expansion data, WPUE at nearby stations, nearby NMFS trawl survey data, and any covariate relationships used in the model (such as the relationship between WPUE and depth).

NMFS Bering Sea trawl survey

IPHC participated in both the Bering Sea and Aleutian Island NMFS groundfish trawl surveys in 2016.

The IPHC has been part of the National Marine Fisheries Service (NMFS) groundfish trawl survey on the eastern Bering Sea shelf since 1979; 2016 marked the IPHC's 19th straight year of participation. The 2016 trawl survey took place from 26 May to 27 July. The current standard trawl survey includes 376 stations on a 20-nmi (1 nmi = 1.852 km) square grid design extending from inner Bristol Bay to St. Matthew Island, within the 200-m depth contour. The stations are placed at the center of each grid square, and additional stations are placed at the corners of grid cells in areas surrounding St. Matthew and the Pribilof Islands to better assess blue king crab (*Paralithodes platypus*) density.

IPHC sea sampler Paul Logan during the NMFS trawl survey. Photo credit: Paul Logan.

IPHC field biologists were deployed on the *F/V Vesteraalen,* one of two vessels completing the NMFS trawl survey, to carryout objectives related to stock assessment and year-class strength estimation for numerous species. A total of 2,248 Pacific halibut were encountered by both vessels combined and the IPHC-staffed vessel encountered a total of 1,329 Pacific halibut in 191 tows. These fish were measured for length and divided into two groups designated for sampling and tagging. A total of 556 Pacific halibut otoliths were collected, along with, sex, maturity, and prior hooking injury information, and 424 fish were tagged and released. One hundred ninety-eight tissue samples were collected from a portion of the otolithed fish for energetics analysis, and fin clips were collected from both those fish and all tagged Pacific halibut for genetic analysis.

Of the sampled fish, 54 percent were female and 46 percent were male, which was the same as in 2015. Samplers assessed 98 percent of the females and 11 percent of the males to be immature. Prior hooking injuries were found on 2.9 percent of the sampled fish; 12 had minor damage, 10 had moderate damage, and none had severe damage.

To determine the abundance (numbers) of Pacific halibut in the NMFS trawl survey area, researchers use results from the area-swept by the trawl and extrapolate out to the entire area. (This measurement is distinct from biomass, which represents the total weight of all those fish). The NMFS tawl survey time series is also the only measure of abundance for much of the Bering Sea in most years, because the IPHC lacks the financial capability to sample it in its entirety annually. The abundance estimate for the Bering Sea in 2016 was 66 million Pacific halibut, a slight uptick from the 64.2 million estimated for 2015. The total biomass was estimated at 338.8 million pounds (153,677 t) which was substantially lower than the 2015 estimate of 380 million pounds (172,365 t). It is important to keep in mind that these numbers include Pacific halibut of all sizes, many of which are substantially smaller than those caught either in the commercial fishery or during the setline survey.

There is a one year lag in obtaining results for ages of trawl survey-caught Pacific halibut. In 2015 fish ranged in age from 2 to 20 years old and 4-year-olds made up the largest portion of the sample at 33 percent of those aged. Fish caught on the trawl survey tend to be younger on average than those caught during the fishery-independent setline survey and commercial fisheries.

The 2015 age sample for the Bering Sea trawl survey showed that the 2011 year class (4-year-olds) were encountered most often.

NMFS Aleutian Islands trawl survey

In 2016, the IPHC participated for the third consecutive time in the NMFS Aleutian Islands Biennial Bottom Trawl Survey which is designed to collect information on the distribution and abundance of principle groundfish species in the area. The Aleutian trawl survey has taken place every two years since 2000 (except 2008), and every three years prior to that, dating back to 1980. This trawl survey covers the area surrounding the Aleutian Islands between Unimak Pass in the east and Stalemate Bank in the west, and the IPHC uses this trawl survey to collect information on Pacific halibut that are not yet vulnerable to the gear used by the IPHC fishery-independent setline survey or commercial fishery, and as an additional data source and verification tool for stock analysis.

The Aleutian trawl survey was initiated on 4 June and concluded on 12 August. An IPHC biologist was aboard the *F/V Sea Storm* for the duration of the trawl survey. The vessel encountered a total of 409 Pacific halibut, of which

NMFS trawl survey vessel *F/V Sea Storm*. Photo by Paul Logan.

Female fish accounted for 39 percent of the Pacific halibut sample from the Aleutian Island trawl survey and 88 percent of those were assessed as immature.

209 were sampled for length, age structures, sex, maturity, and prior hooking injuries. The remaining 200 were selected for the tagging sample, and of those, 170 were released with wire tags attached. The remaining were either outside the target size for tagging or were not deemed to be in good enough condition after capture, and all were subsequently measured and released.

Female Pacific halibut accounted for 39 percent of the biological sample and males were 61 percent, which are the same proportions encountered during the 2014 trawl survey. Most (88%) of the females were immature and 12 percent were ripening. No Pacific halibut were actively spawning or considered spent/resting. The majority of the males were considered mature, with just 13 percent assessed as immature. Prior-hooking injuries were found on 3.7 percent of the Pacific halibut.

After a slight increase to 74 million pounds (33,566 t) in 2014, the population index of Pacific halibut declined to 63 million pounds (28,576 t) in 2016. This is the lowest since 1986 when the biomass was estimated at 60 million pounds (27,216 t). As for abundance, the swept-area abundance estimate of 7.0 million fish in 2016 was the lowest calculated since 1986 (5.4 million fish). Both the 40-79 cm and 80+ cm size class abundance estimates decreased in 2016 compared to 2014, but the smallest size class (0-39 cm) was up slightly.

There is a one year lag in obtaining results for ages of trawl survey-caught Pacific halibut and in this case, the last Aleutian trawl survey was in 2014. In that year, the most frequently encountered Pacific halibut on the IPHC-staffed vessel were the 9- and 10- year olds, the same two year-classes which showed most strongly in the 2012 Aleutian trawl survey and as younger fish in earlier Eastern Bering Sea trawl surveys.

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. This section covers two main topics that have bearing on the population assessment process: (1) the importance of data sources, and (2) the assessment process and its results. The area stock distribution estimation (formerly "apportionment"), harvest policy, and Management Strategy Evaluation are other important elements of the work, and are covered in their own sections immediately following this one.

Data sources

The data for the Pacific halibut stock assessment is comprised of three primary components: fishery-independent (survey) data, fishery-dependent (directed fisheries) data, and auxiliary data.

The data for the stock assessment is of three primary types: fishery-independent data, fishery-dependent data, and auxiliary data. Additionally, since 2013, the IPHC has been including historical data in the assessment, which allows scientists to better identify cyclical trends over time that may be of import to the current population. While data collection has continuously improved and is now the best it has ever been, the historical data are incomplete and/or imperfect, limiting the conclusions that can be drawn.

Fishery-independent data

The first type of fishery-independent data, is the catch-rates, reported as weight-per-unit-effort (WPUE) and numbers-per-unit-effort (NPUE) from the IPHC fishery-independent setline survey, which indexes abundance and are calculated based on the catch in weight or numbers relative to the amount of gear deployed at each setline survey station. The revised survey modelling estimates (WPUE and NPUE) differ from previous estimates in several important ways.

F/V Kema Sue **crew Victoria Lamore, Maggie Eshevario, and Sierra Robertson (left to right) along with IPHC sampler Levy Boitor (second from right). Photo credit: Levy Boitor.**

Pacific halibut in the hold waiting to be offloaded. Photo by Levy Boitor.

First, trends have been more clearly increasing in Regulatory Area 2 over the last 5-10 years; and increasing over a longer period in Areas 2B and 2C than in Area 2A. Second, declines are estimated to have been somewhat more constant in Areas 3A and 3B. Third, the overall coastwide trend is somewhat more muted, with only a decline of approximately 15% since the late 1990s and three years of increase at the end of the series. The latter result in particular indicates that the declines in WPUE have been even more strongly influenced by weight-at-age than previously believed. Very similar trends have been observed for NPUE when compared to the WPUE; however both the O32 (fork length $\geq$ 81.3 cm) and total NPUE show more modest historical declines.

Pacific halibut distribution has shifted over the past 5-10 years with relative increases in Area 2 and decreases in Area 3.

The second measure, survey age distributions, comes from otoliths, the sampling rates for which are adjusted annually to produce parity in sample sizes across Regulatory Areas. All otoliths collected during IPHC setline survey activities are read each year by IPHC scientists to estimate the age of the fish. The age frequencies tend not to show much deviation over time. In 2016 a much larger proportion of males was observed at all ages than in recent years. Ten- and eleven-year-old Pacific halibut represented the largest proportion of survey catch in many areas in 2016, with nine-year-old females slightly more common than 11-year-olds in Area 2A.

The third measure, U32 (fork length < 81.3 cm) setline survey age distributions, was used in 2016 as a means to approximate the Pacific halibut comprising commercial wastage, or Pacific halibut captured as part of the commercial fishery, discarded, and a portion of which are assumed to subsequently die. These data showed a remarkably protracted age-distribution, which illustrates the recent variability in size-at-age, i.e. some fish from each cohort reaching the minimum size limit by age six, and others (particularly males) many years later.

The fourth measure, setline survey weight-at-age, is obtained via individual length observations on all Pacific halibut captured. These are then converted to estimated weights via the currently used length-weight equation. Calculations of average weight-at-age by area, sex, and year are made for each IPHC Regulatory Area. Results for ages with insufficient number of samples are interpolated. Because the setline survey captures few fish younger than age seven or older than age 25, all fish outside this range are aggregated to these 'minus' and 'plus' groups, respectively. Differences among the areas require appropriate weighting—using estimates generated from the setline survey NPUE—to create a coastwide time-series that accurately represents the entire stock. There do not appear to be consistent or strong trends from 2010-2016 in the area-specific data.

The fifth measure, spawning output-at-age, is a reflection of the population-level weight-at-age and spawning biomass. Applying a smoother across years within each age produces results more consistent with those expected for population level values; these summaries most clearly show the population-level decline in weight-at-age observed for both male and female Pacific halibut over the recent time series available from the setline survey.

The sixth measure, National Marine Fisheries Service (NMFS) trawl surveys in Alaska, was used to augment the assessment data. These surveys provide valuable information on the size and abundance of Pacific halibut in the eastern Bering Sea, and the data were used to estimate size-at-age for young fish not frequently encountered in the IPHC setline survey, as well as to compare with trends in abundance and age structure.

Fishery-dependent data

Fishery-dependent data used for the stock assessment includes information from commercial, sport, personal use, and non-Pacific halibut target fisheries.

Fishery-dependent data includes information from commercial, sport, personal use, and non-halibut target fisheries. Pacific halibut landings data from the commercial fishery since 1981 have been reported to IPHC by way of commercial fish tickets. Landings estimates prior to 1981 are more uncertain than more recent estimates as they are not fully represented in current IPHC databases. Historical landings prior to 1935 were reconstructed within current Regulatory Areas from summaries by historical statistical areas. While reported commercial landings of Pacific halibut began in 1888; it seems that the commercial fishery may have already been pulling in at least a million pounds (~454 t) per year by then. The government agencies responsible for managing the sport fisheries are responsible for reporting recreational removals to the IPHC. These include (from south to north) the California Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Fisheries and Ocean Canada (DFO), and Alaska Department of Fish and Game. There is an assumption that there was little sport fishing for Pacific halibut before the mid-1970s, though sport removals have grown dramatically since then, peaking in the mid-2000s with annual harvests of over 10 million pounds (~4,500 t).

Since 1991, the DFO and NMFS 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.

Wastage of Pacific halibut in the commercial fishery has risen and fallen, hitting a peak in the late 1980s and then undergoing another high period between 1995 and 2010. During the latter period, the size-at-age of Pacific halibut declined and fish reached the minimum size limit at older ages. Prior

IPHC Quantitative Scientist Ian Stewart on a port tour in Kodiak, AK. Photo by David Jackson.

Bycatch is estimated to have peaked in 1992 at 20 million pounds (~9,070 t) and declined in most years since then to about 7 million pounds (~3,180 t) in 2016.

to 1981, wastage in Regulatory Area 4 could not be delineated among regulatory areas, though it is believed that little wastage actually occurred then.

NMFS and DFO estimate bycatch of Pacific halibut from non-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 catch occurred in 1992, with over 20 million pounds (~9,070 t) caught, and has mostly declined since then, with an estimated 7.0 million pounds (~3,180 t) caught in 2016 (a slight decrease from the 7.7 million pounds caught in 2015).

Fishery-dependent data are used similarly to fishery-independent data: 1) commercial Pacific halibut fishery WPUE, 2) fishery age distributions, and 3) fishery weight-at-age. The IPHC considers the commercial fishery WPUE to be another "survey" of the stock, and so its estimates are treated as a proxy for density.

Port samplers collect both lengths and otoliths, with lengths converted into individual weight estimates where needed. Ports staffed by the IPHC have samplers gather otoliths in proportion to landings in order to estimate recent fishery ages, a method that allows the direct aggregation of raw ages within each area and year. Dividing the total commercial catch for each regulatory area and year by the average fish weight gives an estimate of the number of fish harvested. The age distribution obtained from this method showed a similar trend to the age distribution found in the setline survey—a plentiful 1987 year class that had moved through the stock. It also revealed that Pacific halibut in the commercial landings from the 1930s to 1973 (when the current 32-inch minimum size was implemented) were predominantly between the ages of 6-14 years.

Another source of information, fishery weight-at-age, measures the average weight of Pacific halibut at a given age, allowing for the tracking of fish size over time. A picture of coastwide weight-at-age since the 1930s was constructed by considering the historical weight-at-age for each Regulatory Area in relation to the number of fish in the landings for that area. This method revealed increasing fish size all the way through the 1970s, followed by a decline in size that continues to the present. For 2016, the same methods from previous analyses were used to estimate trends in weight-at-age, but separated by geographic

regions (Regulatory Areas 2, 3, 4ACDE, and 4B). The results indicate that changes in Area 2 have been less pronounced than the very large decrease in fish size observed for Area 3 from the 1950s through the 1990s and that Area 4 has shown a much more muted historical pattern. The relative weight-at-age for Area 4 is only slightly above the late 1990s for most of the historical period, and the smallest values occur in the most recent years.

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) weight-length relationship, 2) maturity schedule, 3) ageing bias and imprecision, 4) movement rates among geographic regions, and 5) Pacific Decadal Oscillation (PDO). Details of these data sources are as follows.

Auxiliary inputs are additional inputs to the stock assessment that are treated as data, but actually represent data products of other analyses.

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.

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. Development of spatially explicit stock assessment and Management Strategy Evaluation (MSE) operating models requires an understanding of the rates of movement among geographic regions. Varied data sources provided information that was assembled into a single framework representing the IPHC's current working hypothesis regarding movement-at-age among regions; appreciable emigration is estimated to occur from Regulatory Area 4, decreasing with age. Pacific halibut age two to age four, move from Area 3 to Area 2 and from Area 4B to Areas 3 and 2, and some movement of older Pacific halibut is estimated to occur from Area 2 back to Area 3.

5. The PDO is a pattern of Pacific climate variability that changes about every 30 years. Research has shown that during the 20th century these environmental conditions have been correlated with the recruitment of Pacific halibut. In "positive" phases of the

PDO (through 1947, and 1977-2006), the stock saw an increase in younger fish. The PDO's longest "negative" phase since the late 1970s occurred from 2006 through 2013. Highly positive values were observed over 2014-16; however, it is unclear if this represents a change of phase or a different set of environmental conditions altogether.

Population assessment at the end of 2016

Over the last century, Pacific halibut removals from all sources have ranged annually from 34 to 100 million pounds (15,422 to 45,359 t), with an average of 63 million pounds (~29,000 t). Total removals in 2016 were 41.8 million pounds (18,960 t), down slightly from 2015 and below the 100-year average. The 2015 setline survey coastwide O32 Pacific halibut and total (all fork lengths) WPUE were six percent higher than values observed in 2014.

The age distribution over the past several years indicates a stable stock with no evidence of recent outstanding coastwide recruitment of young Pacific halibut.

Age distributions in 2016 from both the survey and fishery remained similar to those observed in 2011-15, indicating a relatively stable stock, and no clear evidence of recent strong coastwide recruitments. At the coastwide level, individual size-at-age remains low relative to the rest of the time series, although there has been little change over the last several years.

Stock assessment

The methods for undertaking the population assessment for Pacific halibut have been improved many times over the last 30 years due to a continual effort

Pacific halibut being offloaded from the *F/V Contender* in Kodiak, AK. Photo by David Jackson.

to improve model assumptions and analytical approaches. For the last five 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. This basic assessment approach used in 2016 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.

Although recent modeling efforts have created some new alternatives, no single model satisfactorily approximates all aspects of the available data and scientific understanding. In 2014, an ensemble of four stock assessment models representing a two way cross of short vs. long time series', and aggregated coastwide vs. Areas-As-Fleets (AAF) models was used to explore the range of plausible current stock estimates. In 2013 and 2014, each of the models in the ensemble was given equal weight, and their integration allowed for a more complete representation of the uncertainty. In 2015, the IPHC Scientific Research Board (SRB) reviewed alternative weighting approaches, but did not recommend any changes. For 2016, the most important change was the transition to a space-time modelling approach for estimating NPUE and WPUE indices from the IPHC fishery-independent setline survey data.

The "ensemble" approach to stock assessment has been used for the past five years at IPHC and was inspired from weather forecast modeling.

An in-depth review of the 2015 assessment models resulted in a number of improvements; however, those ensemble results remained similar to previous assessments. Comparison of this year's results with previous stock assessments indicates that the estimates of spawning biomass from the 2016 ensemble remain consistent with those from 2012-15, which lie inside the predicted 50% interval of the ensemble in recent years.

The risk analysis and decision table include the full range of uncertainty from all the models in the assessment. Therefore, key quantities such as reference points and stock size are reported as distributions, such that the entire plausible range can be evaluated. Where necessary, point estimates reported in this assessment correspond to median values from the ensemble.

Biomass, recruitment, and reference point results

The 2016 assessment results indicate that the Pacific halibut stock declined for much of the decade prior to 2010, and has been relatively stable or increasing since then. Recruitment and size-at-age were the primary factors causing the decline during that period.

The two long time-series models, which include data back to the early 1900s provide different perceptions of current versus historical stock sizes, highlighting the uncertainty in these estimates. One model, separating fleets into areas, estimated the spawning stock to currently be 37 percent of the equilibrium unfished stock size (i.e. what the average stock size is estimated to be without any fishing), and that current spawning biomass is at 121 percent of the minimum values estimated for the 1970s. The second model, aggregating fleets coastwide, estimated that the stock is 47 percent of the equilibrium and 231 percent of the minimum 1970's values. The discrepancies are likely due to the separation of signals from each region, and the allowance for different properties in each region's fishery and survey. The long time-series models also showed that Pacific halibut recruitment was estimated to be highest during periods of favorable PDO conditions, and that the highest level of recruitment observed historically occurred from 1977 to 2006, which led to much larger stock sizes and therefore greater fishery yields during those years. The two short time-series models do not

provide estimates of the historical period. Currently the spawning stock, using the ensemble of models, is estimated to be 41 percent of what they would be in the absence of fishing, with a five percent chance that the stock is below the 30 percent harvest threshold.

Sources of uncertainty

The Pacific halibut population assessment, like any statistical model, includes a significant level of uncertainty due to estimations, data treatment, natural mortality, and other structural differences among the models. The way in which differences among Regulatory Areas are treated in the assessment model and the spatial processes in the underlying stock are important sources of uncertainty, particularly with regard to the distribution of recruitment, and the fishes' movement rates among Regulatory Areas as they grow. With SRB endorsement, the staff is working to develop additional alternative models that take into account the way Pacific halibut migrate among the grounds and the factors influencing this movement for future stock assessments, as well as refinement of available models.

Not knowing the sex ratio of the commercial catch or completely understanding the spatial dynamics in the underlying stock are two major sounces of uncertainty in the assessment.

Two primary uncertainties continue to hinder our current understanding of the Pacific halibut resource: 1) the sex-ratio of the commercial catch (not sampled due to the dressing of fish at sea), which in tandem with assumptions regarding natural mortality, determine the productivity of the stock, and 2) the treatment of spatial dynamics and movement rates among regulatory areas, which have very strong implications for the current stock trend. Ongoing efforts to test methods for direct marking of fish at sea continue in 2017 via voluntary marking by commercial fishers, collection of genetic samples on the setline survey, and development of a genetic test to determine the sex from a tissue sample.

Crewman Brian McKenna cutting bait during the IPHC fishery-independent setline survey on the *F/V Sunward* while cook, Mike Black, looks on. Photo by Jason Taylor.

Recruitment variability remains a significant source of uncertainty in current stock estimates, and natural mortality has been an important source of uncertainty directly included in the assessment since 2012. Other sources of potential uncertainty are bycatch estimation and discard mortality rates. Other unreported sources of removals in either directed or non-directed fisheries, would create bias in this assessment.

Sensitivity analyses revealed that the most important contributors to estimates of both population trend and scale included: the sex-ratio of the commercial catch, the treatment of historical selectivity in the long time-series models, and natural mortality. The results of sensitivity analysis on removals indicated, as expected, that significantly heightened or reduced bycatch levels did not make a large difference in stock trends, but that a greater number of removals was indicative of a larger stock.

Sensitivity analysis showed that higher or lower bycatch levels did not greatly impact stock trend, but that a greater number of removals was indicative of a larger stock size.

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

Forecasts and the decision table

Stock projections were conducted using the integrated results from the stock assessment ensemble, summaries of the 2016 fishery, and other sources of mortality, as well as the results of stock distribution calculations and the target harvest rates from the current IPHC harvest policy guidelines. The projections required estimating stock distribution; applying area-specific harvest rates to estimate yield and removals, and calculating the total mortality and projecting the stock trends both one and three years into the future. This is explained further in the following sections.

			Stock Trend				Stock Status				Fishery Trend				Fishery Status
			Spawning biomass				Spawning biomass				Fishery CEY from the harvest policy				Harvest rate
			in 2018		in 2020		in 2018		in 2020		in 2018		in 2020		in 2017
Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	is less than 2017	is 5% less than 2017	is less than 2017	is 5% less than 2017	is less than 30%	is less than 20%	is less than 30%	is less than 20%	is less than 2017	is 10% less than 2017	is less than 2017	is 10% less than 2017	is above target
Benefits			Risk												

Shown here is a schematic of the harvest decision table presented to Commissioners during the Annual Meeting. When presented, this table includes an assessment of risk and benefits for an array of harvest levels.

The status-quo SPR row in the decision table corresponds to the newly-approved IPHC interim harvest policy guidelines.

Projections indicate gradual stock increase between 2018 and 2020 for any amount of removals up to around 40 million pounds (~18,100 t). The projections beyond 40 million pounds of removals indicate a relatively rapid increase in the risk of stock decline.

The decision table includes a range of harvest levels and risk assessments, with the *status-quo* SPR row corresponding to the newly-approved IPHC interim harvest policy guidelines. The *status quo* SPR (41.6 million pounds, ~18,900 t, total removals) corresponds to a 68/100 (68%) chance of stock decline in 2018 and a 87/100 (87%) chance in 2020. However, the risk of substantial stock decline (>5% decline) is much lower at only 6/100 (6%) in 2018 and a 64/100 (64%) in 2020.

Future research in support of the stock assessment

The data and model exploration undertaken in 2016, combined with recommendations from the SRB, will direct future research to the following areas:

1. Continued expansion of weighting approaches for models included in the ensemble
2. Continued development of the technical specifications for evaluation and diagnosis of each individual model
3. Continued development of methods for sampling the sex-ratio of the commercial catch
4. Further investigation of the factors contributing to recruitment strength, recruitment distribution, and the information available from trawl surveys, particularly in the Bering Sea.
5. Exploration of methods for including uncertainty in wastage and bycatch estimates
6. Exploration of Bayesian methods for fully integrating parameter uncertainty into the models
7. Continued integration of the assessment analyses with ongoing development of the harvest policy and Management Strategy Evaluation process

STOCK DISTRIBUTION ESTIMATION

With the assessment of the Pacific halibut population complete, the distribution of the stock among IPHC Regulatory Areas is estimated. This is achieved using the fishery-independent setline survey mean O32 (fork length ≥ 81.3 cm) weight-per-unit-effort (WPUE) index of Pacific halibut density, weighted by bottom area. To account for factors that are known to affect survey catch rates, two adjustments to the WPUE are made for (1) setline survey timing relative to the harvest, and (2) hook competition

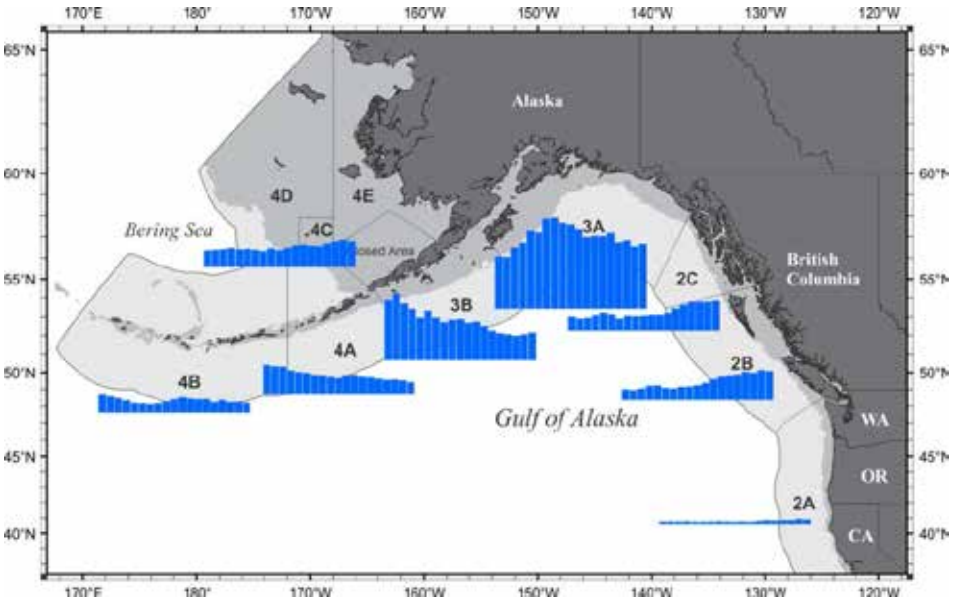
Stock distribution estimates at the beginning of 2017 indicate that our understanding of the distribution of the stock has changed somewhat from last year, with more biomass in Regulatory Area 3 and less in Area 2.

Improvements in 2016

In 2016, the IPHC began using a space-time model for stock distribution estimation.

The most important revision in 2016 was the change to using a space-time model for WPUE estimation, with the results of the modeling used for stock distribution estimation. With this change, the three-year reverse weighting used to smooth the WPUE time series was discontinued, as the space-time modeling now estimates the degree of temporal dependence in the data, which determines the smoothness of the time series. All data were updated with 2016 observations, including new survey data from setline survey expansion stations along the Regulatory Area 4CDE (Bering Sea) shelf edge. For the first time, estimates of uncertainty in the stock distribution estimates were also presented.

The space-time modeling for Regulatory Area 2A covered only the region over which the IPHC has previously undertaken a setline survey, that is, to a southern boundary of 39°N. Stock distribution is based on the bottom area of Area 2A down to 37.75°N and data from the National Marine Fisheries Service



The proportion of the legal-sized (O32) Pacific halibut stock estimated to be in each Regulatory Area from 1999-2017 based on the IPHC's fishery-independent setline survey.

(NMFS) West Coast trawl survey was used to estimate the lower densities at the southern limit of the Pacific halibut range.

Survey timing

The timing of the setline survey relative to the fishery can affect its results. Most notably, a high proportion of early-season fishery removals in an area can result in lower survey WPUE relative to areas where removals occur later in the season. Adjustments for survey timing are now applied at the station-level, with adjusted station WPUE used as data in the space-time modeling, and are no longer detailed in this report.

Adjustments for hook competition and survey timing were applied at the station level.

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 into survey results. As with the timing adjustment, adjustments for competition are also applied at the station level, a change from previous years supported by the Scientific Review Board.

For the 2016 fishery, the stock distribution for Pacific halibut was estimated as follows: Regulatory Area 2A (2.2%), Area 2B (14.1%), Area 2C (15.0%), Area 3A (32.2%), Area 3B (13.6%), Area 4A (5.5%), Area 4B (4.5%), and Area 4CDE (12.6%). Area 3 is estimated to contain the largest portion of the stock (45.8%), followed by Area 2 (31.4%), Area 4 (18.3%), and only a small proportion (4.5%) is estimated to be in Area 4B.

The O32 Pacific halibut biomass was estimated to be roughly divided into thirds: one-third in Area 2 (2A, 2B, and 2C), one-third in Area 3A, and one- third in Areas 3B-4CDE. This distribution represents a large shift towards Area 2 from Areas 3B-4CDE in the last 15 years; in year 2000, about two-thirds of the stock was in Areas 3B-4CDE, and only 12.4 percent was in Area 2.

Harvest policy

At the 2016 Annual Meeting (AM092), the Commission tasked the IPHC Secretariat and the Management Strategy Advisory Board (MSAB) with reviewing and providing recommendations for improving what was considered to be the harvest policy guidelines and associated harvest control rules.

Harvest policy has a long history at the IPHC and many analyses and simulation studies have informed the development of past harvest policy principles. The IPHC harvest policy is the procedure that takes the coastwide stock assessment as an input and outputs the coastwide Total Constant Exploitation Yield (TCEY) across all Regulatory Areas, as well as the TCEY and Fishery Constant Exploitation Yield (FCEY) for each Regulatory Area.

A revised harvest policy was adopted at the 2017 Annual Meeting which centers around fishing intensity which is determined by the spawning potential ratio (i.e. percentage of spawning potential over a fishes' lifetime).

IPHC identified four issues with the harvest policy: 1) simulations that provided guidance for the harvest policy were based on core Regulatory Areas (2A, 2B, and 3A) and then applied to other areas; 2) that the harvest policy confounded the level of fishing intensity (scale) with the distribution of that fishing intensity among Regulatory Areas; 3) exploitable biomass (EBio) is inconsistent with the current assessment results and does not represent what it is expected to represent; and 4) the mortality of U26 fish (fork length < 26 inches or 66 cm) is not explicitly accounted for in annual calculations.

A simple modification to the previous harvest policy was approved by the Commission at the 2017 Annual Meeting (AM093) to address these issues that was to separate the scale (coastwide fishing intensity) and the distribution of fishing mortality. The first step in the modified sequence would be to set the coastwide fishing intensity (scale) on the coastwide stock by defining an acceptable level of fishing mortality that operates on all sizes of fish over all sources of fishing mortality. Once the scale is determined, the coastwide TCEY can be determined and split into a TCEY for each Regulatory Area. This second step is the distribution of catch. This separation of scale and distribution eliminates EBio, accounts for all mortality from all sources, and allows the Commission to separate the decision of coastwide fishing intensity from distributing the TCEY.

The revised harvest policy centers around the fishing intensity which is determined by a fishing mortality rate that corresponds to a Spawning Potential Ratio (SPR). 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. This revised harvest policy is called an SPR-based harvest policy and an interim SPR is based on status quo over the last three years. Therefore, the current harvest policy is called *status quo* SPR and uses an SPR of 46%.

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, guiding the process. The MSAB will provide recommendations that are evaluated against objectives defined by all of the parties involved, and these recommendations are considered by the Commission when developing a new harvest policy.

The MSAB is an advisory body made up of stakeholders and managers with the directive of defining and testing harvest goals and objectives.

Management Strategy Advisory Board (MSAB)

The MSAB met twice in 2016, and developed a two-year work plan, along with terms of reference and an outreach plan to better focus the group and communicate progress to stakeholders. The central role of the MSAB is to define fishery objectives, develop candidate management procedures, develop performance metrics, and measure the performance of various management strategies against the defined objectives.

The MSAB made progress on the investigation of the current harvest policy, an examination of the realized decisions made over the last three years, and development of a revised harvest policy to account for mortality of all sizes and from all sources (described above as an SPR-based harvest policy). Work in 2017 will involve evaluating various fishing intensities to determine one that best meets the objectives defined by the MSAB.

Quantitative Scientist Allan Hicks presents results to the MSAB. Photo by Ed Henry.

Abundance-based management of Pacific halibut bycatch

At its October meeting, the North Pacific Fishery Management Council (NPFMC) took up one of its top priorities: the development of abundance-based Pacific halibut bycatch (Prohibited Species Cap; PSC) limits. The NPFMC reviewed a discussion paper on the abundance-based management approach prepared by an inter-agency workgroup, including staff from the NPFMC, National Marine Fisheries Service, and IPHC. The paper focused primarily on identification of NPFMC objectives for this initiative; which included indexing PSC to abundance; protecting spawning stock biomass at low levels; allowing flexibility in groundfish operations; maintaining Pacific halibut directed fishing operations; and stability in PSC limits.

Clearly some of these are competing objectives, and the NPFMC did not prioritize them or attempt to quantify any of them. Rather, the NPFMC provided direction to the working group relative to the next iteration of this analysis, which would allow for public input into the development of performance metrics. Ultimately the NPFMC will need to identify specific alternatives, elements, and options for formal analysis.

Abundance-based management of Pacific halibut bycatch would have the result of fluctuating bycatch caps or limits based on Pacific halibut stock abundance, much like the directed fisheries experience through rising and falling catch limits that are based on stock assessment results.

Research

Biological research projects are conducted to add to the knowledge base about Pacific halibut that support the stock assessment and fisheries. The two largest data gathering projects at the IPHC, the fishery-independent setline survey and commercial sampling, are described earlier in this report. Research described in this section encompasses a variety of other projects that address short and long term objectives and can be modified each year to respond to the shifting priorities of scientists and policymakers. In 2016, these projects included oceanographic monitoring; observing trends in seabird occurrence; tagging, otolith studies, genetics, and maturity investigations.

Successful oceanographic casts were made at 88 percent of the fishery-independent setline survey stations in 2016.

Oceanographic monitoring during the IPHC fishery-independent setline survey

A coastwide oceanographic monitoring project on the Pacific halibut grounds went into its eighth consecutive year in 2016. The project aims to better understand the factors behind the fluctuations in distribution, growth, and recruitment of fish populations, especially those relating to climatic and oceanic conditions. Oceanic conditions directly affecting fish include variations in water temperature, salinity, dissolved oxygen, and pH, among other environmental factors.

Crewman Sam Cameron preparing to launch the profiler from the *F/V Free to Wander*. Photo by Jason Taylor.

The IPHC used water column profilers at all setline survey stations ranging from southern Oregon in the U.S.A. northward to British Columbia in Canada, into the Gulf of Alaska, Bering Sea, and Aleutian Islands (U.S.A.). This area of investigation has gained momentum in recent years as scientists and stakeholders try to understand the direct and indirect effects of environment on fisheries. In 2016, the IPHC chartered 14 fishing vessels, each outfitted with a Seabird™ Seacat19plus V2 profiling unit, a laptop computer, and accessory gear. Out of 1,366 possible stations coastwide, 1,206 useable casts of environmental data were successfully collected.

Deployment of the profiler happens just prior to hauling the gear at each fishery-independent setline survey station. The instrument is allowed to drop freely to the bottom while taking measurements four times every second. Each profiler takes a snapshot of a specific column of seawater, measuring depth, temperature, salinity, dissolved oxygen, pH, and chlorophyll *a* concentration. The data are sent back to the Seattle office either electronically or through data storage cards at each port stop.

Data access and uses

The data are edited, compiled, and sent to the National Oceanic and Atmospheric Administration's (NOAA) Pacific Marine Environmental Laboratory for review. Once reviewed, they are posted for use by scientists worldwide. http://www.ecofoci.noaa.gov/projects/IPHC/efoci_IPHCData.shtml. The IPHC is also working to integrate the environmental data into the larger IPHC database that contains survey and commercial data so that it can be used in stock assessment and Management Strategy Evaluation analyses.

Environmental conditions on the Pacific halibut grounds

Off the U.S. West Coast during the 2016 IPHC setline survey, there were a few very deep stations where near-bottom waters were hypoxic (i.e. where dissolved oxygen levels are very low and may affect the organisms living there; <1.4 ml/L), but the hypoxic zone typically seen near the bottom at the more shallow stations since 2002 was not detected during the setline survey for the second year in a row. Coastwide, the lowest near-bottom dissolved oxygen concentration detected (0.57 ml/L) was in the western Gulf of Alaska at 444 m depth. Both the coldest and the warmest near-bottom conditions coastwide were found in the Bering Sea at setline survey expansion stations. The coldest water was found north of St. Matthew Island at -0.67°C and the warmest was at the shallow, nearshore stations in northern Bristol Bay at about 12.25°C. The highest chlorophyll *a* concentration was found in southeast Alaska in the Ommaney survey region, although that occurred on the shelf edge and did not appear widespread among adjacent stations.

Both the coldest and warmest near-bottom temperatures were found in the Being Sea in 2016: the coldest was found north of St. Matthew Island and the warmest was in the shallow nearshore waters of Bristol Bay.

Observing trends in seabird occurrence

The IPHC fishery-independent setline survey provides an opportunity to collect information on seabirds off the coasts of Oregon to Alaska in the summer months. Since 2002, the IPHC has recorded the occurrence of more than 859,000 seabirds (composed of 36 unique species) in 19,553 observations taking place during the setline survey. In 2016, a total of 63,600 seabirds (comprising 20 unique species) were recorded during 1,362 observations. Northern fulmar (*Fulmarus glacialis*), glaucous-winged gulls (*Larus glaucescens*), black-footed albatross (*Phoebastria nigripes*), and fork-tailed storm petrels (*Oceanodroma furcata*) were the most commonly sighted species. While the observed number of unidentified gulls has decreased year after year, the number of observations of glaucous-winged gulls and herring gulls (*L. argentatus*) has increased, likely a result of better training of samplers on gull identification.

In 2016, Northern fulmar observations dropped slightly to 37,462 from last year's 43,383 birds. Laysan albatross numbers increased to an all-time

Nesting seabirds. Photo by Jason Taylor.

high of 1,397 in 2016. On a positive note, 2016 saw a relatively high number of endangered short-tailed albatross (*Phoebastria albatrus*), with 27 sightings, above the average of 22 sightings per year. Fork-tailed petrel numbers remained nearly unchanged from 2016 with only a slight increase to 663 from 649.

Tagging studies

In the past 91 years, IPHC has managed to tag and release more than 462,000 Pacific halibut for multitudes of projects.

Since 1925, the IPHC has tagged and released more than 462,000 Pacific halibut, from which more than 51,000 tags have been recovered. The purpose of tagging studies includes investigation of patterns of migration, utilization of habitat, age, growth, and mortality. The tags have taken different forms over the years, due both to experimental goals and requirements, and to technological advancements. The projects currently underway are described here.

Wire tagging small Pacific halibut

In 2016, the IPHC conducted the second year of a program to wire-tag small Pacific halibut during the National Marine Fisheries Service (NMFS) groundfish trawl surveys. The goal of the project is to tag, over a number of years, Pacific halibut that are expected to migrate from nursery areas to adult feeding grounds. The study assesses both movement and growth. Migration information on adult Pacific halibut has been well documented in recent tagging studies, but less is known about young Pacific halibut movement, and tag recoveries from this project help the IPHC's understanding of juvenile Pacific halibut movement in the Bering Sea and Gulf of Alaska. This year, the trawl survey included both the Bering Sea and Aleutian Islands and an IPHC sampler was aboard one vessel in each survey to perform sampling and tagging duties. Pacific halibut were randomly assigned to one of two groups: a group to be sampled for otoliths and a group to be tagged. Only fish <32 inches (<81.3 cm or U32) were considered for tagging. Additionally, Pacific halibut in the tagging subsample were assessed

for viability and placed in a viability category using predetermined criteria (*Excellent*, *Poor*, and *Dead)* that coincides with the viability criteria used by observers. Only individuals assessed as *Excellent* or *Poor* were tagged. A total of 736 Pacific halibut were tagged on the NMFS trawl surveys in 2016 (424 in the Bering Sea and 170 in the Aleutian Islands).

Due to the success of the tagging project on the NMFS trawl vessels, in 2016 the project was expanded to include a pilot study on the IPHC fishery-independent setline survey, but was limited to Regulatory Area 4D. The area was chosen because catches of small Pacific halibut were expected to be relatively low there and tagging could be incorporated into the workflow without compromising other setline survey objectives. The otolith sampling rate was reduced to 75 percent from 100 percent and all viable U32 Pacific halibut not selected for otolith sampling were tagged and released.

2016 was the second year of a wire tagging effort to tag small Pacific halibut. The project is designed to study migration and growth in these fish.

A total of 169 Pacific halibut were tagged and released during the setline survey; as on the trawl surveys, only fish assessed as *Excellent* and *Poor* were

IPHC sea sampler Paul Logan wire tags a young Pacific halibut during the NMFS trawl survey in the Bering Sea. Photo credit: Paul Logan.

tagged. Fork length of the tagged fish ranged from 50-81 cm. Most of the tagged Pacific halibut (94%) were assessed as *Excellent;* only one fish that would have been eligible for tagging was assessed as *Dead* and therefore not tagged.

The IPHC plans to expand the U32 wire-tagging effort to other setline survey regions in 2017 and continue the tagging effort on the NMFS trawl surveys. Tagging as many small Pacific halibut as possible over the next several years will increase the chance of meaningful recoveries. Tagging will not be done in Regulatory Areas where the otolith sampling rate is 100 percent. During both the trawl and setline tagging efforts, fin clips are collected from all released fish with the eventual goal of genetically sexing them. This portion of the project is still in the pilot phase.

Deployment and reporting of PAT tags in the Bering Sea

The IPHC has conducted a series of studies using pop-up archival transmitting (PAT) tags in the Bering Sea and Aleutian Islands (BSAI) region in order to identify winter spawning locations for Pacific halibut, determine the timing of seasonal movements, and investigate mixing within the BSAI and between the Bering Sea and Gulf of Alaska. However, neither PAT nor PIT (passive integrated transponder) tagging has been conducted on the Bering Sea continental shelf between 59°50' North latitude and the border of the United States of America and-Russia, because this region has not been previously surveyed by the IPHC. PAT tags are a type of archival tag that can collect, store, and transmit data via satellite. The PAT tag body contains temperature, pressure (depth), and light sensors, and data storage. The body is attached by a release pin to a leader and dart assembly, and the dart is embedded in the fish near the dorsal fin. The release pin is programmed to corrode after a specific period of time, after which the tag body floats to the surface and transmits via satellite temperature and depth readings along with location estimate, which is calculated from the light levels. The dart and leader remain with the fish.

Satellite tags were put on 31 Pacific halibut in 2016 in a remote area of the Bering Sea in order to study seasonal and longer term migration patterns of adult fish.

In 2016, the IPHC setline survey expansion stations were used to generate data for this unstudied region that will complement prior work. Thirty-one Pacific halibut ranging from 82-167 cm fork length were tagged at locations that spanned from southern Pervenets Canyon (59°30'N) to the southeastern margins of Navarin Canyon (61°10'N). Twenty tags were programmed to detach from their host fish to report their location and download environmental data to passing Argos (Advanced research and global observation system) satellites during the 2016-2017 spawning season, from late December to mid-January; 11 tags were programmed to detach and report after 365 days at liberty, in mid-June of 2017. In addition to determining the length of each tagged Pacific halibut, blood samples were obtained for future analysis of plasma hormone levels that might be predictive of individual migratory behavior, and ultrasound was employed to determine sex and the likelihood that tagged females (n = 24) were mature.

Tag recoveries in 2016

In 2016, a total of 33 Pacific halibut from various IPHC tagging projects were recovered, as well as 31 tags from sport tagging programs implemented by third parties.

- Four wire tags were recovered from the 2010 Aleutian wire tagging experiment, a study designed to identify potential future tagging sites for archival tag releases in Regulatory Area 4B.
- Six fish tagged during the 2015 NMFS trawl survey were recovered; one fish had been released in the Bering Sea and five had been released in the Gulf of Alaska. All six fish were recovered in the same regulatory area in which they were released.
- Tags from 22 fish stemming from the 2013 dummy archival tag experiment in Regulatory Area 3A were returned in 2016. This experiment was designed to evaluate different tag attachment methods. Seventeen of these fish had been tagged with both a dummy archival dart tag and a plastic-coated wire cheek tag, and five had been tagged with only an external dummy archival tag attached to the operculum.

- One PAT tag leader was recovered in 2016 from a fish tagged as part of the 2014 Salish Sea PAT tag study. The tag body had already detached and transmitted its data.

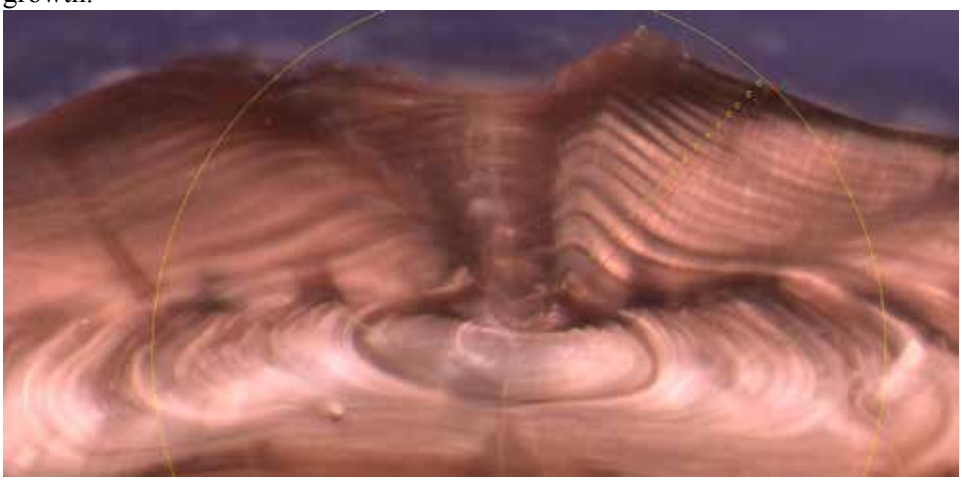
Every year, the IPHC supplies wire tags to the Homer Jackpot Halibut Derby and the Seward Halibut Tournament in Alaska. Sixteen tags from the 2016 Homer Derby were recovered. Additionally, 13 tags from previous Homer Derby releases were recovered in 2016: four from each of the 2015 and 2014 derbies, three from the 2013 derby, and two from the 2012 derby. Twenty-seven of the Homer Derby tags recovered in 2016 were recovered by sport fishers out of Homer and most were caught during the Derby. One Homer Derby tag was recovered on the IPHC setline survey in Area 3A and one was recovered on a sport fishing trip out of Seward. Two tags from the 2016 Seward Halibut Tournament were recovered by sport fishers during the tournament.

An examination of otolith growth increments in relation to Pacific halibut length

Otolith growth has often been used as a proxy for somatic (body) growth in marine and freshwater fish species. Since the IPHC maintains a long-term, coast-wide otolith collection, the aim was to determine if otolith growth corresponds with somatic growth in Pacific halibut. Specifically, this study looked at otoliths from the 1977, 1987, 1992, and 2002 cohorts from the Gulf of Alaska.

A study of otolith growth in relation to Pacific halibut length over time showed that otolith growth does not reflect body growth of the fish.

Over the past few decades, the IPHC has observed a significant decline in Pacific halibut size at age, especially in the Gulf of Alaska. However, there has not been a similar decline in otolith growth during this same time period for Pacific halibut in this area. For example, in 15-year-old females sampled from the 1977 and 1992 cohorts, there was a 2.45 percent increase in mean otolith radius during that time period, despite a 14.97 percent decrease in mean body length for those fish. Additionally, otolith size in Pacific halibut does not reflect the large difference in length that exists between males and females of the same age. Although factors regulating otolith growth in Pacific halibut are not well understood, otolith growth appears at least somewhat independent of somatic growth.



Cross section of an otolith from a 15-year-old Pacific halibut with increments marked for measurement. Photo by Joan Forsberg.

Development of production-scale genetic sexing

Over the past four decades, the average size of Pacific halibut in the commercial harvest has declined dramatically (by ~20 pounds or 9 kg). Given that female Pacific halibut grow faster than males, and that a minimum size limit is placed on commercially-harvested fish, the expectation is that commercial harvests contain a much higher proportion of females than in the past. Understanding the annual contribution of both sexes to the commercial harvest is important for predicting population dynamics and for setting catch limits. However, there has been no reliable way to determine sex in the commercial harvest given that Pacific halibut are gutted at sea. When Pacific halibut arrive in port to be sampled, there are no sex organs for port samplers to inspect. Therefore, the IPHC has sought to develop rapid genetic assays for easy sex determination in Pacific halibut and to compare the Pacific halibut genome to other flatfish .

Understanding the annual contribution of both females and males to the commercial harvest is important for predicting population dynamics and for setting catch limits.

DNA sequencing has resulted in the identification of more genetic markers in Pacific halibut than ever before: 40,308 of them. Of these markers, 56 have been found to be linked to sex, and three loci have been identified to exist only in females. Consistent with earlier work, this suggests that the sex-determination mechanism in Pacific halibut is one in which the females have two different sex chromosomes (Z and W), while the males have two copies of the same chromosome (Z and Z). The portions of the genetic code that have been identified in Pacific halibut show considerable similarity to both the Atlantic halibut (*Hippoglossus hippoglossus*) and half-smooth tongue sole (*Cynoglossus semilaevis*) genomes. In addition, all of the markers that were linked to sex in the Pacific halibut were observed on a single chromosome, as is also true for both the Atlantic halibut and half-smooth tongue sole. This suggests that the sex-determining chromosome has been identified. Using these markers, a genetic test for sex has been designed and is being tested on Pacific halibut collected during the IPHC's fishery-independent setline survey and from commercial harvests.

Identifying potential molecular physiological markers for growth and reproduction in Pacific halibut

Monitoring physiological processes (e.g. growth, reproduction, performance) in Pacific halibut is necessary in understanding the physiological status and condition of the fish in its environment. It is also important to be able to detect changes in the various physiological processes as a result of environmental, ecological, or fisheries-induced influences to provide a full understanding of Pacific halibut. The objective of this study was to identify molecular physiological markers through the use of state-of-the-art RNA sequencing of Pacific halibut tissues. This study has generated more than 300,000 transcripts in six tissues that, after annotation, has led to the identification of a large dataset of genes of known function in other species and that represent potential molecular marker genes. This study represents the first successful attempt at providing genomic resources for Pacific halibut and, specifically, molecular tools that will allow us to better understand physiological changes related to growth and reproduction in Pacific halibut.

IPHC biologist Dana Rudy prepares vials for a study designed to identify molecular physiological markers related to growth and reproduction in Pacific halibut. Photo by Joan Forsberg.

Initial description of oocyte development in summer and winter caught female Pacific halibut

Current maturity estimates in female Pacific halibut are collected during the surveys and are derived from macroscopic examination of the ovaries. In order to improve maturity estimates and to provide updated estimates of maturity-at-age, the IPHC is carrying out studies to improve the understanding of reproductive development in female Pacific halibut. A study was conducted using Pacific halibut females from three geographical locations throughout the distribution range of the species, and samples were collected during both the summer (non-spawning season), and the winter (spawning season). Histological examination of the ovaries found differences between summer and winter samples in oocyte size distribution and stages. These results appear to be relatively consistent with females sexually maturing in the winter, and undergoing yolk development in the summer as a prerequisite for spawning in the winter.

An initial study to look at oocyte development comparing seasonal differences in Pacific halibut was completed. There are plans to expand the project in the future.

Staff happenings

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

Many new faces joined the IPHC in 2016. Pictured left to right: Dr. Josep Planas (Biological and Ecosystem Science Program Manager), Dr. David Wilson (IPHC Excecutive Director), Dr. Allan Hicks (Quantitative Scientist), Keith Jernigan (Technology Program Manager), and Jamie Goen (Fisheries Statistics Program Manager). Photo by Tom Kong.

Committees and organization appointments

- NPFMC Scientific and Statistical Committee - Ian Stewart
- NPFMC Plan Team Member - Allan Hicks
- NPFMC Halibut Discard Mortality Work Group - Bruce Leaman
- Western Groundfish Conference organizing committee - Claude Dykstra
- NPFMC Electronic Monitoring Working Group - Claude Dykstra
- 57th Annual Meeting of the Technical and Subcommittee of the Canada-United States Groundfish Committee - Lara Erikson
- 10th International Flatfish Symposium steering committee - Tim Loher
- 2017 PICES Early Career Scientist Meeting steering committee - Allan Hicks
- National Academies of Science, NMFS Marine Recreational Information Program reviewer - Bruce Leaman
- NOAA SWFSC & PFMC Workshop on CPS Assessments reviewer - Ian Stewart
- Journal of Sea Research Special Issue guest editor - Tim Loher
- NPFMC Abundance-Based Bycatch Management Work Group - Bruce Leaman
- Western Regional Aquaculture Center program reviewer - Josep Planas
- Individual Fishing Quota program, NPFMC reviewer - Bruce Leaman

Conferences, meetings, and workshops

- 19th Western Groundfish Conference, Newport, OR - Josep Planas, Claude Dykstra, Ian Stewart, Joan Forsberg, Dana Rudy, Chris Johnston, Robert Tobin
- 8th International Fisheries Observer and Monitoring Conference, San Diego, CA - Lara Erikson, Eric Soderlund
- World Fisheries Congress, Busan, South Korea - Ian Stewart
- American Fisheries Society Annual Meeting, Kansas City, MO - Allan Hicks
- Ocean Sciences Meeting, New Orleans, LA - Lauri Sadorus
- 12th International Congress on the Biology of Fish, San Marcos, TX - Josep Planas, Dana Rudy
- Atlantic Halibut Research Workshop, Halifax, NS - Bruce Leaman
- American Society for Public Administration Annual Conference, Seattle, WA - Mike Larsen
- Developing Electronic Data Capture Systems Workshop, Newport, OR - Lara Erikson
- NOAA SIS workshop, Seattle, WA - Ian Stewart
- 2nd MARVLS Workshop, San Diego, CA - Josep Planas
- International Fisheries Commissions Pension Society Meeting, Seattle, WA - Bruce Leaman, Mike Larsen, Stephen Keith
- Dynamics GP User Group Conference, Tampa, FL - Mike Larsen
- Halibut Biotracking Project Planning Workshop, Dalhousie University, Halifax, NS - Tim Loher
- Western Division American Fisheries Society Meeting, Reno, NV - Ian Stewart
- American Fisheries Society WA-BC chapter meeting, Chelan, WA - Robert Tobin

Awards, training, and certifications

- Master of Public Administration degree from University of Washington - Mike Larsen
- Annual eLandings and CDQ training - Lara Erikson
- Train the Trainer Workshop - Aregash Tesfatsion

Outreach and education

- Booth at Fishermen's Fall Festival, Seattle, WA - Claude Dykstra, Lara Erikson, Stephen Keith, Aregash Tesfatsion
- Booth at Pacific Northwest Sportsmen's Show, Portland, OR - Claude Dykstra, Stephen Keith
- Booth at Pacific Marine Expo, Seattle, WA - Claude Dykstra, Lara Erikson, Jamie Goen, Aregash Tesfatsion, Stephen Keith, Josep Planas, Huyen Tran
- Booth at Discover Science Weekend at the Seattle Aquarium, Seattle, WA - Lara Erikson, Jamie Goen, Lauri Sadorus, Aregash Tesfatsion, Allan Hicks, Dana Rudy
- Homer Halibut Festival, Homer, AK - Claude Dykstra
- Affiliate Faculty at University of Washington, Seattle, WA - Ian Stewart
- Affiliate Faculty at Alaska Pacific University, Anchorage, AK - Josep Planas
- Lecturer at University of Washington, Seattle, WA - Ray Webster
- Graduate Student Committee member, University of Washington School of Aquatic and Fishery Sciences, Seattle, WA - All an Hicks, Ian Stewart
- Graduate Student Committee member, University of Alaska, Fairbanks, AK - Tim Loher
- Co-instructor for a stock assessment class in Ponza, Italy - Allan Hicks
- Expanding Your Horizon's STEM Workshops, Bellevue and Edmonds, WA - Lauri Sadorus
- UW School of Aquatic and Fishery Sciences invited speaker, Seattle, WA - Ian Stewart, Josep Planas
- OSU Hatfield Marine Science Center invited speaker, Newport, OR - Josep Planas
- UBC Comparative Physiology invited speaker, Vancouver, BC - Josep Planas

Thank You

The Commissioners and Staff wish to thank all of the agencies, industry, and individuals who helped us in our scientific investigations this year. A special thank you goes to the following:

- The many processing plants personnel who assist the IPHC port sampling and survey programs by storing and staging equipment and supplies.
- The Bering Sea and Aleutian Islands NOAA/NMFS/RACE division groups for saving us a spot on their groundfish surveys.
- 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 Area 2A tribal commercial fisheries.
- CDQ managers for providing the total number and weight of undersized halibut taken and retained by authorized persons and the methodology used to collect these data.
- The NMFS Observer Program for collecting, documenting, and forwarding tags recovered during observer deployments on commercial vessels.
- The staffs of the PFMC and NPFMC for their ongoing coordination with IPHC.
- State and federal agency staffs, as well as government contractors for their assistance in the provision of data for sport and personal use fisheries, commercial fisheries, as well as the provision of halibut bycatch estimates, and for their assistance in conducting the setline survey.
- The skippers, crews, and plant personnel, as well as those individuals from outside agencies, whose dedicated contributions and efforts make the IPHC operations a success.
- The staff of the Pacific Halibut Management Association of British Columbia for conducting fleet outreach in advance of the 2016 commercial fishing season; and its members for voluntarily conducting at-sea sex marking in support of the IPHC's stock assessment process.

LOOKING FORWARD

This section summarizes the main decisions made at the 2017 Annual Meeting that pertain to the Pacific halibut fishery, and are based on data collected and analyses done in 2016. For a full accounting of documents provided to the Commission during the meeting, visit the IPHC webpage: http://www.iphc.int/meetings-and-events/annual-meeting.html.

Catch limits

The Commission received harvest advice for 2017 from the IPHC Secretariat, Canadian and United States harvesters and processors, and recommended the following catch limits for 2017, to the two governments.

Regulatory Area	Catch Limit (pounds)
Area 2A (California, Oregon, and Washington)	1,330,000
Non-treaty directed commercial (south of Pt. Chehalis)	225,591
Non-treaty incidental catch in salmon troll fishery	39,810
Non-treaty incidental catch in sablefish fishery (north of Pt. Chehalis)	70,000
Treaty Indian commercial	435,900
Treaty Indian ceremonial and subsistence (year-round)	29,600
Sport - Washington	237,762
Sport – Oregon	256,757
Sport - California	34,580
Area 2B (British Columbia) (includes sport catch allocation)	7,450,000
Area 2C (southeastern Alaska) (combined commercial/guided sport)1	5,250,000
Commercial fishery (4,212,000 catch and 123,000 incidental mortality)	4,335,000
Guided sport fishery	915,000
Area 3A (central Gulf of Alaska) (combined commercial/guided sport)	10,000,000
Commercial fishery (7,739,000 catch and 371,000 incidental mortality)	8,110,000
Guided sport fishery	1,890,000
Area 3B (western Gulf of Alaska)	3,140,000
Area 4A (eastern Aleutians)	1,390,000
Area 4B (central/western Aleutians)	1,140,000
Areas 4CDE	1,700,000
Area 4C (Pribilof Islands)	752,000
Area 4D (northwestern Bering Sea)	752,000
Area 4E (Bering Sea flats)	196,000
Total	31,400,000

Catch sharing plans

IPHC Regulatory Area 2A

The Pacific Fishery Management Council's (PFMC) Catch Sharing Plan (CSP) for Area 2A was accepted by the Commission and is reflected in the catch limits adopted for the Area 2A fisheries. The overall catch limit for Area 2A in 2017 is sufficient to permit non-treaty incidental harvest of Pacific halibut during the limited-entry sablefish longline fishery, under the provisions of the CSP.

IPHC Regulatory Area 2B

Fisheries and Oceans Canada (DFO) will allocate the Area 2B catch limit between commercial and sport fisheries.

IPHC Regulatory Areas 2C and 3A

The North Pacific Fishery Management Council's (NPFMC) CSP for Areas 2C and 3A was accepted by the Commission and is reflected in the catch limits adopted for Areas 2C and 3A. That CSP sets the allocation between the commercial and charter sport sectors in those two Regulatory Areas. The Area 2C commercial fishery allocation is 4,212,000 pounds and 123,000 pounds estimated for incidental mortality within the fishery. The Area 3A commercial fishery allocation is 7,739,000 pounds for the commercial fishery catch and 371,000 pounds estimated for the O26 (> 81.3 cm) incidental mortality within the fishery.

The season for the IQ fisheries in 2017 was set to begin 11 March and conclude 7 November.

IPHC Regulatory Area 4CDE

The IPHC sets a combined catch limit for Area 4CDE. The individual catch limits for Areas 4C, 4D, and 4E reflect the 4CDE CSP adopted by the NPFMC. The CSP also allows Area 4D Community Development Quota (CDQ) harvest to be taken in Area 4E, and Area 4C Individual Fishing Quota (IFQ) and CDQ to be fished in Areas 4D and 4C.

Fishing periods (season dates)

The Commission approved a season of 11 March to 7 November 2017, for the U.S. and Canadian quota fisheries. Seasons will commence at noon local time on 11 March and terminate at noon local time on 7 November 2017 for the following fisheries and areas: the Canadian Individual Vessel Quota (IVQ) fishery in Area 2B, and the United States IFQ and CDQ fisheries in Areas 2C, 3A, 3B, 4A, 4B, 4C, 4D, and 4E. All Area 2A commercial fishing, including the treaty Indian commercial fishery, will take place between 11 March and 7 November 2017. The Saturday opening date was chosen to facilitate marketing.

In Area 2A, seven 10-hour fishing periods for the non-treaty directed commercial fishery south of Point Chehalis, Washington, are recommended: 28 June, 12 July, 26 July, 9 August, 23 August, 6 September, and 20 September 2017. All fishing periods will begin at 8 a.m. and end at 6 p.m. local time, and will be further restricted by fishing period limits announced at a later date.

Area 2A fishing dates for incidental commercial Pacific halibut fisheries concurrent with the limited-entry sablefish fishery north of Point Chehalis and the salmon troll fishing seasons will be established under U.S. domestic regulations by the National Marine Fisheries Service (NMFS). The remainder of the Area 2A

CSP, including sport fishing seasons and depth restrictions, will be determined under regulations promulgated by NMFS.

Regulatory changes

Charter Pacific halibut sector management measures for IPHC Regulatory Areas 2C and 3A

The Commission received a request from NPFMC to adopt charter Pacific halibut sector management measures in accordance with the NMFS CSP for Areas 2C and 3A. The NPFMC proposal is designed to keep removals by the charter fishery within the limits of the CSP. The Commission approved the following measures:

- In Area 2C: 1) a one-fish daily bag limit, and 2) a "reverse slot" size limit restriction (≤ 44 inches or ≥ 80 inches).
- In Area 3A: 1) a two-fish daily bag limit, 2) a maximum size limit for the second fish of 28 inches, 3) a four-fish annual limit, with a recording requirement, 3) a vessel limit of one trip per calendar day, 4) a limit of one trip per charter permit per calendar day, 5) a one-day-per-week closure of Pacific halibut charter fishing on Wednesdays throughout the year, and 6) Tuesday closures on 18 July, 25 July, and 1 August.

The Commission adopted a regulation requiring that Pacific halibut be landed and weighed head-on in order to eliminate differences in reported net weight caused by varying heading practices.

Head-on Pacific halibut landing requirement

The Commission adopted a proposal aimed at eliminating a recently identified bias in Pacific halibut removal estimates (net weight), by requiring all commercial Pacific halibut to be landed and weighed with their heads attached for data reporting purposes and to only be subject to a 32-inch minimum size limit. An exemption was agreed upon whereby vessels that freeze Pacific halibut at sea may land their frozen fish with the head removed and remain subject to a 24-inch minimum size limit only.

Other actions

Harvest policy analysis

The Commission agreed that the current IPHC harvest policy is outdated and that there is a need to remove the current "blue line" reference in the harvest decision table, which reflects this outdated harvest policy. The Commission will use the "status quo SPR" (F46%) fishing intensity as the reference line for this and future years' catch limit discussions, and will use its Management Strategy Evaluation (MSE) process to evaluate options for a modified harvest policy that separates the decisions regarding scale of the coastwide fishing intensity and the distribution of the removals among Regulatory Areas, and accounts for all sizes and sources of Pacific halibut mortality.

The Commission also requested that the IPHC Secretariat initiate a process to develop alternative, biologically based stock distribution strategies for consideration by the Commission and its subsidiary bodies. This should also be incorporated into the MSE Program of Work.

The Commission recommended that the IPHC MSE process be accelerated so that more of the elements contained within the current Program of Work are delivered at the 94th Annual Meeting of the Commission in 2018.

Expanded survey

The Commission approved the next in a series of expansions to its annual fishery-independent setline survey. The purpose of the expansion series is to provide more accurate and precise estimates among regulatory areas and to encompass all depths over which the stock is distributed. In 2017, the Commission's survey in Area 2A and Area 4B will be expanded.

IPHC Merit Scholarship

The Commission honored Ms. Ysabel Echeverio of Stevensville, Montana, as the 15th recipient of the IPHC Merit Scholarship. Ms. Echeverio was able to attend this Annual Meeting to accept the scholarship. Ms. Echeverio was the first recipient under the adjusted scholarship format and received an award of $4,000 per year, renewable for up to four total years of study. New scholarships will be awarded every other year, with the next one being awarded in 2018.

The 2018 Annual Meeting was set to take place in Portland, Oregon 22-26 January.

Upcoming meetings

The Commission's 2017 Interim Meeting will be held 29-30 November 2017, in Seattle, Washington in a venue accessible to the public and will be webcast. The next Annual Meeting (AM094) of the Commission will take place 22-26 January 2018 in Portland, Oregon at the Portland Suites and Executive Tower. The 95th Annual Meeting (AM095) is planned for 28 January – 1 February 2019 in Victoria, British Columbia.

Commission membership

United States Government Commissioner Dr. James Balsiger of Juneau, Alaska, was elected Chairperson for 2017. Canadian Government Commissioner Mr. Paul Ryall of Vancouver, British Columbia, was elected Vice-Chairperson. The other Canadian Commissioners are Mr. Jake Vanderheide of Duncan, British Columbia, and Mr. Ted Assu of Campbell River, British Columbia. The other U.S. Commissioners are Mr. Robert Alverson of Seattle, Washington, and Ms. Linda Behnken of Sitka, Alaska.

PUBLICATIONS

The IPHC publishes three serial publications - Annual reports, Scientific reports, and Technical Reports - and also prepares and distributes regulation pamphlets and information bulletins. Articles and reports produced during 2016 by the Commission and Staff are shown below and a list of all Commission publications is shown on the following pages. All reports published by IPHC are available through the online library at www.iphc.int/library.html.

2016 research publications

Bentzen, R., Castellini, J. M., Gerlach, R., Dykstra, C., and O'Hara, T. 2016. Mercury concentrations in Alaska Pacific halibut muscle relative to stable isotopes of C and N and other biological variables. Marine Pollution Bulletin 113(1-2):110-116.

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Hicks, A. C., Cox, S. P., Taylor, N., Taylor, I. G., Grandin, C., and Ianelli, J. N. 2016. Conservation and yield performance of harvest control rules for the transboundary Pacific hake fishery in US and Canadian waters. [In] Management Science in Fisheries: An Introduction to Simulation-based Methods. Edited by C. T. T. Edwards and D. J. Dankel. Routledge, Abingdon, Oxon, UK and New York, New York, USA: 69-85.

International Pacific Halibut Commission. 2016. Annual Report 2015. 96 p.

Loher, T., Woods, M. A., Jimenez-Hidalgo, I., and Hauser, L. 2016. Variance in age-specific sex ratios of Pacific halibut catches and comparison of statistical and genetic methods for reconstructing sex ratios. Journal of Sea Research 107:90-99. doi: 10.1016/j.seares.2015.06.004

Sadorus, L., Walker, J., and Sullivan, M. 2016. IPHC oceanographic data collection program 2000-2014. Int. Pac. Halibut Comm. Tech. Rep. 60. 32 p.

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Reports

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3. Determination of the chlorinity of ocean waters. Thomas G. Thompson and Richard Van Cleve. 14 p. (1930).
4. Hydrographic sections and calculated currents in the Gulf of Alaska, 1927 and 1928. George F. McEwen, Thomas G. Thompson, and Richard Van Cleve. 36 p. (1930).
5. History of the Pacific halibut fishery. William F. Thompson and Norman L. Freeman. 61 p. (1930).
6. Biological statistics of the Pacific halibut fishery. Changes in the yield of a standardized unit of gear. William F. Thompson, Harry A. Dunlop, and F. Heward Bell. 108 p. (1930). [Out of print]
7. Investigations of the International Fisheries Commission to December 1930, and their bearing on the regulation of the Pacific halibut fishery. John Pease Babcock, William A. Found, Miller Freeman, and Henry O'Malley. 29 p. (1930). [Out of print]
8. Biological statistics of the Pacific halibut fishery, Effects of changes in intensity upon total yield and yield per unit of gear. William F. Thompson and F. Heward Bell. 49 p. (1934). [Out of print]
9. Life history of the Pacific halibut - Distribution and early life history. William F. Thompson and Richard Van Cleve. 184 p. (1936). [Out of print]
10. Hydrographic sections and calculated currents in the Gulf of Alaska. 1929. Thomas G. Thompson, George F. McEwen, and Richard Van Cleve. 32 p. (1936).
11. Variations in the meristic characters of flounder from the northeastern Pacific. Lawrence D. Townsend. 24 p. (1936).
12. Theory of the effect of fishing on the stock of halibut. William F. Thompson. 22 p. (1937).
13. Regulation and investigation of the Pacific halibut fishery in 1947 (Annual Report). IFC. 30 p. (1948).
14. Regulation and investigation of the Pacific halibut fishery in 1948 (Annual Report). IFC. 30 p. (1949).
15. Regulation and investigation of the Pacific halibut fishery in 1949 (Annual Report). IFC. 24 p. (1951).
16. Regulation and investigation of the Pacific halibut fishery in 1950 (Annual Report). IFC. 16 p. (1951).
17. Pacific Coast halibut landings 1888 to 1950 and catch according to areas of origin. F. Heward Bell, Henry A. Dunlop, and Norman L. Freeman. 47 p. (1952).
18. Regulation and investigation of the Pacific halibut fishery in 1951 (Annual Report). Edward W. Allen, George R. Clark, Milton C. James, and George W. Nickerson. 29 p. (1952).
19. The production of halibut eggs on the Cape St. James spawning bank off the coast of British Columbia 1935-1946. Richard Van Cleve and Allyn H. Seymour. 44 p. (1953).
20. Regulation and investigation of the Pacific halibut fishery in 1952 (Annual Report). Edward W. Allen, George R. Clark, Milton C. James, George W. Nickerson, and Seton H. Thompson. 29 p. (1953).
21. Regulation and investigation of the Pacific halibut fishery in 1953 (Annual report). IPHC. 22 p. (1954).
22. Regulation and investigation of the Pacific halibut fishery in 1954 (Annual Report). IPHC. 32 p. (1955).
23. The incidental capture of halibut by various types of fishing gear. F. Heward Bell. 48 p. (1955).
24. Regulation and investigation of the Pacific halibut fishery in 1955 (Annual Report). IPHC 15 p. (1956).

25. Regulation and investigation of the Pacific halibut fishery in 1956 (Annual Report). IPHC. 27 p. (1957).
26. Regulation and investigation of the Pacific halibut fishery in 1957 (Annual report). IPHC. 16 p. (1958).
27. Regulation and investigation of the Pacific halibut fishery in 1958 (Annual Report). IPHC. 21 p. (1959).
28. Utilization of Pacific halibut stocks: Yield per recruitment. IPHC Staff. 52 p. (1960).
29. Regulation and investigation of the Pacific halibut fishery in 1959 (Annual Report). IPHC. 17 p. (1960).
30. Regulation and investigation of the Pacific halibut fishery in 1960 (Annual Report). IPHC. 24 p. (1961).
31. Utilization of Pacific halibut stocks: Estimation of maximum sustainable yield, 1960. Douglas G. Chapman, Richard J. Myhre, and G. Morris Soutward, 35 p. (1962).
32. Regulation and investigation of the Pacific halibut fishery in 1961 (Annual Report). IPHC. 23 p. (1962).
33. Regulation and investigation of the Pacific halibut fishery in 1962 (Annual Report). IPHC. 27 p. (1963).
34. Regulation and investigation of the Pacific halibut fishery in 1963 (Annual Report). IPHC. 24 p. (1964).
35. Investigation, utilization and regulation of the halibut in southeastern Bering Sea. Henry A. Dunlop, F. Heward Bell, Richard J. Myhre, William H. Hardman, and G. Morris Soutward. 72 p. (1964).
36. Catch records of a trawl survey conducted by the International Pacific Halibut Commission between Unimak Pass and Cape Spencer, Alaska from May 1961 to April 1963. IPHC. 524 p. (1964).
37. Sampling the commercial catch and use of calculated lengths in stock composition studies of Pacific halibut. William H. Hardman and G. Morris Southward, 32 p. (1965).
38. Regulation and investigation of the Pacific halibut fishery in 1964 (Annual Report). IPHC 18 p. (1965).
39. Utilization of Pacific halibut stocks: Study of Bertalanffy's growth equation. G. Morris Southward and Douglas G. Chapman. 33 p. (1965).
40. Regulation and investigation of the Pacific halibut fishery in 1965 (Annual Report). IPHC. 23 p. (1966).
41. Loss of tags from Pacific halibut as determined by double-tag experiments. Richard J. Myhre. 31 p. (1966).
42. Mortality estimates from tagging experiments on Pacific halibut. Richard J. Myhre. 43 p. (1967).
43. Growth of Pacific halibut. G. Morris Southward. 40 p. (1967).
44. Regulation and investigation of the Pacific halibut fishery in 1966 (Annual Report). IPHC 24 p. (1967).
45. The halibut fishery, Shumagin Islands westward not including Bering Sea. F. Heward Bell. 34 p. (1967).
46. Regulation and investigation of the Pacific halibut fishery in 1967 (Annual Report). IPHC. 23 p. (1968).
47. A simulation of management strategies in the Pacific halibut fishery. G. Morris Southward. 70 p. (1968).
48. The halibut fishery south of Willapa Bay, Washington. F. Heward Bell and E.A. Best. 36 p. (1968).
49. Regulation and investigation of the Pacific halibut fishery in 1968 (Annual report). IPHC. 19 p. (1969).
50. Agreements, conventions and treaties between Canada and the United States of America with respect to the Pacific halibut fishery. F. Heward Bell. 102 p. (1969). [Out of print]
51. Gear selection and Pacific halibut. Richard J. Myhre. 35 p. (1969).
52. Viability of tagged Pacific halibut. Gordon J. Peltonen. 25 p. (1969).

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53. Effects of domestic trawling on the halibut stocks of British Columbia. Stephen H. Hoag. 18 p. (1971).
54. A reassessment of effort in the halibut fishery. Bernard E. Skud. 11 p. (1972).
55. Minimum size and optimum age of entry for Pacific halibut. Richard J. Myhre. 15 p. (1974).
56. Revised estimates of halibut abundance and the Thompson-Burkenroad debate. Bernard Einar Skud. 36 p. (1975).
57. Survival of halibut released after capture by trawls. Stephen H. Hoag. 18 p. (1975).
58. Sampling of landings of halibut for age composition. G. Morris Southward. 31 p. (1976).
59. Jurisdictional and administrative limitations affecting management of the halibut fishery. Bernard Einar Skud. 24 p. (1976).
60. The incidental catch of halibut by foreign trawlers. Stephen H. Hoag and Robert R. French. 24 p. (1976).
61. The effect of trawling on the setline fishery for halibut. Stephen H. Hoag. 20 p. (1976).
62. Distribution and abundance of juvenile halibut in the southeastern Bering Sea. E.A. Best. 23 p. (1977).
63. Drift, migration, and intermingling of Pacific halibut stocks. Bernard Einar Skud. 42 p. (1977).

64. Factors affecting longline catch and effort: I. General review. Bernard E. Skud; II. Hookspacing. John M. Hamley and Bernard E. Skud; III. Bait loss and competition. Bernard E. Skud. 66 p. (1978). [Out of print]
65. Abundance and fishing mortality of Pacific halibut, cohort analysis, 1935-1976. Stephen H. Hoag and Ronald J. McNaughton, 45 p. (1978).
66. Relation of fecundity to long-term changes in growth, abundance and recruitment. Cyreis C. Schmitt and Bernard E. Skud. 31 p. (1978).
67. The Pacific halibut resource and fishery in regulatory Area 2; I. Management and biology. Stephen H. Hoag, Richard J. Myhre, Gilbert St-Pierre, and Donald A. McCaughran. II. Estimates of biomass, surplus production, and reproductive value. Richard B. Deriso and Terrance J. Quinn, II. 89 p. (1983).
68. Sampling Pacific halibut (*Hippoglossus stenolepis*) landings for age composition: History, evaluation, and estimation. Terrance J. Quinn, II, E.A. Best, Lia Bijsterveld, and Ian R. McGregor. 56 p. (1983).
69. Comparison of efficiency of snap gear to fixed-hook setline gear for catching Pacific halibut. Richard J. Myhre and Terrance J. Quinn, II. 37 p. (1984).
70. Spawning locations and season for Pacific halibut. Gilbert St-Pierre. 46 p. (1984).
71. Recent changes in halibut CPUE: Studies on area differences in setline catchability. Stephen H. Hoag, Richard B. Deriso, and Gilbert St-Pierre. 44 p. (1984).
72. Methods of population assessment of Pacific halibut. Terrance J. Quinn, II, Richard B. Deriso, and Stephen H. Hoag. 52 p. (1985).
73. Recent studies of Pacific halibut postlarvae in the Gulf of Alaska and eastern Bering Sea. Gilbert St-Pierre. 31 p. (1989).
74. Evaluation of Pacific halibut management for Regulatory Area 2A, I. Review of the Pacific halibut fishery in Area 2A, II. Critique of the Area 2A stock assessment. Robert J. Trumble, Gilbert St-Pierre, Ian R. McGregor and William G. Clark. 44 p. (1991).
75. Estimation of halibut body size from otolith size. William G. Clark. 31 p. (1992).
76. Mark recapture methods for Pacific halibut assessment: a feasibility study conducted off the central coast of Oregon. Patrick J. Sullivan, Tracee O. Geernaert, Gilbert St-Pierre, and Steven M. Kaimmer. 35 p. (1993).
77. Further studies of area differences in setline catchability of Pacific halibut. Steven M. Kaimmer and Gilbert St-Pierre. 59 p. (1993).
78. Pacific halibut bycatch in the groundfish fisheries: Effects on and management implications for the halibut fishery. Patrick J. Sullivan, Robert J. Trumble, and Sara A. Adlerstein. 28 p. (1994).
79. The Pacific halibut stock assessment of 1997. Patrick J. Sullivan, Ana M. Parma, and William G. Clark. 84 p. (1999).
80. The efficacy of electronic monitoring systems: a case study on the applicability of video technology for longline fisheries management. Robert T. Ames. 64 p. (2005).
81. Microsatellite screening in Pacific halibut (Hippoglossus stenolepis) and a preliminary examination of population structure based on observed DNA variation. Lorenz Hauser, Ingrid Spies, and Timothy Loher. 28 p. (2006).
82. Seasonal migration and environmental conditions experienced by Pacific halibut in the Gulf of Alaska, elucidated from Pop-up Archival Transmitting (PAT) tags [Appendices included in attached compact disk]. Timothy Loher and Andrew Seitz. 40 p. (2006).
83. Assessment and management of Pacific halibut: data, methods, and policy. William G. Clark and Steven R. Hare. 104 p. (2006).
84. Seasonal movements and environmental conditions experienced by Pacific halibut in the Bering Sea, examined by pop-up satellite tags. Andrew C. Seitz, Timothy Loher, Jennifer L. Nielsen. (2007).
85. Seasonal movements and environmental conditions experienced by Pacific halibut along the Aleutian Islands, examined by pop-up satellite tags. Andrew C. Seitz, Timothy Loher, and Jennifer L. Nielsen. 24 p. (2008).

Technical Reports

1. Recruitment investigations: Trawl catch records Bering Sea, 1967. Edward A. Best. 23 p. (1969).
2. Recruitment investigations: Trawl catch records Gulf of Alaska, 1967. Edward A. Best. 32 p. (1969).
3. Recruitment investigations: Trawl catch records Eastern Bering Sea, 1968 and 1969. Edward A. Best. 24 p. (1969).
4. Relationship of halibut stocks in Bering Sea as indicated by age and size composition. William H. Hardman. 11 p. (1969).
5. Recruitment investigations: Trawl catch records Gulf of Alaska, 1968 and 1969. Edward A. Best. 48 p. (1969).
6. The Pacific halibut. F. Heward Bell and Gilbert St-Pierre. 24 p. (1970). [Out of print]
7. Recruitment investigations: Trawl catch records Eastern Bering Sea, 1963, 1965,and 1966. Edward A. Best. 52 p. (1970).
8. The size, age and sex composition of North American setline catches of halibut (*Hippoglossus stenolepis*) in Bering Sea, 1964-1970. William H. Hardman. 31 p. (1970).
9. Laboratory observations on early development of the Pacific halibut. C.R. Forrester and D.G. Alderdice. 13 p. (1973).
10. Otolith length and fish length of Pacific halibut. G. Morris Southward and William H. Hardman. 10 p. (1973).
11. Juvenile halibut in the eastern Bering Sea: Trawl surveys, 1970-1972. E.A. Best. 32 p. (1974).
12. Juvenile halibut in the Gulf of Alaska: Trawl surveys, 1970-1972. E.A. Best. 63 p. (1974).
13. The sport fishery for halibut: Development, recognition and regulation. Bernard Einar Skud. 19 p. (1975).
14. The Pacific halibut fishery: Catch, effort, and CPUE, 1929-1975. Richard J. Myhre, Gordon J. Peltonen, Gilbert St-Pierre, Bernard E. Skud, and Raymond E. Walden, 94 p. (1977).
15. Regulations of the Pacific halibut fishery, 1924-1976. Bernard E. Skud. 47 p. (1977).
16. The Pacific halibut: Biology, fishery, and management. International Pacific Halibut Commission. 56 p. (1978). [Out of print]
17. Size, age, and frequency of male and female halibut: Setline research catches, 1925-1977. Stephen H. Hoag, Cyreis C. Schmitt, and William H. Hardman. 112 p. (1979).
18. Halibut assessment data: Setline surveys in the north Pacific Ocean, 1963-1966 and 1976-1979. Stephen H. Hoag, Gregg H. Williams, Richard J. Myhre, and Ian R. McGregor. 42 p. (1980).
19. I. Reducing the incidental catch of prohibited species in the Bering Sea groundfish fishery through gear restrictions. Vidar G. Wespestad, Stephen H. Hoag, and Renold Narita. II. A comparison of Pacific halibut and Tanner crab catches (1) side-entry and top-entry crab pots and (2) side-entry crab pots with and without Tanner boards. Gregg H. Williams, Donald A. McCaughran, Stephen H. Hoag, and Timothy M. Koeneman. 35 p. (1982).
20. Juvenile halibut surveys, 1973-1980. E.A. Best and William H. Hardman. 38 p. (1982).
21. Pacific halibut as predator and prey. E.A. Best and Gilbert St-Pierre. 27 p. (1986).
22. The Pacific halibut: Biology, fishery, and management. International Pacific Halibut Commission. 59 p. (1987).
23. Incidental catch and mortality of Pacific halibut, 1962-1986. Gregg H. Williams, Cyreis C. Schmitt, Stephen H. Hoag, and Jerald D. Berger. 94 p. (1989).
24. Egg and yolk sac larval development of Pacific halibut (*Hippoglossus stenolepis*). G.A. McFarlane, J.O.T. Jensen, W.T. Andrews and E.P. Groot. 22 p. (1991).
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Other publications

Children's book

Pacific Halibut Flat or Fiction? Lauri Sadorus and Birgit Soderlund (*illustrator*). 24 p. (2005). This is a full-color, non-fiction children's book. Hardcopies are available free of charge in limited quantities upon request and a pdf is available on the IPHC website.

Annual Reports

These reports provide summaries of Commission and Staff research and activities as well as the state of the fishery, and have been produced annually since 1969. Reports are available on the IPHC website. Limited quantities of the most current reports in hard copy may be available upon request.

Information bulletins and news releases

Bulletins and news releases are periodically issued to disseminate important information in a timely manner. They can be accessed on the IPHC website.

IPHC website and social media

In addition to maintaining a website (www.iphc.int), the IPHC disseminates information via a Facebook™ page (https://www.facebook.com/InternationalPacificHalibutCommission/) and Twitter™ account (https://twitter.com/iphcinfo). Both the Annual and Interim meetings are webcast live, and those remain accessible after the meetings via YouTube™.

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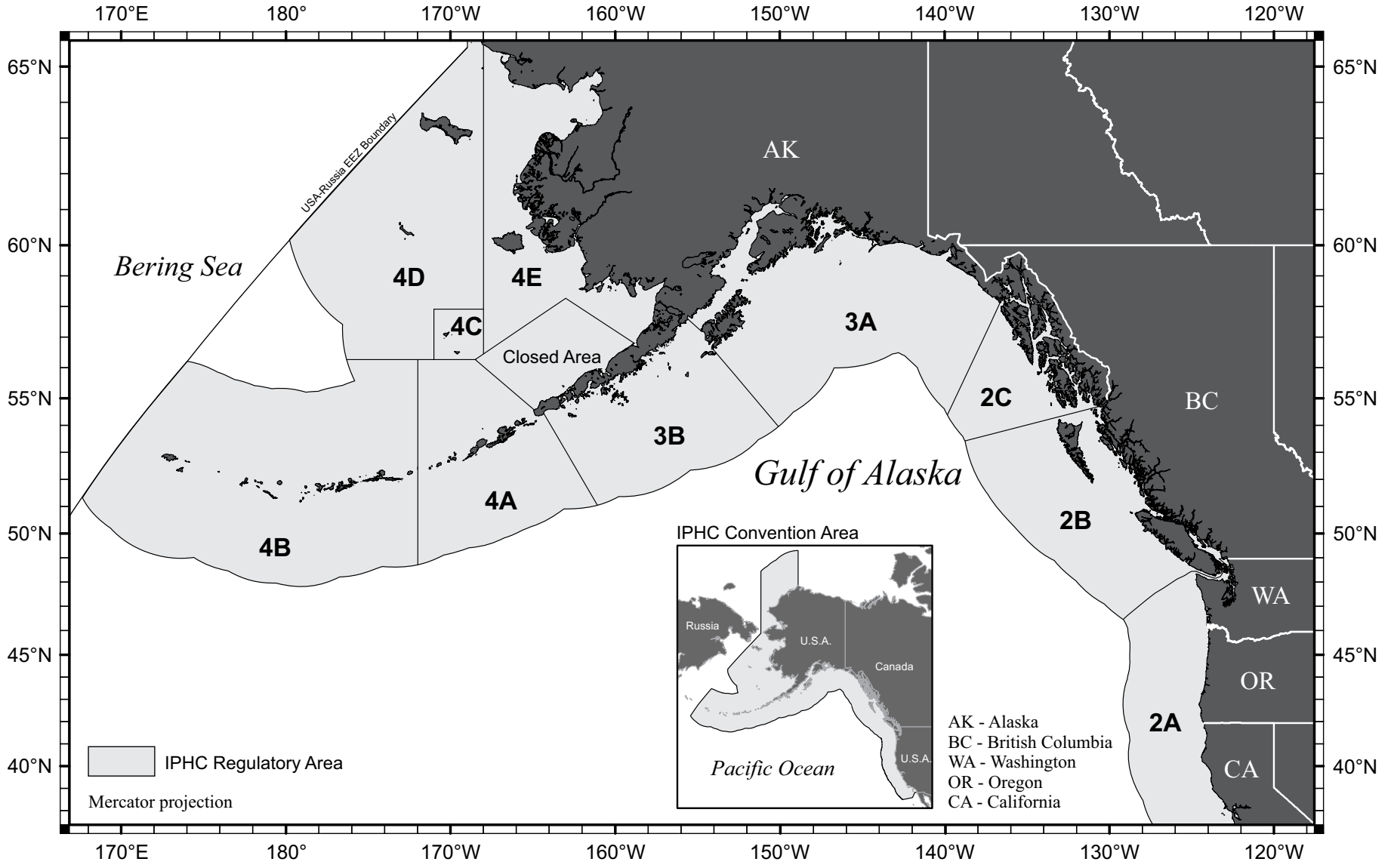

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