**TSC Agency Reports – IPHC 2017**

Contents



## I. Agency Overview

Management of the Pacific halibut resource and fishery has been the responsibility of the International Pacific Halibut Commission (IPHC) since its creation in 1923. Assessing, forecasting, and managing the resource and fishery requires accurate assessments, continuous monitoring, and research responsive to the needs of managers and stakeholders. The fishery for Pacific halibut (*Hippoglossus stenolepis*) is one of the most valuable and geographically largest in the northeast Pacific Ocean. Industry participants from Canada and the United States have prosecuted the modern fishery and have depended upon the resource since the 1880s. Annual removals have been as high as 100 million pounds, and the long-term average of removals is 64 million pounds.

Staffing Updates: In addition to some standard turnover seen in both the port and sea sampling seasonal positions, the following transitions occurred in 2016 and early 2017:

| Name | Position | Start Date | End Date |
|---|---|---|---|
| Dr. Josep Planas | Biological and Ecosystem Science Program Manager | January 2016 | |
| Dr. Allan Hicks | Quantitative Scientist | April 2016 | |
| Heather Gilroy | Fisheries Statistics Program Manager | | April 2016 |
| Keith Jernigan | Database and IT Program Manager | May 2016 | |
| Jamie Goen | Fisheries Statistics Program Manager | June 2016 | |
| Dr. Bruce Leaman | Executive Director | | August 2016 |
| Dr. David Wilson | Executive Director | August 2016 | |
| Anna Henry | Survey Manager | | September 2016 |
| Tracee Geernaert | Survey Manager | December 2016 | |
| Kirsten MacTavish | 1 Commercial Fisheries Data Manager * | | June 2016 |
| Lara Erickson | 2 Commercial Fisheries Data Manager | July 2016 | |
| Aregash Tesfatsion | 3 US Port Sampler Supervisor | September 2016 | |

| Name | Position | Start Date | End Date |
|---|---|---|---|
| Huyen Tran | 4 Lead Data Transcriber | September 2016 | |
| Kelly McElligott | 5 Data Transcriber | January 2017 | |
| Melissa Knapp | 1 Administrative Coordinator * | | January 2017 |
| Tamara Briggie | 2 Administrative Coordinator | January 2017 | |
| Stephanie Hart | 3 Administrative Assistant | January 2017 | |
| Kelly Chapman | 4 Front Office Administrative Assistant | January 2017 | |

* Note that the numbering in the subsequent lines reflects the sequence of position changes starting with this opening. In each of these sequences, only the last person is new to IPHC.

## II. Surveys

In 2016, fourteen commercial longline vessels, four Canadian and ten U.S., were chartered by the IPHC for survey operations. During a combined 77 trips and 698 charter days, these vessels fished 29 charter regions, covering habitat from southern Oregon to the island of Attu in the Aleutian Islands, and north along and including the Bering Sea continental shelf.

The 2016 survey design encompassed nearshore and offshore waters of southern Oregon, Washington, British Columbia, southeast Alaska, the central and western Gulf of Alaska, Aleutian Islands, and northern Bering Sea. Stations were located at the intersections of a 10 nmi by 10 nmi square grid within the depth range occupied by Pacific halibut during summer months (20-275 fm [37-503 m] in most areas).

As the next stage of a multi-year coastwide effort to expand our survey coverage and depth profile, an additional 83 stations were added to Regulatory Area 4D for 2016, including stations as shallow as 50 fathoms (91 m) and as deep as 400 fathoms (732 m).

Figure 1 depicts the survey station positions, charter region divisions, and regulatory areas surveyed.

All 1,366 survey stations planned for the 2016 survey season were either scouted or completed. Of these stations, 1,359 (99.5%) were considered successful for stock assessment analysis. A total of 14 special projects were facilitated and completed, and 15,505 otoliths were collected coastwide. Approximately 681,553 pounds (309 mt) of Pacific halibut, 43,374 pounds (20 mt) of Pacific cod, and 42,152 pounds (19 mt) of rockfish were landed from the setline survey stations.

Compared to the 2015 survey, weight per unit effort (WPUE) increased in Regulatory Areas 3A, 3B, 4A, and, 4C, and decreased in areas 2A, 2C, and 4D. WPUE in Regulatory Areas 2B and 4B remained the same as in 2015.

In 2017, the IPHC survey will include expansion stations in Regulatory Areas 2A and 4B. Expansion in Regulatory Areas 2B and 2C is planned for 2018, and in areas 3A and 3B in 2019.

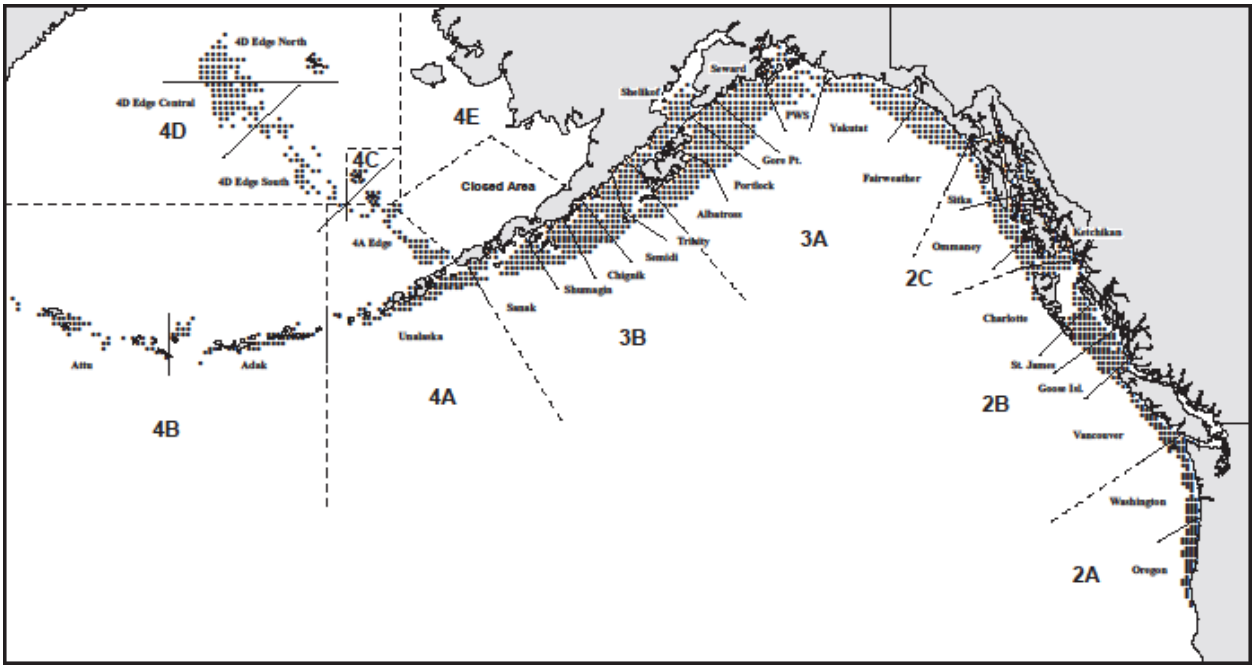

Figure 1. 2016 IPHC fishery-independent survey stations with regulatory area (two-character codes) and charter region (formal names) divisions.

## III. Reserves – N/A

## IV. Review of Agency Groundfish Research, Assessment, and Management

### A. Pacific halibut and IPHC activities

#### 1. Research

Abstract

Since its inception, the IPHC has had a long history of research activities devoted to describe and understand the biology of the Pacific halibut (*Hippoglossus stenolepis*). Currently, the main objectives of the Biological and Ecosystem Science Research Program at IPHC are to:

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

Traditionally, IPHC staff annually propose new projects designed to address key biological questions as well as the continuation of certain projects initiated the previous year, based on their own input as well as input from the Commissioners, stakeholders, and the IPHC Scientific Review Board (SRB) and the Research Advisory Board (RAB). Proposed research projects are evaluated internally by IPHC staff and presented to the Commission for feedback and subsequent approval. Importantly, biological research activities at IPHC are guided by a Five-Year Research Plan that identifies key research areas that follow Commission objectives. In this document, we present an outline of a new proposed Five-Year Research Plan for the period 2017-21 and an overview of the research projects proposed by IPHC staff for 2017.

IPHC Five-Year Research Plan

The new proposed Five-Year Research Plan for the period 2017-21 includes extensive studies covering five major research areas:

1) Reproduction (i.e., sex identification, maturity estimates),
2) Growth (i.e., decrease in size-at-age, temperature effects),
3) Discard mortality rates (i.e., physiological condition and survival post-release of bycatch),
4) Migration (i.e., larval dispersal, adult and reproductive migrations) and
5) Genetics and Genomics (i.e., genetic population structure, genome characterization).

These studies are intended to provide information on factors that influence the biomass of the Pacific halibut population (e.g., distribution and movement of fish among regulatory areas, growth patterns and environmental influences on growth in larval, juvenile and adult fish) and, specifically, of the spawning (female) population (e.g., reproductive maturity, skipped spawning, reproductive migrations). Furthermore, these studies are also intended to provide information on the survival of bycatch and wastage fish and eventually refine current estimates of discard mortality rates. An overarching objective of the Five-Year Research Plan is to promote integration and synergies among the various research activities led by IPHC in order to significantly improve our knowledge of key biological inputs that are introduced into the stock assessment.

Overview of research projects for 2017

For 2017, seven new projects are proposed that cover specific research needs related to reproduction (Projects 2017-01, 2017-02), migration (Projects 2017-02, 2017-03, 2017-04), growth (Project 2017-05), viability assessment and survival post-capture (Projects 2017-04, 2017-06) and genetics (Project 2017-07).

Project 2017-01 ("Full characterization of the annual reproductive cycle in adult female Pacific halibut") proposes to study the annual reproductive cycle of Pacific halibut females in order to further our understanding of sexual maturation in this species and to improve maturity assessments and maturity-at-age estimates.

Project 2017-02 ("Investigation of Pacific halibut dispersal on Bowers Ridge via Pop-up Archival Transmitting [PAT] tags") proposes to study the migratory behavior of females prior to the spawning season in order to identify potential spawning areas in Regulatory Area 4B.

Project 2017-03 ("Tail pattern recognition analysis in Pacific halibut") is a pilot study that proposes to identify individual fish by ways of photographic recognition of tail patterns to complement migratory studies.

Project 2017-04 ("Condition Factors for Tagged U32 Fish") proposes to study the relationship between the physiological condition of fish and migratory performance as assessed by tagging U32 fish in order to better understand the potential use of quantitative physiological indicators in predicting migratory (as well as other types of) performance.

Project 2017-05 ("Identification and validation of markers for growth in Pacific halibut") proposes to identify and validate molecular and biochemical profiles that are characteristic of specific growth patterns and that will be instrumental to describe different growth trajectories in the Pacific halibut population and evaluate potential effects of environmental influences.

Project 2017-06 ("Discard mortality rates and injury classification profile by release method") proposes to study the relationship between hook release methods in the longline fishery and associated injuries with the physiological condition of fish in order to improve our understanding of factors influencing post-release survival in the directed fishery.

Project 2017-07 ("Sequencing of the Pacific halibut genome") proposes to characterize for the first time the genome of the Pacific halibut and provide genomic resolution to genetic markers for sex, reproduction, and growth that are currently being investigated.

In addition to the new projects, eight continuing projects are proposed, including two projects dealing with sex identification (621.15, 621.16), two projects monitoring the Pacific halibut population for mercury and *Ichthyophonus* contamination (642.00, 661.11), three projects continuing migration-related research with the use of wire and satellite tagging (650.18, 650.20, 670.11) and one project finalizing work conducted on the reevaluation of the weight-length relationship (669.11).

Summaries of each of the new and continuing projects are included in the following sections with indication of the principal investigator(s) (PIs). Figure 2 presents a schematic diagram of new and continuing research projects, their interactions, and their relationship to the major research areas identified in the IPHC Five-Year Research Plan.

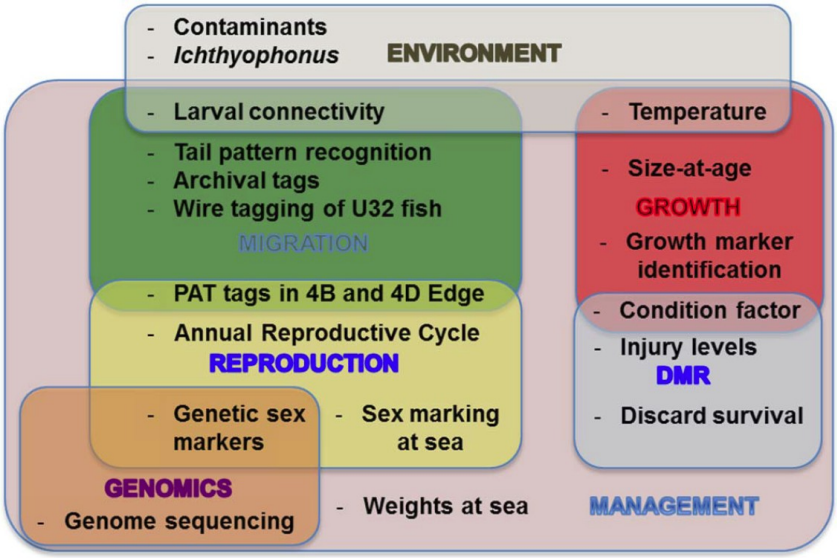


Figure 2. Schematic diagram of new and continuing IPHC research projects and their interactions

Following the discussion of new and continuing projects is a short description of other ongoing IPHC data collection projects that take place as part of the fishery-independent setline survey or as part of the commercial fishery data collection program.

<u>New research projects for 2017</u>

*2017-01 Full characterization of the annual reproductive cycle in adult male and female Pacific halibut*

*PI: Josep Planas*

In fisheries, understanding the reproductive biology of a species is important for estimating the reproductive potential and spawning biomass of the stock and, consequently, for optimizing the management of the species. The main purpose of this study is to improve our knowledge on basic aspects of the reproductive physiology of the Pacific halibut and to provide an updated and more comprehensive description of maturity in this species. The Pacific halibut is generally believed to reproduce following an annual cycle with spawning typically occurring in the winter. However, skipped spawning and biennial maturation cycles are not uncommon in temperate and

subarctic species. Very large yet putatively immature female Pacific halibut are often observed in the setline survey and analyses of PAT tag data are consistent with the hypothesis that skipped spawning is common in Pacific halibut. Regional and temporal variation in maturation and spawning schedules can affect the relationship between estimates of mature biomass and effective female spawning stock. Additionally, seasonal changes in fish condition can affect stock productivity and the relative impact of any given volume of harvest over time. Given that reproduction is under the control of the endocrine system, knowledge on the reproductive hormones involved and their temporal pattern of production is essential for understanding the temporal progression of gonadal maturation. In Pacific halibut, a comprehensive characterization of the reproductive cycle has not been performed to date and no information on how reproductive hormones may control gonadal maturation is available. In the present study, we propose to describe the temporal changes in gonadal morphological characteristics as well as in the levels of reproductive hormones and physiological condition throughout an entire annual reproductive cycle in order to improve and update our estimation of maturity in this species.

*2017-02 Investigation of Pacific halibut dispersal on Bowers Ridge via Pop-up Archival Transmitting (PAT) tags.*

*PI: Tim Loher*

The IPHC has a history of conducting PAT tagging in the Bering Sea and Aleutian Islands (BSAI) in order to investigate both seasonal (2002-2007, 2016; Projects 622, 622.11.84, 622.14) and inter-annual (2008-2010, 2016; Projects 622.12, 622.14) dispersal. In total, (152) satellite tags have been deployed in the course of those experiments, covering the historically surveyed range of this stock component throughout Areas 4A, 4B, 4C, and the 4D Edge. These studies have been aimed at gaining greater understanding of the timing of movements within this stock component, identifying winter spawning locations, and investigating mixing among regulatory areas in a fishery-independent manner. The results of these experiments have complemented large-scale Passive Integrated Transponder (PIT) tagging and have jointly resulted in an understanding of population function that is generally consistent with the structure of the IPHC's current Area-as-Fleets stock assessment model. However, notable gaps in spatial coverage of these tag deployments, relative to areas fished by BSAI fleet components, still exist: 1) Bowers Ridge (in 4B); 2) all of Area 4E. In 2016, The IPHC extended its fishery-independent setline survey northward along the eastern Bering Sea continental shelf edge, providing for the first time demographic data and an opportunity to tag fish in southern Navarin Canyon, quite possibly the northern-most major spawning ground for this species. In 2017, the IPHC intends to extend its Area 4B survey northward along Bowers Ridge, presenting a unique opportunity to fill another gap in our understanding of Bering Sea stock structure. In particular, recent genetic analyses have indicated that Pacific halibut in western 4B are genetically distinct from the remainder of the stock, raising questions regarding the relationship between Pacific halibut found along Bowers Ridge and the remainder of the Aleutian Islands region.

*2017-03 Tail pattern recognition analysis in Pacific halibut*

*PIs: Claude Dykstra, Tracee Geernaert*

The purpose of the study is to collect high resolution images of Pacific halibut tail patterns with the hypothesis that these patterns are unique to individual fish. Images will be combined with the 2017 U32 tagged fish allowing us to track growth/migration and re-image individuals when they are recaptured. By comparing images at tagging and recapture we can test the hypothesis that the tail morphology is unique and stable through growth. If a natural tag is

discovered it could allow for large scale tracking of movement and as a potential control for other tagging experiments with the added benefit of shedding light on discard mortality rates. The first step would be to determine if the patterns are unique and then the next step to determine if they are static or stable with growth.

*2017-04 Condition Factors for Tagged U32 Fish*

*PI: Claude Dykstra*

In this study we propose to collect condition factor information opportunistically on all fish under 32 inches in length (U32) that are tagged and released. This would need to be on a boat that was already carrying the scale for use in the weight-at-age project. In addition to the round weight of the tagged fish, this project would capture information on fat levels (utilizing the FatMeter device), and blood stress hormones. Over future years this would develop a deeper data set that could be related to some of the underlying physiology for tag recovery rates associated with different release injuries and subsequent tag recoveries.

*2017-05 Identification and validation of markers for growth in Pacific halibut*

*PI: Josep Planas*

Growth is a physiological process that takes place throughout the lifetime of Pacific halibut and that results from the complex interaction among dietary or trophic influences, environmental conditions, genetic background, energy expenditure requirements, etc. Growth is intimately linked to fitness and performance, adaptive capabilities and reproductive potential and, therefore, is a key process in determining the species' success in the ecosystem. From a fisheries perspective, growth at an individual and, ultimately, at a population level influences the amount of available biomass. In Pacific halibut, a significant decrease in size at age has been recorded over the last three decades. One of the various possible causes that have been attributed to this pattern, in addition to size-selective fishing, harvest pressure or size-dependent migration, is a decrease in somatic growth. Unfortunately, little is known regarding the factors that influence growth in this species. In order to begin to understand how growth in Pacific halibut can be modulated under specific (biotic or abiotic) conditions, it is necessary to develop appropriate tools to monitor growth. In this study, we propose to identify and validate appropriate molecular markers for growth that can be used to identify the presence of distinct growth patterns in the Pacific halibut population and evaluate the influence of environmental conditions on somatic growth in this species.

*2017-06 Discard mortality rates and injury classification profile by release method*

*PI: Claude Dykstra*

Discard mortality rates (DMR) in the longline fishery are currently estimated from Pacific halibut injury or vitality data obtained on observed trips. The small vessel longline fleet (<57') is currently developing electronic monitoring (EM) capabilities to collect data normally collected by the observer program. Determining vitality codes requires handling of the animal (which includes looking at both sides of the fish, testing muscle tone and opercular responses), which is something that cannot be achieved with cameras. EM data analysts are able to collect information on Pacific halibut release techniques for close to 95% of events; however, the suite of injuries incurred by each release technique is unknown. This study proposes to begin developing an injury profile for different release techniques with associated physiological condition measures, which could then be used to calculate DMRs on vessels carrying EM systems rather than observers. Additionally, this project could be a platform to tag and release Pacific halibut to further refine DMRs by each release category. DMRs calculated based on this

sort of effort would need to be understood to be in pristine condition as fisher would likely still try to release fish with minimal injury regardless of what treatment they would be randomly assigned.

*2017-07 Sequencing the Pacific halibut genome*

*PI: Josep Planas*

The genome of an organism is the collection of genes that are organized in chromosomes and that contain the genetic material necessary for its development, growth, and maintenance. The genome sequence therefore contains information on all the genes present in the genome, namely their DNA sequence and location in the genome. The purpose of this project is to generate a first draft of the genome of the Pacific halibut. Through the sequencing of the Pacific halibut's genome we will be able to identify genomic regions and genes that are responsible for temporal and spatial adaptive and phenotypic characteristics and better understand genetic and evolutionary changes that occur in response to environmental and fisheries-related influences. Therefore, the genome sequence will be essential for understanding possible changes in the genetic constitution of the Pacific halibut population. Importantly, the genome sequence will also allow us to understand the genetic basis of growth, reproductive performance, migratory behavior, etc. in this species. In the short term, the genome sequence will allow us to effectively map and capitalize information derived from all the identified single nucleotide polymorphisms (SNPs) associated with sex that are being derived through restriction-site associated DNA sequencing (RADseq) as well as the transcripts generated from our current RNA sequencing efforts.

<u>Continuing research projects for 2017</u>

*621.15 Voluntary at-sea sex marking and portside sampling of commercial longline vessels*

*PIs: Tim Loher, Ian Stewart, Claude Dykstra, Lara Erikson – and relevant port samplers; Collaborators: Lorenz Hauser and Dan Drinan (UW)*

The current IPHC stock assessment is sex-structured, but it is not based upon direct observations of sex in the landed catch. Historically, fishery sex ratio at age has been estimated on the basis of the sex ratios at size and age observed in IPHC survey catches, according to regulatory area. While this is statistically robust for some combinations of age and size (e.g., large young and small old fish), this procedure can be sensitive to small sample sizes and it ultimately provides an estimator of the properties of the survey catch, not fishery landings. In particular, the survey spans only ~40% of the commercial fishing period, and seasonal migration and the fishery's ability to target specific stock components and geographic areas have the potential to generate unknown degrees of variance between survey and fishery landings composition. In the absence of derived fishery sex-ratio data, the 2013 stock assessment was found to be very sensitive to the assumption that the relative selectivity at age of males and females is equivalent in the survey and fishery: a 20% range in fishery selectivity sex ratio translated into an ~50 million pound range in female spawning biomass estimates (i.e., ~25% of the total estimated value). Without direct observations of fishery sex ratio at age there is no way to determine the magnitude of the uncertainty and/or bias from this source that would be included in assessment results. The current study represents one component of a suite of integrated studies that are ultimately designed to obtain reliable sex data from eviscerated commercial landings.

*621.16 Development of production-scale genetic sexing techniques for routine catch sampling of Pacific halibut*

*PI: Tim Loher. Collaborators: Dr. Lorenz Hauser, Dan Drinan (UW).*

Declines in size at age of Pacific halibut, in concert with sexually dimorphic growth and a constant minimum commercial size limit, have led to the expectation that the sex composition of commercial catches should be increasingly female-biased. Given this likelihood, it is important to correctly estimate sex-specific fishing mortality rates in order to accurately predict stock trajectories for long-term policy analyses. Recent sensitivity analyses have indicated that uncertainty regarding sex ratios within commercial harvest may be the most influential factor affecting our understanding of female spawning stock biomass ($SSB_f$), with 10% variance in estimated sex ratios translating into a roughly 50 million pound range in estimates of $SSB_f$. Such uncertainty may be exacerbated if age-specific sex compositions vary in space and time, as recent studies have suggested that they do. However, there is no reliable way to determine sex at landing because all Pacific halibut are eviscerated at sea. The current work will develop genetic assays that will allow for the rapid and cost-effective sex identification of large samples from the commercial Pacific halibut fishery at relatively low cost.

*642.00 Assessment of Mercury and other contaminants in Pacific Halibut*

*PI: Claude Dykstra; Collaborator: Bob Gerlach (ADEC)*

Ongoing public concern over contaminants in seafood requires a better understanding of these levels in wild caught fish in different areas and by size of animal. We have been working with the Alaska Department of Environmental Conservation (ADEC) since 2002 to better characterize the levels of contaminants found in Alaska-caught Pacific halibut. The project is ongoing to further characterize, update and expand our understanding, and provide monitoring of contaminants encountered in wild-caught Pacific halibut from all regions of Alaska.

*650.18 Archival tags: tag attachment protocols*

*PI: Tim Loher*

Recovery rates of archival tags affixed to Pacific halibut using four different external mounting protocols (three dart-and-tether configurations; wired to the operculum) are being tested in a field release of “dummy” archival tags. During the summer of 2013, 900 fish were tagged off northern Kodiak Island (Area 3A), with an equal number of fish tagged with each tag attachment type. Fish carrying a dart-and-tether tag were also tagged with a bright pink cheek tag, and rewards of $100 are being given for all tags recovered. Total tags recovered in FY2015 were 4); there were 32 in FY2016. We expect approximately 25 recoveries in FY2017.

*650.20 Investigation of Pacific halibut dispersal on the far northern 4D Shelf Edge via Pop-up Archival Transmitting (PAT) tags*

*PI: Tim Loher*

During the summer of 2016, 35 Pacific halibut were tagged with Lotek PSATs on northern Area 4D Edge survey stations. Of these tags, 32 were programmed to detach from their host fish and report to the Argos system during FY2017 (n=20 during January; 12 during June). The remaining three tags were scheduled to report in September 2016.

*661.11 Ichthyophonus Incidence Monitoring*

*PI: Claude Dykstra*

*Ichthyophonus* is an internal histozoic parasite that can be found in all visceral organs and the musculature of infected hosts. Over a six-year period, infections in Pacific halibut were

detected at a relatively high prevalence compared to other host species. Between 2011 and 2016, the infection prevalence was 10.8 to 37.3% in the Bering Sea, 16.7 to 50% off the coast of Oregon, and with significantly higher infection prevalence ranging from 58.3 to 76.7% in Prince William Sound. Inter-annual infection prevalence has been relatively stable within geographic locations. While prevalence has been high for a marine species, infection intensity (i.e. number of schizonts in the liver or heart) has been extremely low to not detectable. Effects of infection vary greatly among individuals and host species, and can include reduced swimming performance, retarded growth, and acute mortality in other hosts; however, effects on Pacific halibut remain uninvestigated. The ongoing nature of the study is to monitor changes in infection prevalence at the three base sites (Bering Sea, inside Prince William Sound, Oregon) and more specifically in infection intensity. Sudden increases in infection intensity have been followed by large die off events in other species, and could then warrant a more intensive grow-out study.

*669.11 At-sea Collection of Pacific Halibut Weight to Reevaluate Conversion Factors*

*PI: Eric Soderlund*

Net weight is a fundamental concept that the IPHC uses for stock assessment, apportionment, and all facets of Pacific halibut management. However, individual net weight is not a strictly biological quantity; instead it is the result of natural variation as well as of one to several processing steps. The purpose of this study is to collect data on IPHC's fishery-independent setline survey for use in estimating the relationship between fork length and net weight, including the estimation of adjustments necessary to convert head-on weight to net weight, as well as estimation of shrinkage (potentially occurring in both length and weight) from time of capture to time of offload. This project will complement an ongoing project (665.11), in which portions of commercial deliveries are measured and weighed at the dock, by providing length-to-weight data that is not available at commercial offloads: from U32 fish, round fish, and freshly killed and dressed fish, as well as measurements of shrinkage from the time of capture to final weighing at the offload. The current length to net weight relationship was estimated in 1926. Using 1989 data, Clark re-estimated the relationship's parameters and found good agreement with the earlier curve. However, when Courcelles estimated the relationship data collected in 2011, she found significant differences between her estimated curve and that derived from the 1989 data, although inference was limited to a relatively small part of Area 3A and to the time of the setline survey. IPHC staff has also raised the issue of the relationship varying both regionally and seasonally. If the relationship varies among regulatory areas, there may be systematic bias in regulatory area estimates of weight or weight per unit effort (WPUE) derived from length measurements. The current relationship between fork length and net weight also includes adjustments for the weight of the head, and of ice and slime. As a secondary goal, we also plan to collect data to provide direct estimates of adjustment factors to compare with the currently assumed values, and to assess variability in the weight of heads and ice and slime.

*670.11 Wire tagging of Pacific halibut on NMFS trawl and setline surveys*

*PIs: Joan Forsberg, Lauri Sadorus*

In response to bycatch-related requests at the 2015 Annual Meeting to learn more about juvenile Pacific halibut distribution and movement, IPHC staff launched a pilot project during the 2015 survey season to test the practicality of wire tagging Pacific halibut aboard the NMFS trawl surveys. IPHC routinely participates in the NMFS groundfish trawl surveys in the Bering Sea (annual), Gulf of Alaska (biennial) and Aleutian Islands (biennial, alternate years from the GOA survey). Pacific halibut caught on the trawl survey range in size from about 20-100 cm fork length with most of the catch under 82 cm. The tagging effort was successful and the decision

was made to continue the project into the foreseeable future on NMFS trawl surveys and to expand the tagging effort to small Pacific halibut captured on the IPHC setline survey. The IPHC setline survey tagging effort conducted in 2016 was limited to one regulatory area (4D) and to Pacific halibut less than 82 cm fork length that were not part of the otolith sample. In 2016, a total of 424 and 170 Pacific halibut were tagged and released on the Bering Sea and Aleutian Islands surveys, respectively. As of 31 August 2016, a total of eight tags from the NMFS trawl releases have been recovered and returned to IPHC: four tags from the 2015 Bering Sea and four tags from the 2015 Gulf of Alaska releases. A total of 169 Pacific halibut were tagged on the IPHC setline survey in Area 4D. No tags from the 2016 releases had been recovered as of 31 August. In 2017, a broader tagging project will take place on our setline surveys. U32 halibut not sampled for their otoliths will be wire tagged. None will be tagged on the Area 2A and 4D Edge surveys where the otolith sampling rate is 100%. The goal is 500 tags per charter area.

Other ongoing data collection projects

In addition to specific research projects, the IPHC collects data each year through ongoing data collection projects that are funded separately, either as part of the fishery-independent setline survey or as part of the commercial fishery data collection program. Ongoing data collections projects that are continuing in 2017 include the following:

*IPHC fishery-independent setline survey*

*IPHC Survey Team – Tracee Geernaert, survey manager*

The IPHC fishery-independent setline survey provides catch information and biological data on Pacific halibut that are independent of the commercial fishery. These data, which are collected using standardized methods, bait, and gear during the summer of each year, provide an important comparison with data collected from the commercial fishery.

Biological data collected on the surveys (e.g., the size, age, and sex composition of Pacific halibut) are used to monitor changes in biomass, growth, and mortality in adult and sub-adult components of the Pacific halibut population. In addition, records of non-target species caught during survey operations provide insight into bait competition, rate of bait attacks, and serve as an index of abundance over time, making them valuable to the assessment, management, and avoidance of non-target species.

The Commission has conducted fishery-independent setline surveys in selected areas during most years since 1963. The majority of the current survey station design and sampling protocols have been consistent since 1998.

*Environmental data collection aboard the IPHC setline survey using water column profilers*

*PIs: Lauri Sadorus, Jay Walker*

The IPHC collects oceanographic data using water column profilers during the IPHC fishery-independent setline survey. The profilers collect a suite of oceanographic data, including pressure (depth), conductivity (salinity), temperature, dissolved oxygen, pH, and fluorescence (chlorophyll concentration). The IPHC has operated profilers since 2000 on a limited basis, and coastwide since 2009.

*IPHC aboard National Marine Fisheries Service groundfish trawl surveys in the Gulf of Alaska, Bering Sea, and Aleutian Islands*

*PI: Lauri Sadorus*

The National Marine Fisheries Service (NMFS) has conducted annual bottom trawl surveys on the eastern Bering Sea continental shelf since 1979 and the IPHC has participated in the survey on an annual basis since 1998 by directly sampling Pacific halibut from survey catches. The IPHC has participated in the NMFS Aleutian Islands trawl survey, which takes place every two years, since 2012. Alternating year by year with the Aleutian Islands trawl survey is the NMFS Gulf of Alaska trawl survey, which IPHC has participated in since 1996. The IPHC uses the NMFS trawl surveys to collect information on Pacific halibut that are not yet vulnerable to the gear used for the IPHC fishery-independent setline survey or commercial fishery, and as an additional data source and verification tool for stock analysis. In addition, trawl survey information is useful as a forecasting tool for cohorts approaching recruitment into the commercial fishery.

*Commercial fishery port sampling program*

*IPHC Port Team – Lara Erikson, port manager*

The IPHC positions field staff to sample the commercial catch for Pacific halibut in Alaska, British Columbia, Washington, and Oregon. Commercial catch sampling involves collecting Pacific halibut otoliths, fork lengths, logbook information, and final landing weights.

The collected data are used in the stock assessment and other research and the collected otoliths provide age composition data. Lengths of sampled Pacific halibut provide the basis for estimates of mean weight and, in combination with age data, size-at-age analyses. Mean 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. Finally, tags are collected to provide information on migration, exploitation rates, and natural mortality.

In addition to sampling the catch, other objectives include collecting recovered tags, and copying information from fishing logs along with the respective landed weights, for as many Pacific halibut trips as possible throughout the entire season.

## 2. Assessment

The stock assessment reports the status of the Pacific halibut (*Hippoglossus stenolepis*) resource in the Convention Area, including the Exclusive Economic Zones of the United States of America and Canada. Commercial fishery landings in 2016 were approximately 25.0 million pounds (~11,400 t, all weights in this document are reported as ‘net’ weights, head and guts removed; this is approximately 75% of the round weight), up from a low of 23.7 million pounds (~10,700 t) in 2014. Bycatch mortality was estimated to be 7.1 million pounds (~3,200 t), the lowest level in the estimated time series. The 2016 IPHC fishery-independent setline survey estimates of coastwide aggregate legal sized Pacific halibut (O32; over 32 inches (81.3 cm) in length) WPUE were 6% higher than the value observed in 2015, representing the fifth year of stable WPUE rates. Age distributions in 2016 from both the survey and fishery remained similar to those observed in 2011-15, indicating a relatively stable stock, but not showing clear evidence of strong coastwide recent recruitment events. At the coastwide level, individual size-at-age

continues to be very low relative to the rest of the time-series, although there has been little change over the last several years.

This stock assessment consists of an ensemble of four equally-weighted models, two long time-series models, and two short time-series models either using data sets by geographical region, or aggregating all data series into coastwide summaries. As has been the case since 2012, this stock assessment is based on the approximate probability distributions derived from the ensemble of models, thereby incorporating the uncertainty within each model as well as the uncertainty among models. The results at the end of 2016 indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2010, as a result of decreasing size-at-age, as well as somewhat weaker recruitment strengths than those observed during the 1980s. Since the estimated female spawning biomass (SB) stabilized near 200 million pounds (~90,100 t) in 2010, the stock is estimated to have been increasing gradually. The SB at the beginning of 2017 is estimated to be 212 million pounds (~96,200 t), with an approximate 95% confidence interval ranging from 153 to 286 million pounds (~69,400-129,700 t). Recruitment estimates show the largest recent cohorts in 1999 and 2005, and there is little information on the relative strength of subsequent cohorts, which will be the most important for stock productivity over the next decade.

A comparison of the median current ensemble SB to reference levels specified by the current harvest policy suggests that the stock is currently at 41% of equilibrium unfished levels; however, the probability distribution indicates considerable uncertainty, with a 5/100 (5%) probability the stock is below the $SB_{30\%}$ level. Stock projections for a range of alternative management actions 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 apportionment calculations and the target harvest rates from the current IPHC harvest policy. The results for 2017 show somewhat more risk than those from last year's assessment: the stock is projected to increase gradually over 2018-20 in the absence of any removals, and for removals of up to around 40 million pounds (~18,100 t). For removals around 40 million pounds (~18,100 t), projections are slightly decreasing. The risk of stock declines begins to increase rapidly for levels of harvest above 40 million pounds (~18,100 t) of total mortality, becoming more pronounced by 2020. The current IPHC Harvest Policy (the Blue Line) suggests that 37.9 million pounds, ~17,200 t, total removals, corresponds to a 56/100 (56%) chance of stock decline in 2018 and the *status quo* SPR line (41.6 million pounds, ~18,900 t) corresponds to a 68/100 (68%) chance of stock decline in 2018.

An executive summary of the 2016 stock assessment is posted on the IPHC website at: http://iphc.int/meetings-and-events/interim-meeting/im2016-documents.html.

The complete report of the 2016 stock assessment is available on the IPHC website at: http://www.iphc.int/publications/rara/2016/IPHC-2016-RARA-26-R-4.2_Assessment_of_the_Pacific_halibut_stock.pdf.

## 3. Management

The International Pacific Halibut Commission (IPHC) completed its 93rd Annual Meeting (AM093) in Victoria, British Columbia, Canada, on 27 January 2017, with Mr. Paul Ryall of Canada presiding as Chairperson. More than 330 Pacific halibut industry stakeholders attended the meeting, with over 160 more participating via the web. All of the Commission's

public and administrative sessions during the meeting were open to the public and broadcast on the web.

The Commission recommended to the governments of Canada and the United States of America catch limits for 2017 totaling 31.4 million pounds. The Commission also addressed other regulatory issues and took actions regarding the IPHC fishery-independent setline survey expansion and its harvest policy. A news release issued on 27 January 2017 announced the catch limits and fishing seasons for 2017. Documents and presentations from the Annual Meeting can be found on the Annual Meeting page on the IPHC website: 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:

| IPHC 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[1]) | **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** |

[1]The combined total includes estimated mortality from regulatory discards of sublegal Pacific halibut and lost gear in the commercial fishery, plus discard mortality in the guided sport fishery, as mandated in the U.S. Catch Sharing Plan.

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. Further information regarding the depth restrictions in the commercial directed Pacific halibut fishery, and details for the sport fisheries, is available at the NMFS hotline (1-800-662-9825). The Area 2A IPHC licensing procedures did not change.

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.

*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.

*Harmonize IPHC and NMFS Regulations Regarding Fishing in Multiple Regulatory Areas*

The Commission adopted a proposal aimed at harmonizing IPHC and NMFS regulations regarding fishing in multiple IPHC Regulatory Areas in Alaska, specifically to clarify that retention of Pacific halibut on a vessel in excess of the total amount of unharvested IFQ or CDQ that is currently held by all IFQ or CDQ permit holders aboard the vessel for the area in which the vessel is fishing is prohibited unless the vessel has a NMFS-certified observer on board and maintains a daily fishing log only.

*Use of the eLog in British Columbia*

The Commission directed the IPHC Secretariat to work with DFO to incorporate the use of the electronic version of the DFO British Columbia Integrated Groundfish Fishing Log into IPHC Regulations as an acceptable logbook for use in the Area 2B commercial Pacific halibut fishery.

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 Areas 2A and 4B will be expanded.

Meeting Report

The Report of the 93rd Session of the IPHC Annual Meeting (AM093) has been published and posted at the Annual Meeting page of the IPHC website: http://www.iphc.int/meetings-and-events/annual-meeting.html . The Report includes details on all the decisions, recommendations, and requests made by the Commission during the Annual Meeting.

## V. Ecosystem Studies

[See the description of “Environmental data collection aboard the IPHC setline survey using water column profilers” in the Research section on ongoing IPHC data collection projects above.]

## VI. Publications

International Pacific Halibut Commission. 2017. Report of Assessment and Research Activities 2016. http://iphc.int/library/raras/485-rara2016.html