2014 IPHC Research Report for TSC

Review of 2013 Projects and Proposals for 2014

International Pacific Halibut Commission Staff

Introduction

This report reviews research conducted by the IPHC staff in the past year as well as research proposed for the upcoming year. The report is divided into three sections: the first section briefly reviews staff changes over the past and upcoming year(s), the second section reviews the status of research conducted in 2013, and the third section presents the preliminary staff research proposals for 2014 and a summary of ongoing projects. This report does not include annual staff tasks such as data collection and processing that are necessary for the management of the fishery.

SECTION I:

Staffing Updates

In 2013 the IPHC hired Sierra Summers (Administrative Assistant) and Chris Johnston (Age Technician). These are in addition to some standard turnover seen in both the port and sea sampling seasonal positions.

SECTION II:

Review of 2013- Project Summaries

This section provides a brief recap of projects conducted in 2013. Full reports on most projects can be found in the 2013 RARA.

Research is conducted within four areas of study which connect to the IPHC mission and support the assessment and management objectives of the Commission. These four areas are 1) assessment and stock identification; 2) management strategy; 3) biology; and 4) ecology.

Assessment and stock identification

Project 604.00: Monitoring juvenile halibut abundance via NMFS trawl surveys
Start Date: 1996
Priority: High
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, I. Stewart

The NMFS trawl survey data series on halibut, parallel to our assessment survey data, is extremely valuable as a second fishery-independent data source for stock assessment. Trawl data

are particularly useful because they include large numbers of juveniles (ages 3-7) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS trawl surveys since 1996 and provide relevant age information. These data are incorporated into and stored in IPHC's database, and expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area). For 2013, samplers were deployed in the Bering Sea and Gulf of Alaska surveys.

Project 650.13: Archival tags: mounting protocols (OCA)
Priority: Medium
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

For 2013, the staff continued holding halibut in tanks at the Oregon Coast Aquarium (OCA) in Newport, OR to investigate alternate mounting protocols for the externally-mounted archival tags. A total of 30 halibut were captured via hook-and-line and transported live to the OCA. The fish are treated for parasites, examined regularly to assess healing and/or relative infection rates among mounting types, and behavior monitored. At the end of the holding period, fish will be measured to assess relative growth among treatment groups, and tags will be removed to examine the effects of the tag mounts on the tissue and musculature at the attachment site, or internal interactions in the case of an internal-external-streamer modification. The results will support the anticipated use of this type of technology in subsequent years.

Project 650.14: Archival tags: tag attachment protocols
Priority: High
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

External and internal tag recovery rates are being tested in the field release of archival test tags. In August-September 2009, 200 fish were tagged off southern Kodiak Island (in Areas 3A and 3B), half with external tags and half with internal implants. Fish were also tagged with a bright pink cheek tag, and rewards of $100 have been given for all tags recovered. Thirty-nine fish were recovered as of Dec. 2013. Because of a subsequent decision to focus only on an external mount protocol, this project was redone in Area 3A in 2013 (as Project 2013-04 with an anticipated ending in 2015). The project was redone to fully evaluate external attachment as the results are needed to evaluate three potential tag attachment sites on the fish. The release was designed to occur from the surveys to reduce costs while still achieving a broad distribution of releases. During the 2013 survey, a total of 900 halibut were tagged using one of four different attachment methods. As of December 2013, twelve fish were recovered.

Project 650.15: Archival tags: coastwide deployment

Priority: High
Start Date: 2016
Anticipated ending: Continuing
Personnel: T. Loher, B. Leaman, R. Webster, J. Forsberg

In preparation for a coastwide release of archival tags in 2016, the staff has been working with Lotek Wireless (St. John's, NL) on a specific tag design and configuration for IPHC use. Although no field activity occurred in 2013, Lotek is continuing their work on our requirements and construction. Results from the 2009 and 2013 release of dummy archival tags in Area 3A and the examination of several mounting protocols on fish being held at the Oregon Coast Aquarium will feed into the design of the tag and its attachment to the fish.

Project 650.16: Archival tags: Area 4B site selection
Priority: High
Start date: 2010
Anticipated ending: 2014
Personnel: T. Loher, J. Forsberg, survey team

In 2009, 773 fish were tagged in Area 4B to evaluate tag recovery rates in preparation for a future release of archival tags in the area. Recovery rates of PIT tags released in the Aleutians were quite low, without evidence of recovery hotspots. This suggests that if archival tags were deployed in the Aleutians, we would likely recover relatively few of those tags (to date 38 tags have been recovered which equates to a 5% recovery rate). This would result in either too few data to draw any conclusions or require that a very large number of tags be initially deployed. Given that archival tags cost $500-1200 each, resorting to a very large deployment would be financially prohibitive and problematic. The goal was to locate at least two release sites which will yield a sufficient number of recoveries.

Project 650.17: Archival tags: geomag tag performance
Priority: Low
Start Date: 2011
Anticipated ending: 2012
Personnel: T. Loher, J. Nielsen (UAF Juneau)

In 2011 we deployed both Desert Star and Lotek geomagnetic tags on 30 halibut in two regions of the Gulf of Alaska: in Area 2C, just offshore of southern Prince of Wales Island; and in Area 3A, offshore of southern Kodiak Island. Tagging was restricted to large fish (110-150 cm FL), most likely to be mature females and likely to conduct a spawning migration shortly after tagging, and was divided into two deployment locations because the coastline and bathymetry of the areas are largely perpendicular to one another with respect to the magnetic environment. In Area 2C, total magnetic field gradients run largely parallel to shore, whereas in Area 3A around Kodiak that gradient runs perpendicular to shore. As such, we hypothesized that geomagnetic positioning based on total field strength would more accurately detect onshore-offshore movement in 2C and alongshore migration around Kodiak. One tag was recovered (3% recovery

rate) as of December 2013. The study is proposed to be redone because an improved geomag design has recently been released, which is expected to perform better than the design used in 2011.

Project 2013-03: Estimate of length/weight relationship and head/ice/slime adjustment (NEW) – Pilot Project

Priority: Low
Start: 2013
Anticipated Ending: open ended
Personnel: R. Webster, L. Erickson, K. MacTavish, H. Gilroy

The purpose of this study is to collect data for use in estimating the relationship between fork length and net weight, including the estimate of adjustments necessary to convert head-on weight to net weight. Data was collected in most sampled ports coastwide for part of the season. The goal is to collect data coastwide in sampled ports throughout the commercial season in order to estimate spatial and seasonal variation in the length to weight relationship. In the current length-weight relationship, adjustments are made for head, ice, and slime, and are used when estimating the net weight of commercial offloads. The current relationship between fork length and net weight includes adjustments for the weight of the head, and of ice and slime: gross weight is assumed to include 12% head weight and 2% ice and slime, which combine to give a multiplier of 0.8624 to convert gross to net weight. In practice, deductions of 12% in Areas 2A and 2B, and 11.8% in Alaska, are applied to commercial landings at the plants to convert from gross to net weight. These both include the 2% deduction for ice and slime assumed in the IPHC length-net weight relationship, but 10% for the head. IPHC port samplers were tasked with collecting data at plants within their ports. Therefore in addition, data collected during the study will provide direct estimates of adjustment factors to compare with the currently assumed values, and will allow us to assess variability in the weight of heads and ice and slime. The end result is expected to be new adjustment factors that, if appropriate, can be applied consistently across all ports, or be allowed to vary with regulatory area.

Project 2013-06: SSA Expansion – California pilot (NEW)

Priority: Medium
Start: 2013
Anticipated Ending: currently planned for 2013 only
Personnel: C. Dykstra, survey team

The IPHC staff extended the assessment survey into the waters off northern California for the first time in 2013. In the past, the survey stopped at the Oregon/California border, which was traditionally the southern end of commercial fishing in past years. However, recent reports of previously unknown but significant sport fishery harvests of halibut from northern California waters, which contributed to exceeding the catch limit for that area, indicated the potential for a larger share of the resource in this area than was assumed. Adding this area into the assessment required a measure of fish density, which was provided by the survey. This issue also has implications for the Pacific Fishery Management Council's Area 2A Catch Sharing Plan, which

allocates a portion of the Area 2A catch limit to the area south of Humbug Mountain, Oregon, including California. The survey expansion extended the 10 x 10 nm systematic survey grid off northern California, to a terminus of 40° N., based on a review of halibut sport fishery sampling by California Fish and Game.

Biology

Project 636.00: Evaluation of Pacific halibut macroscopic maturity stage assignments
Priority: High
Start: 2004
Anticipated Ending: Continuing
Personnel: K. MacTavish, other staff as needed

The staff believes it is necessary to re-evaluate our classification criteria for female gonad maturity stage. The method currently used on the assessment surveys is based on visual criteria established in the early 1990s and modified in 1995. These survey data combined with the age data are important components in the stock assessment model. Four maturity stages are presently assigned to female halibut; immature (F1), maturing (F2), spawning (F3) and resting (F4). Once a female halibut has spawned, the gonad transitions to a resting phase, back to maturing, and then to spawning again. Our criteria for classification also assume that the immature (F1) stage is only seen with immature fish but we are seeing anomalies during the survey that question this assumption. Gonad samples were collected in 2004 from which to base this study. In 2013, work continued on determining if oocyte diameter is homogeneous within a single gonad.

Project 2012-01: Otolith increment analysis (New)
Priority: High
Start Date: 2013
Anticipated ending: 2015
Personnel: T. Loher, S. Wischniowski

This study is an internal IPHC project but may be part of a broader, comprehensive study to examine potential causes for the recent changes in halibut size at age (SAA) as well as an integrated approach to incorporating SAA dynamics into halibut assessment and management. The broader study would be funded through a grant application to the North Pacific Research Board, in cooperation with National Marine Fisheries Service and the University of Alaska. For the internal IPHC project staff will mine the otolith archives for historical samples which were collected at prescribed time intervals and measure the otolith growth increments. The relation between otolith growth and somatic growth is not well understood in many fishes, including halibut. But the IPHC otolith archives provide a unique opportunity to potentially examine changes in otolith growth over time and, by extension, halibut growth. Work in 2013 included refining the study design, otolith selection, cross sectioning, and aging.

Ecology

Project 610.13: Oceanographic monitoring of the north Pacific and Bering Sea continental shelf with water column profilers

Priority: Medium
Start date: 2009
Anticipated ending: Continuing
Personnel: L. Sadorus, P. Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the north Pacific. This platform provides enormous potential for collection of valuable oceanographic data. In particular, understanding the dynamics of the structure of the mixed layer depth – a major GLOBEC goal - requires *in situ* vertical profiling. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey. A second profiler was added to the program in 2007. In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment.

Project 642.00: Assessment of mercury and contaminants in Pacific halibut

Priority: Medium
Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, B. Gerlach (ADEC)

Our collaboration with the Alaska Department of Environmental Conservation (ADEC) continued in 2013, collecting halibut tissue samples for analysis of heavy metal and organic pollutant loading. This work has been ongoing since 2002. Results from a 2002 collection of halibut samples led the Alaska Division of Public Health in 2003 to conclude that the concentrations of heavy metals in Alaskan Pacific halibut were not a public health concern. In 2004 the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. The Alaska Division of Public Health updated their advice on fish consumption in 2007 with some restrictions on the number of meals of halibut for women of child bearing age and young children. Since 2002 the IPHC has submitted 1,293 samples for testing by ADEC. The IPHC and ADEC are continuing to qualify the data with physical parameters (age, size, and weight) and additional analyses will be done on the samples. ADEC and EPA planned on going ahead with this study regardless of IPHC input. Our involvement in the project has allowed us to provide input on study design, sampling protocols in the field, etc., which will make the resultant information much more robust.

Project 661.11: *Ichthyophonus* prevalence in halibut

Priority: Medium
Start Date: 2012
Anticipated ending: ongoing
Personnel: C. Dykstra, G. Williams, J. Gregg (USGS), P. Hershberger (USGS)

Ichthyophonus is a protozoan parasite from the class Mesomycetozoea, a highly diverse group of organisms having characteristics of both animals and fungi. It has been identified in many marine fish, and is considered a causative agent in herring fishery collapses world-wide and there is concern over its effects on the success of salmon spawning on major rivers such as the Yukon.

In 2011 the IPHC ran a small pilot project looking at *Ichthyophonus* prevalence in Pacific halibut in response to some initial test results from a 2010 USGS study which found high incidence rates in sport caught halibut in Cook Inlet, AK. The 2011 pilot took place in three geographically disparate areas (Oregon, Prince William Sound proper, and the northern Bering Sea). Results from this study found some of the highest incidence rates for any marine species in the Prince William Sound region (76.7% incidence), with lower, but still significant levels in Oregon (33.8%) and the northern Bering Sea (26.6%). USGS defines the Prince William Sound result as an epizootic event as the incidence rate is much higher than background rates seen in other halibut studies.

In 2012, sampling was expanded to collect tissue samples in all survey areas to further describe the spatial nature of the prevalence. In addition, samples were collected from smaller juveniles caught on the NMFS trawl survey in the Bering Sea. Prevalence of infection measured at ten longline survey sites ranged from 15% near Attu Island to over 70% in Prince William Sound, with a mean overall prevalence (Bering Sea to Oregon Coast) of 47%. Prevalence in smaller halibut (<50 cm) captured by trawl in the Bering Sea and Aleutian Island was 2.4%, indicating infections establish after some ontogenetic shift in diet, habitat, or behavior.

The prevalence of infection reported here is higher than that which has been observed in studies of other sympatric fish species, including other pleuronectids, suggesting that either susceptibility and/or infection pressures are higher in halibut. While ichthyophoniasis has been shown to reduce growth rate, decrease swimming stamina, and cause mortality in other fish hosts, its effects on Pacific halibut are unknown. For this reason, the IPHC staff and USGS researchers believe that future work should examine the effect of infection intensity on infection progression, tissue preferences (tropism), growth and survival. This type of work would be conducted on fish held in a controlled environment at the USGS lab at Marrowstone, WA. Field work in 2013 was limited to repeating collection of samples at the three sites initially surveyed in 2011 (and repeated in 2012) – Area 4D, Prince William Sound, and Oregon, with the objective of further describing the interannual variability of prevalence and infection over a broad spatial scale.

Other

Project 618.00: Undergraduate Internship
Start Date: 2002
Anticipated duration: Continuing
Personnel: L. Sadorus, other staff support as needed

The IPHC's 2013 summer intern, Hesper Kohler, worked on a pilot study to determine if a data collection request by NMFS was feasible during the IPHC setline survey. Specifically, NMFS was interested in biological information from longnose and big skates. During the pilot, 110 skates were sampled in IPHC Regulatory Area 3A. Skates were brought on board, stunned, and sampled for total length, sex, and a maturity rating. In addition, a section of the vertebral column was removed from each sampled skate for aging. The pilot study included experimentation with the best means of sampling the skates and storing the vertebral samples. Sampling the skates on the halibut measuring cradle made sampling easiest and most efficient, decreasing sampling time to less than two minutes. Freezing was the preferred method of storing bertebra samples over icing or salting. By the end of the study, it was determined that skate age and maturity sampling could be added to the Commission's summer survey in most cases, without hindering the halibut sampling. However, the project should not be added to areas with five or more other special projects in order to maintain the integrity of data collection for each project and the halibut survey.

Remote Data Entry Development

In 2013, the IPHC worked on developing software applications for data entry of commercial and survey data into tablets with the intent of replacing the pencil and paper method currently used in both programs. IPHC's programmers created and are still developing two applications: eLogs and eSurvey.

The eLogs application was finalized for testing in the field and tablets were deployed with port samplers in Alaskan ports at the start of the commercial halibut season (March 2013). Port samplers are using Panasonic Toughpads on which the eLog application was installed. The intent is for samplers to enter fishing log data directly into the eLog application during skipper interviews. Testing is ongoing with an anticipated completion date of May or June 2014.

The eSurvey application was also developed to replace the paper data forms that are currently used on the survey. The eSurvey application is still in the development phase with the expectation that it will be ready for in-field testing during the 2014 IPHC survey season.

SECTION III:

Ongoing and Proposed for 2014

Research proposed by IPHC staff goes through an internal review process by a staff Science Board. This year, the Board met in early October to review staff proposals for 2014 research. For each proposal, the Board discussed the merits, objectives, design, and coherence with the Commission's research goals and objectives. The Principal Investigator (PI) subsequently joined the Board for a broad discussion of the project. Concerns, questions and need for refinements or revisions, if any, about the proposal were communicated to the PI at that time. Following a full review of all proposals, the Board assigned a priority rating to each project, based on the following criteria:

High – Research which has a direct bearing on the assessment or its inputs, harvest policy, or current management structure. Postponement of a high priority project would have a significant and immediate impact on management or IPHC operation.

Medium – Research which addresses an assessment issue or management question/need. Postponement will not have an immediate significant impact on fishery management or IPHC operation but may impact future analyses.

Low – Research which addresses current issues of any subject but is not considered having a timely need or being crucial to current IPHC management or operation.

For the past several years, two primary topics have been at the forefront of discussions about the halibut resource. The first has been the continuing decline in size at age, with the resulting effects and impacts on the harvest policy and stock status. The second issue has been the migratory behavior of the stock, specifically seasonal and ontogenetic migration, including sex- and age-specific differences in spawning migration timing and duration. Research into both areas is of high priority for the Commission and staff. In the following section, studies for 2014 will be presented which address both topics. Briefly, the IPHC staff recommends continuing the otolith increment study which was started in 2013, which would examine growth patterns during earlier time periods (project 664.11). Understanding migration patterns is the overarching goal of the archival tag program, which has several aspects examining tag type, location, tag shedding and resolution of geomagnetic location data (projects 650.xx).

Based on the Science Board discussions and the topics previously outlined, the following sections describe the upcoming work by IPHC staff and also provide descriptions of recommended research studies for funding in FY2014.

OBJECTIVE 1: STOCK IDENTIFICATION, MONITORING AND ASSESSMENT

Research in this area focuses on stock identification, monitoring, assessment, forecasting, and incorporation of uncertainty in both data and processes into management advice. The staff seeks to understand the underlying Pacific halibut stock structure and the influence of age, size, and sex on movement as they relate to stock components. Additionally, monitoring occurs through the IPHC Port Sampling program (fishery removals), standardized setline stock assessment survey (fishery-independent stock indices), and trawl surveys (pre-recruits).

The most significant work is the annual stock assessment, which produces estimates of abundance based on a comprehensive suite of fishery-dependent and -independent variables. The assessment also forecasts short-term trends in the stock to support the IPHC decision-making process. Assessment staff also works at determining and reducing the level of uncertainty associated with stock assessments through advanced analytical techniques. Where needed, improved data collection or other studies are recommended.

For 2014, in addition to the annual assessment, the staff is proposing a field study to more fully characterize the selectivity of large halibut by examining hooking success for fish > 40 pounds. Additional detail is provided below.

Funded research - Proposed

Project 2014-02: Estimating hooking success for large halibut
Priority: Medium
Start: 2014
Anticipated Ending: 2014
Personnel: S. Kaimmer, I. Stewart

The study will observe hook attacks by halibut in the 110 to 150+ cm, i.e., 40-60 lb., range to estimate hooking success. Previous studies examining hooking success (2006 and 2007) estimated an increasing relationship between hooking success and fish size, but did not have enough observations on large fish (>100 cm; 20 lb.) to estimate whether this relationship might be dome shaped. Although the limited information available suggests an asymptotic curve, this is an important relationship for stock assessment modelling. Observing 50 attacks from halibut in the 110 to 150+ cm size range is expected to provide sufficient data to estimate the form of the relationship between hooking success and fish length for these larger fish. The study requires a suitable location from which captures of large halibut can be assured. IPHC stock assessment staff have placed a high priority on obtaining a more precise estimate of this relationship.

OBJECTIVE 2: HARVEST POLICY AND MANAGEMENT

Work to support this objective involves annual evaluations of IPHC's harvest policy with regard to the current stock dynamics and management goals. The staff develops stock projection procedures which incorporate a realistic range of alternative hypotheses about stock behavior, environmental influences, and fishing effects on stock abundance and halibut characteristics. The staff also provides harvest management advice to the Commission and user groups in a form which allows the consideration of uncertainty in the assessment and forecasting processes.

In 2013 the Commission approved the formation of a Management Strategy Advisory Board (MSAB) to oversee the Management Strategy Evaluation (MSE) process and to advise the Commission and Staff on the development and evaluation of candidate objectives and strategies for managing the fishery. The MSE process will help the Commission develop and thoroughly test alternative management procedures, prior to actually implementing any management changes for the fishery. A web site has been set up for all MSAB information and activities (http://www.iphc.info/msab).

The staff is not proposing any additional research for 2014 requiring separate funding. All work will be done within current staff work assignments.

OBJECTIVE 3: BIOLOGY, PHYSIOLOGY AND MIGRATION

Staff research within this objective seeks to collect and monitor primary biological characteristics of all sizes of halibut throughout the species' range. This includes directed studies but also involves incorporating studies monitoring the size at age of halibut within ongoing data

programs wherever possible. IPHC also collaborates with other institutions and agencies to obtain biological and ecosystem information on halibut not otherwise available through IPHC programs and to incorporate that information into understanding and prediction of halibut population dynamics. Specific migration research objectives focus on the impacts of ontogenetic and seasonal movements on long-term yield, spatial distribution of spawning biomass, impact of fishing seasons on interceptions, and temporal variations in fish movement.
Research specific to halibut migration and movement was requested by the Commission in 2001 (Leaman et al., 2002). Dr. T. Loher of the IPHC staff has designed a tag study to provide information on seasonal migration of halibut that can provide input for discussing appropriate fishing seasons with four objectives. These objectives will be accomplished by quantifying, for the eastern Pacific halibut population, on regional bases:

1) the active spawning season for Pacific halibut, defined as the period over which eggs are released into the water column;

2) depth-specific spawning habitat, defined as the range of bottom depths over which halibut initiate active spawning behavior;

3) the fall and spring migratory periods, including estimates of the proportion of stock in a state of seasonal migration by date; and

4) where possible, timing of seasonal movement among regulatory areas, and the proportion of the spawning stock likely to be located out-of-area, by date.

Since 2009, the IPHC staff has been actively engaged in studies explicitly designed to establish protocols for the proposed work. This includes selection of appropriate tag type, tagging attachment and location protocols on the fish, and reliable, cost-effective tag technology. The ongoing studies outlined below support this work.

Also, in 2013 the IPHC embarked on an extensive set of studies to examine the recent decline in halibut size at age. The work encompasses several focused pieces of research, including those being conducted by IPHC staff and others in a collaborative study with the National Marine Fisheries Service (NMFS), the University of Washington (UW), and the Alaska Department of Fish and Game (ADF&G). Work will continue in 2014 as the decadal samples are identified and extracted from the archives, and aging/measuring of the growth increments begins.

The staff is also proposing a study of halibut movements within the southern Salish Sea (Puget Sound) in response to recent proposed hypotheses about the nature of the population in that region. There has been a suggestion that the fish in this region are isolated and may require unique management. A demonstration of the movement of halibut from inside and outside waters will address the hypotheses.

Funded Research - ongoing

Project 636.00: Evaluation of Pacific halibut macroscopic maturity stage assignments
Priority: High
Start: 2004
Anticipated Ending: Continuing
Personnel: K. MacTavish, other staff as needed

The staff believes it is necessary to re-evaluate our classification criteria for female gonad maturity stage. The method currently used on the assessment surveys is based on visual criteria established in the early 1990s and modified in 1995. These survey data combined with the age data are important components in the stock assessment model. Four maturity stages are presently assigned to female halibut; immature (F1), maturing (F2), spawning (F3) and resting (F4). Once a female halibut has spawned, the gonad transitions to a resting phase, back to maturing, and then to spawning again. Our criteria for classification also assume that the immature (F1) stage is only seen with immature fish but we are seeing anomalies during the survey that question this assumption. Gonad samples were collected in 2004 from which to base this study. In 2014, work will continue on determining the maximum precision for oocyte diameter measurements by oocyte maturation stage, finalizing a sampling protocol for measurement of oocyte diameters, and contract slide preparation for gonads. The PI will also begin assessment of archived gonads from a set of previously-prepared slides.

Project 650.13: Archival tags: mounting protocols (OCA)
Priority: High
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

For 2014, the staff intends to continue holding halibut in tanks at the Oregon Coast Aquarium (OCA) in Newport, OR to investigate alternate mounting protocols for the externally-mounted archival tags. A total of 30 halibut were captured via hook-and-line and transported live to the OCA. The fish are treated for parasites, examined regularly to assess healing and/or relative infection rates among mounting types, and behavior monitored. At the end of the holding period, fish will be measured to assess relative growth among treatment groups, and tags will be removed to examine the effects of the tag mounts on the tissue and musculature at the attachment site, or internal interactions in the case of an internal-external-streamer modification. The results will support the anticipated use of this type of technology in subsequent years.

Project 650.14: Archival tags: tag attachment protocols
Priority: High
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

External and internal tag recovery rates are being tested in the field release of archival test tags. In August-September 2009, 200 fish were tagged off southern Kodiak Island (in Areas 3A and 3B), half with external tags and half with internal implants. Fish were also tagged with a bright pink cheek tag, and rewards of $100 will be given for all tags recovered. Nine fish were recovered in 2011. A subsequent decision to focus on an external tag led to an additional release of externally-tagged fish in 2013 (project 650.18).

Project 650.16: Archival tags: Area 4B site selection
Priority: High

Start date: 2010
Anticipated ending: 2014
Personnel: T. Loher, J. Forsberg, survey team

In 2009, 773 fish were tagged in Area 4B to evaluate tag recovery rates in preparation of a future release of archival tags in the area. Recovery rates of PIT tags released in the Aleutians were quite low, without evidence of recovery hotspots. This suggests that if archival tags were deployed in the Aleutians, we would likely recover relatively few of those tags. This would result in either too few data to draw any conclusions or require that a very large number of tags be initially deployed. Given that archival tags cost $500-1200 each, resorting to a very large deployment would be financially prohibitive and problematic. The goal is to locate at least two release sites which will yield a sufficient number of recoveries.

Project 650.17: Archival tags: geomag tag performance
Priority: High
Start Date: 2011
Anticipated ending: on hold until sufficient tags are developed/produced
Personnel: T. Loher, J. Nielsen (UAF Juneau)

Project 650.18: Archival tags: tag attachment protocols
Priority: High
Start Date: 2013
Anticipated ending: 2015
Personnel: T. Loher, J. Nielsen (UAF Juneau)

This study has the objective of refining an appropriate external tag protocol for the geomagnetic tagging. Recovery rates of archival tags affixed to 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 either $200 or $100, depending on tag configuration, will be given for all tags recovered.

Project 664.11: Otolith increment study
Priority: High
Start Date: 2013
Anticipated ending: 2014
Personnel: B. Leaman, T. Loher, Ian Stewart, S. Martell, J. Forsberg

This research focuses on the decrease in size at age, and the desire to examine similar metrics in previous time periods of the halibut stock. The project is part of a broad-based study of changing size at age in halibut, involving food web and ecosystem drivers, bioenergetics, fisher effects,

and analytic modeling. The study, in collaboration with NMFS, UW, and ADF&G, is partially funded by NPRB. Primary work by IPHC staff will include the use of the otolith archives to examine growth patterns and size at age in earlier time periods. Thus far, the IPHC staff has been examining the IPHC historical otolith collection for samples available for specific decadal time periods and ages. In addition, several otolith collections from more recent samples have been re-aged using the now-standard bake and burn (B&B) aging technique. The re-aging allows us to estimate the bias in the surface age readings. We intend to extend this study by looking at samples by decade, back to the 1920s. Stomach and relative abundance samples for halibut and co-occurring groundfish species were also collected for the larger project during the 2013 NMFS Gulf of Alaska survey.

Project 665.11: Estimate of length/weight relationship and head/ice/slime adjustment
Priority: High
Start: 2013
Anticipated Ending: open ended
Personnel: R. Webster, L. Erikson, K. MacTavish, H. Gilroy

The purpose of this study is to reexamine the relationship between fork length and net weight, including the estimation of adjustments necessary to convert head-on weight to net weight. The current length-net weight relationship was estimated in 1926. Using 1989 data, Clark (1992) re-estimated the relationship's parameters and found good agreement with the earlier curve. However, when Courcelles (2012) 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 always known that the relationship varies seasonally and likely regionally. If the relationship varies among regulatory areas, there may be systematic bias in regulatory area estimates of weight or WPUE derived from length measurements. Seasonal variation could affect weight estimates that are made from data collected during only a small part of the year. Therefore, we are collecting data coastwide throughout the season in order to estimate spatial and seasonal variation in the length to weight relationship. Data will be collected in 2014 from ports staffed with IPHC samplers throughout the fishing season. The goal is to determine whether seasonal or area-specific L-W relationships are warranted, or whether the effect of any variation can be incorporated via variation about the existing relationship.

The current relationship used by IPHC between fork length and net weight also includes adjustments for the weight of the head, and of ice and slime: gross landed weight (gutted, with head, ice and slime) is assumed to include 12% head weight and 2% ice and slime, which combine to give a multiplier of 0.8624 to convert gross to net weight. However, the industry standard for head, ice and slime deduction is a total of 12%. Therefore 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. To achieve this, we plan to record multiple weights on at least a subsample of fish.

In 2013, a pilot phase of the project was implemented that tested the equipment and methods at a selection of ports (Bellingham, Port Hardy, Prince Rupert, Petersburg, Sitka, Juneau, and Homer). The need to carefully test potential scales prior to full implementation, and the fact that

the scales we used were far more expensive than those considered within the 2013 project budget, meant that the scope of the project in 2013 was more limited than initially proposed. In 2014, the project will be expanded to all ports with samplers. Sampling rates will be re-calculated based on the 2013 length distribution of market samples.

Funded Research - proposed

Project 2014-01: Archival tags: Salish Sea PAT tags
Priority: Low
Start: 2014
Anticipated Ending: 2015 (or 2016)
Personnel: T. Loher

This study is a test of several hypotheses regarding halibut movements within Area 2A. Specifically, that halibut found in the southern Salish Sea, i.e., Puget Sound, are an isolated stock component requiring management independent of the larger outer coast population. In this proposal, 14 halibut would be marked with PAT tags at four setline survey locations during the summer of 2014, either from a dedicated chartered vessel or in collaboration with tribal fishers. The tags would be programmed to pop up the following January. The study proposes to use refurbished PAT tags currently on hand with IPHC for deployment. An additional 12 would be deployed in the summer of 2015, unless inter-area migration is detected from the 2014 releases.

OBJECTIVE 4: ECOSYSTEM INTERACTIONS AND ENVIRONMENTAL INFLUENCES

Research on this objective seeks to advance the understanding of the ecological context for halibut, including predation and competition, as well as fishing and environmental effects on recruitment and distribution. This also includes understanding the relationship between environmental influences and halibut distribution and behavior. This is primarily accomplished with broad-scale monitoring programs, some of which can occur on IPHC research platforms. Additionally, IPHC seeks to share its environmental data set with other researchers and institutions. Collaborative research is sought out whenever possible.

IPHC is actively involved in a large-scale monitoring program from the setline assessment survey using water column profilers. The program is making environmental data available to other researchers through a public access portal with the Pacific Marine Environmental Laboratory (PMEL). Other monitoring is occurring from the survey platform, including an appraisal of contaminants in halibut and the prevalence of *Ichthyophonus*. These three programs are proposed to continue in 2014, and are discussed below.

Funded research - ongoing

Project 610.13: Oceanographic monitoring of the north Pacific and Bering Sea continental shelf with water column profilers

Priority: Medium
Start date: 2009
Anticipated ending: Continuing
Personnel: L. Sadorus, P. Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the north Pacific. This platform provides enormous potential for collection of valuable oceanographic data. In particular, understanding the dynamics of the structure of the mixed layer depth – a major GLOBEC goal - requires in situ vertical profiling. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey. A second profiler was added to the program in 2007. In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center.

Project 642.00: Assessment of mercury and contaminants in Pacific halibut
Priority: Low
Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, B. Gerlach (ADEC)

The staff proposes to continue IPHC's collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2014, collecting halibut tissue samples for analysis of heavy metal and organic pollutant loading. This work has been ongoing since 2002. Results from a 2002 collection of halibut samples led the Alaska Division of Public Health in 2003 to conclude that the concentrations of heavy metals in Alaskan Pacific halibut were not a public health concern. In 2004 the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. The Alaska Division of Public Health updated their advice on fish consumption in 2007 with some restrictions on the number of meals of halibut for women of child bearing age and young children. Since 2002 the IPHC has submitted 2,088 samples for testing by ADEC. The IPHC and ADEC are continuing to qualify the data with physical parameters (age, size, and weight) and additional analyses will be done on the samples. ADEC and EPA planned on going ahead with this study regardless of IPHC input. Our involvement in the project has allowed us to provide input on study design, sampling protocols in the field, etc., which will make the resultant information much more robust.

Project 661.11: *Ichthyophonus* prevalence in halibut
Priority: Low
Start Date: 2012
Anticipated ending: ongoing
Personnel: C. Dykstra, G. Williams, J. Gregg (USGS), P. Hershberger (USGS)

Ichthyophonus is a protozoan parasite from the class Mesomycetozoea, a highly diverse group of organisms having characteristics of both animals and fungi. It has been identified in many marine fish, and is considered a causative agent in herring fishery collapses world-wide and there is concern over its effects on the success of salmon spawning on major rivers such as the Yukon.

During 2011-2013, samples have been collected from halibut caught on the IPHC setline assessment survey over a broad geographic range, with a goal of describing the spatial and temporal distribution of *Ichthyophonus* prevalence. Limited sampling of small (<50 cm) halibut from the NMFS trawl survey recorded a very low prevalence rate of 2.4%, suggesting that infections establish after some ontogenetic shift in diet, habitat, or behavior. Sampling of larger, adult halibut have shown a wide range of rates, with Prince William Sound showing some of the highest observed in fish.

The prevalence of infection is higher than that which has been observed in studies of other sympatric fish species, including other pleuronectids, suggesting that either susceptibility and/or infection pressures are higher in halibut. While ichthyophoniasis has been shown to reduce growth rate, decrease swimming stamina, and cause mortality in other fish hosts, its effects on Pacific halibut are unknown. For this reason, the IPHC staff and USGS researchers believe that future work should examine the effect of infection intensity on infection progression, tissue preferences (tropism), growth and survival. Work in 2014 will continue with the monitoring of the three original sites (OR, PWS, northern Bering Sea). Investigations will also be made into the logistics of conducting a controlled exposure/growth experiment at the USGS lab at Marrowstone, WA. Juvenile halibut would be randomly assigned to one of three treatment groups to assess the effect on halibut growth and survival. Costs would be shared between IPHC and USGS. A written manuscript describing results will be prepared by USGS and IPHC researchers.

References

Clark, W. G. 1992. Validation of the IPHC length-weight relationship for halibut. Int. Pac. Halibut
Comm. Report of Assessment and Research Activities 1991: 113-116.

Courcelles, D. 2012. Re-evaluation of the length-weight relationship of Pacific halibut (*Hippoglossus stenolepis*). Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2011: 459-470.

Leaman, B. M., Geernaert, T. O., Loher, T., and Clark, W. G. 2002. Further examination of biological issues concerning an extended commercial fishing season. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2001:53-73.