IPHC Research Program

Review of 2010 Projects and Proposals for 2011

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 two sections, with the first section briefly reviewing the status of research conducted in 2010. The second section presents the preliminary staff research proposals for 2011. Information is provided on when each project was initiated, the anticipated completion date, the annual cost, a description of the costs, and the purpose of the project. This report does not include ongoing staff tasks such as data collection and processing that are necessary for the management of the fishery.

Research projects are organized into three funding categories that reflect availability and source of research funds. Limited research requiring direct financial support from the Commission is possible under the basic $4.1 million (as of FY2010) government appropriations, although a number of programs can be conducted using only the staff resources that are supported by the appropriations. The three funding categories are:

1) **Funded Research:** Necessary research projects of high priority that can only be conducted with appropriations funding or carryover from 2010;

2) **Contracts and Grants:** Agreements with other parties to conduct specific research. In this case, contracts and grants are shown for projects where the IPHC staff is the principle investigator; and

3) **Research conducted without direct funding:** Necessary research projects of high priority that can be conducted through staff time alone or if sufficient funds are available within the IPHC budget.

Nearly all of the research done by the staff is directed toward one of three continuing objectives of the Commission:

i) Improving the annual stock assessment and quota recommendations;

ii) Developing information on current management issues; and

iii) Adding to knowledge of the biology and life history of halibut.

In each of these areas our routine work program applies the best information and methods available, and our research program aims to improve the information and methods by answering the most important outstanding questions.

SECTION I:
REVIEW OF RESEARCH CONDUCTED IN 2010

Research conducted by the IPHC staff during 2010 continued in three basic areas: life history, fish movements, and general biology. Most of the projects were conducted as part of the normal staff duties, with no additional funding required outside of staff salaries. Funding for projects outside of staff salaries came from supplemental funding, and these projects are outlined below.

Overview

Genetics and population structure

Research on population structure through genetics research (#621) continued in 2010 with additional sample analysis under the supervision of Dr. Lorenz Hauser at the University of Washington's Marine Molecular Biology Laboratory (MMBL). The work, initiated with Dr, Hauser in 2002, has not detected significant genetic structure and the present results support the hypothesis that a genetically well-mixed population exists from at least the Queen Charlotte Islands through the southeast Bering Sea and eastern Aleutian Islands. Dr. Heather Galindo, a post-doctoral researcher in the MMBL, has been screening samples from several winter collections for neutral microsatellite markers and more powerful markers derived from coding genes (expressed sequence tags, or ESTs) for further tests of population structure. During the course of the microsatellite screenings, she "chanced" upon three markers that appear to be strongly correlated with sex, despite the fact that no genetic test for sex has even been published for Pacific halibut and the species' sex-determining mechanism is unknown. While the use of these three markers does not result in fool-proof identification of sex, a preliminary test suggests that using these markers to assess sex is, on average, >90% accurate. It can also be used on individual fish compared with the sample-based mathematical estimates presently used to estimate sex-ratios in the commercial catch for the stock assessment. A manuscript describing these alleles is presently undergoing peer-review, and in order to more fully test this possibility, a 2010 student internship was designed to collect commercial samples amenable to conducting a formal comparison of methods (see below).

PAT tagging

PAT tag studies in 2010 involved further analysis of recoveries from past deployments. The most recent set of Area 4 PAT tag releases in 2008 were deployed to investigate the low recovery rates of PIT tags from Area 4 and the possibility that eastward migration is higher south of Unimak Pass than north of it. The tags released from the fish after one year. Dispersal patterns of the tag pop ups varied by area: no fish tagged in Area 4B produced an out-of-area endpoint location, whereas six fish tagged in Area 4A reported from Areas 3B and 3A, and a seventh fish from Area 2A. From the fish tagged in Area 4A, no fish tagged north of Unimak Pass reported from the Gulf of Alaska; all movement into Areas 2 and 3 was observed from fish that had been tagged south of the Aleutians. No fish tagged in the Bering Sea reported from outside the Bering Sea, whereas movement was observed from the Gulf of Alaska (southern 4A) northward into the Bering Sea (n = 3). Although there was no evidence of fish departing the Bering Sea, three of the fish tagged in Areas 4C & D moved along the contiguous northern shelf to Russian waters. Additionally, three of the summer pop-ups occurred in the Bristol Bay Closed Area, as did another nine of the premature releases.

Archival tags

Research continued on several fronts in 2010 on the use of archival tags (Project #650), which began in 2006. In one study, approximately 900 fish (> 32 in) were wire tagged and released at four distinct locations in Area 4B from the 2010 assessment survey, with the goal of locating a high recovery rate site for future deployment of archival tagged halibut. A single tag has been recovered to date. A second study is being conducted at the Oregon Coast Aquarium (Newport, OR), where halibut held in tanks have been tagged with a variety of both internally-implanted and externally-affixed tags. External mounts included through-body, opercular, and dart-and-tether. The fish will be regularly monitored for growth and behavioral effects over a period of at least one full year post-tagging. Other longer term studies include (1) the tagging of 162 halibut in Area 2B in 2008 with external cradle-mount tags and an additional four fish with internal implants, (2) double-tagging in 2009 of 200 fish near Kodiak with an external wire tag plus either an internal or external dummy archival in order to compare tag recovery rates. To date, 20 of the 2008 external tags have been recovered, in addition to one of the internal implants. Twenty-nine of the 2009 double-tagged fish have been recovered, represented by 22 internally-tagged and seven externally-tagged individuals.

Pacific Ocean Shelf Tracking (POST)

The multi-agency POST (Pacific Ocean Shelf Tracking) collaboration continued in 2010. This work began in 2009, with IPHC partnering with NMFS Auke Bay and ADF&G in the deployment of four sets of receiver-transmitter systems in Area 2C. The receiver-transmitter systems were deployed in depths of approximately 160, 300, 500, and 560 m, slightly different than originally planned. During a May, 2010 cruise to deploy the remaining stations off Cape Ommaney and recover the receivers deployed in 2009, we experienced 100% failure of the release assemblies at each station and were unable to retrieve any of the receivers. However, we were able to confirm that the acoustic releases had, in fact, tripped. We hypothesized that the receivers failed to surface because the chains attaching the receivers to the releases had become bound, although this design was recommended by the manufacturer. The receivers from one inshore station were recovered after 12 hours of dragging with a grappling hook during a 4-day follow-up cruise, using ADF&G funds. We did not have time to attempt recovery of the other receivers, but depth sounder returns from the submerged trawl floats indicated that at least one of the moorings was still in place in June. We hope that the receiver moorings from both “stranded” stations will eventually release and will be recovered and returned. All mooring equipment is labeled with contact information and an indication of reward for return of the equipment. Analysis of the data from the recovered receivers is ongoing by ADF&G.

Estimation of discard mortality with reflex action mortality predictors (RAMP)

IPHC staff participated for a second year in a study conducted by the North Pacific Fisheries Foundation (NPFF) to collect data from trawl-caught halibut for evaluating the effects of fishing practices on estimated discard mortality. The reflex action mortality predictors (RAMP) method uses reflex actions (six in this study) to produce a numerical condition score. The RAMP procedure is similar in concept to the existing IPHC condition factor scoring used by NMFS observers for estimation of discard mortality rates, but there are no survival correlates for the RAMP indices, as there are for the IPHC scoring. An initial cruise in 2009 was unable to catch a sufficient number of fish for analysis, so a follow-up took place in May, 2010. This latter cruise

also was unable to meet the experimental goals; tow sizes were sufficiently large enough that few halibut were lively enough to provide the full range of typical physical conditions. The IPHC sampler on board also had doubts about the practical application of this approach, which involves placing the fish in s small restraint and rotating the fish to monitor eye movement. The results are being analyzed by NPFF but initial results suggest that halibut may not be suitable for the RAMP methodology.

Bering Sea radiocarbon curve for age validation

Work continued in 2010 on a collaborative aging study with NMFS, using the samples from IPHC's historical otolith collection to form a Bering Sea radiocarbon, or ^{14}C, curve to validate the ageing techniques used by both agencies. In 2009, the staff was approached by staff from the fish aging unit at NMFS with a proposal to construct a Bering Sea bomb radiocarbon curve. Several agencies have used the halibut radiocarbon curve created in 2003 by IPHC staff to successfully validate their age determination methodologies. Those comparisons have been made between fish caught in the Gulf of Alaska (GOA) and a halibut radiocarbon curve which was constructed with samples from the GOA. However, NMFS has been unsuccessful in using the GOA halibut radiocarbon curve to validate age determination methodologies for several Bering Sea flatfish. NMFS proposed several possible explanations for this difference, and offered to share the costs of constructing a Bering Sea curve. In mid 2009, we selected otoliths from ages 1-6 halibut caught during 1954-1981 from the Bering Sea and a set of older halibut also from the Bering Sea. Upon completion, both the GOA curve and the Bering Sea curve will be compared to determine the initial onset of ^{14}C into both systems.

Water column profilers

Water column profilers were deployed in 2010 on all IPHC survey vessels. This is the result of the grant from NOAA for the purchase of profilers in 2008. The profilers collect data on salinity, temperature, dissolved oxygen, ocean acidity (pH), and fluorescence (chlorophyll) throughout the water column, which will provide a unique and valuable annual snapshot of oceanic conditions above the continental shelf over most of the northeast Pacific Ocean. Over 1,200 casts were made in 2010.

Cooperative data collection of bycatch species on IPHC surveys

Cooperative data collection continued on the assessment surveys in 2010. On the Area 2A surveys, cooperative studies continued with Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) to collect rockfish (*Sebastes* spp.) bycatch data. In addition, this year we worked with WDFW to fish supplemental stations designed to further enhance the understanding of rockfish status in these areas. On the Area 2B survey, IPHC worked with the Canadian Department of Fisheries and Oceans (DFO) to provide a third biologist on our survey vessels to collect hook by hook occupancy information for all species, and otoliths, maturities, and lengths for rockfish (except thornyheads). Cooperative work with the Alaska Department of Fish and Game (ADF&G) resulted in the collection of whole-haul catch data for yelloweye rockfish from survey vessels operating in the Fairweather survey region of Area 3A and in the Sitka, Ommaney and Ketchikan charter regions of Area 2C.

Whale interactions on stock assessment surveys
Additional data collection was undertaken on the 2010 assessment surveys in an effort to increase our understanding of the scope and impact of whale interactions with longline gear, and in particular the impact on setline surveys. Gear damage was noted on every set, and additional data were collected when marine mammals were in the area. The protocols for this data collection were developed in concert with other agencies, in particular the NMFS Auke Bay sablefish survey team, who are struggling with quantifying the impact of sperm whale depredation on their surveys.

Genetic techniques for determining male vs female within commercial catch
As noted in the summary of the UW genetics work, IPHC hired an intern (Project 618) in 2010 to collect tissue and otolith samples aboard commercial fishing vessels engaged in IQ trips. These samples will be used to test whether genetic techniques can be used to aid in segregating commercial catch into male and female components in the context of the sex-specific stock assessment. During the course of our genetics program, a suite of alleles was identified that show strong sex-linkage. We wish to conduct a formal comparison of the accuracy of genetics relative to the numerical method present used to partition catches, but this cannot be conducted using survey-collected samples because survey data provide the primary input for the numerical method. This year's intern, an undergraduate student from Simon Fraser University (Burnaby, B.C.), was deployed on two vessels (the *Ashley Erin* and *Kruzof*) conducting fishing in Areas 2B and 3A, and successfully sampled 254 and 225 fish in each area, respectively. In addition, she was deployed to Area 4C, but bad weather and her need to return to university prevented full sampling from that area; still, 34 fish were sampled. She presented the data to IPHC staff at the end of her internship, and her samples will be combined with additional samples expected to be collected in 2011 in order to yield a robust future analysis.

Ongoing programs
Other field activities in 2010 included (1) placing staff aboard the NMFS trawl surveys in the Bering Sea to collect otoliths and data on the relative abundance of juveniles, (2) continued collection of halibut tissue samples on the surveys for studies on mercury and other contaminants by the Alaska Department of Environmental Conservation, and (3) collection of seabird occurrence data on the surveys.

Every year, the quantitative staff of the Assessment Program produces a stock assessment which forms the basis for the annual staff catch limit recommendations. The data that go into the assessment, the assessment itself, and the harvest policy used to determine sustainable catch levels are all continually reviewed and refined. A few of this year's more influential and substantive analyses included:

(1) U32 mortality. For years, the under-32 inch (U32) halibut bycatch and wastage mortality (BAWM) have been accounted for through harvest rate adjustment. Options have been developed whereby U32 BAWM can now be factored directly into catch limit recommendations;

(2) Apportionment. The apportionment of the coastwide estimates of Exploitable Biomass (ebio) is based on survey catch rate, adjusted for catchability differences among areas, weighted by bottom area, and averaged over time. Standard procedure has been to equally weight the three most recent years. Statistical analysis of within-region and

among-year variance has shown that an optimal weighting scheme places much more emphasis on the most recent year's value and substantially less weight on previous years.

(3) Migration. The single most important result from the years-long PIT tag program was the unequivocal demonstration that halibut migrate much more extensively than previously believed. This finding has implications for the harvest policy and determination of the impact of U32 bycatch. Quantifying these losses has been the subject of ongoing research and has helped to frame the discussion about out-of-area impacts.

2010 contracts and grants

NMFS Auke Bay Lab (ABL) has had a sablefish data collection program for several years and IPHC has been contracted by NMFS to assist with the program. In 2003/2004, the program was reviewed and modified to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work (SOW), NMFS contracts IPHC to collect and review information on sablefish catches (Project 617.00) during the IPHC port sampler's logbook interview. Sablefish data are entered by IPHC staff, edited, and an electronic summary provided to the ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality. The SOW was renewed for 2010.

IPHC also received several grants in 2010. NMFS provided a grant for the incremental increase in port sampling costs due to the IFQ program (Project 300.00-81). We also were in the final year of a grant from NPRB to partially cover our costs associated with the study examining the use of electronic monitoring (video) of the halibut fishery off Alaska (#654.11-84).

2010 Research Publications

IPHC staff noted in **Bold** type.

Cahalan, J. A., **B. M. Leaman, G. H. Williams,** B. H. Mason, and W. A. Karp. 2010. Bycatch characterization in the Pacific halibut fishery: A field test of electronic monitoring technology. U.S. Dept. Commer., NOAA Tech Memo. NMFS-AFSC-211, 66 p.

Loher, T., and Rensmeyer, R. *In Press*. Physiological responses by Pacific halibut, *Hippoglossus stenolepis*, to intracoelomic implantation of archival tags, with a review of tag implantation techniques employed in flatfishes. *Reviews in Fish Biology and Fisheries*. DOI: 10.1007/s11160-10-9192-4.

Section II:
Research Proposed for 2011 - Overview

Projects to be carried out in 2011 consist of a continuation of several projects currently underway. Selected continuing projects include:

1. **Water column profilers (Projects 610.11, 610.12, 610.13)** – The first profiler was deployed on an IPHC survey vessel in 2003, and a second went out in 2007. Coastwide deployment began in 2009. The profilers measure temperature, salinity, dissolved oxygen, pH, and florescence and will be deployed at each station during the 2011 summer assessment survey.

2. **Archival tagging (Project 650.13)** – Staff proposes to continue with the holding experiment at the Oregon Coast Aquarium in Newport, to monitor the response to several different archival mounting configurations. The results will support the anticipated future use of this type of technology.

Staff will also continue with other long-standing projects in 2011. These include the collaborative work on contaminants in halibut with ADEC (#642.00), placement of IPHC staff on the NMFS summer trawl surveys (#604.00), and the undergraduate internship program (#618.00). Cooperative projects with WDFW and ODFW to provide data on bycatch species on the setline surveys in Area 2A will continue, as will efforts with DFO in Area 2B, in Areas 2C/3A with ADF&G. Additionally, we will resume collecting Pacific cod information for NMFS in predetermined areas within the Bering Sea.

In addition, projects conducted under contract to other agencies or through research grants will be continued in 2011. IPHC port sampling activities in Alaska will continue being augmented by a grant from NMFS (Project 300.00-81), and IPHC port samplers in Alaska will collect sablefish logbook data for the NMFS Auke Bay lab (Project 617.00).

Four new funded projects are proposed for 2011:

1. **Area 2A assessment survey pilot expansion.** Improving the precision of the estimates of catch rates (WPUE) in the Area 2A assessment survey, as well as examining the requirements and ramifications of fishing in depths not currently included in the survey design (< 20f and >275f), are the objectives of this study.

2. **Comparison of alternative baits for use in assessment survey.** The increasingly high cost of chum salmon is having us look for a suitable alternative for future survey work. In this pilot study, two different designs will be fished and evaluated for a broader, more comprehensive comparison.

3. **Pilot study to test geomagnetic tag performance in the Gulf of Alaska.** Geomagnetic tags have the potential for providing better information on fish location, as they are not dependent upon light levels as with the current PAT tags. We wish to begin an evaluation of this new tag technology with a small pilot study in the Gulf of Alaska.

4. **Use of genetic techniques for partitioning commercial catch by gender.** We began initial work on this approach in 2010, with limited sample collections from two areas. A full evaluation requires samples from additional areas, which we propose conducting in 2011.

Continuing Research in 2011

1. PIT tagging study: Double tag experiment

Start Date: 2003
Anticipated ending: Continuing
Personnel: J. Forsberg, G. Williams, S. Hare, A. Ranta

In September 2003, over 2,600 halibut were double tagged with PIT and external wire tags to provide data for estimating PIT tag shedding. Double-tagged fish continue to be recovered, and

this section accounts for the premium rewards paid for the recovered tags. No rewards were paid in 2010.

2. NMFS trawl survey: At-sea data collection

Start Date: 1996
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, S. Hare

The series of NMFS trawl survey data 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 yr) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS surveys since 1996 and provide relevant age information. These data are incorporated into IPHC's database of the NMFS haul data, expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area), and stored in a database at IPHC. Project cost is comprised of personnel and travel. In 2011, samplers will be deployed on the NMFS Gulf of Alaska and Bering Sea surveys.

3. Water column profiler project

General survey: Start date: 2000
Oregon: Start date: 2007
Coastwide: Start date: 2009
Anticipated ending: Continuing
Personnel: L. Sadorus, S. Hare, 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 (#610.11). A second profiler was added to the program in 2007 (#610.12). 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.

4. Undergraduate Internship

Start Date: 2002
Anticipated duration: Continuing
Personnel: L. Sadorus, T. Loher, other staff support as needed

One undergraduate will be selected through the intern/co-op programs at regional universities and colleges to do a combination of office and at-sea work based out of the Commission offices during the summer months. The program includes various pre-determined office tasks as well as being assigned a research project then designing and executing said project. A final report and presentation are given at the conclusion of the employment term.

5. Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity – lab work by UW

Start: 2002
Anticipated Ending: Continuing
Personnel: T. Loher, L. Hauser (UW MMBL), other staff as needed

Additional work by researchers at the University of Washington's Marine Molecular Biology Laboratory (MMBL) and College of Ocean and Fishery Sciences (COFS) is scheduled for this coming year. This work will complete the work which began in late 2009. The MMBL lead, Dr. Heather Galindo, unexpectedly left for another position at the end of September, but other technicians were available to complete the remaining microsatellite work. Work on sequencing mitochondrial DNA (mtDNA), which are maternally-inherited and have proven useful in other species for investigating sex-biased migration and demographics in relation to climate change, will be conducted by another UW COFS graduate student under the supervision of Dr. Vince Galluci.

6. Histology: Analysis of gonad staging

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 2010, proposed work entails looking for a size gradient for oocytes dependent on their location within the gonad, determine the maximum precision for oocyte diameter measurements by oocyte maturation stage, determine a sampling protocol for measurement of oocyte diameters, and contract slide preparation for gonads. We will also begin assessment of archived gonads from a set of previously-prepared slides.

7. Assessment of mercury and contaminants in Pacific halibut

Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, Alaska Department of Environmental Conservation (ADEC)

The staff plans on continuing our collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2010, 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.

8. Archival tagging: Pilot studies (2008 Area 2B releases)

Start Date: 2006
Anticipated ending: Continuing
Personnel: T. Loher

This study, involving PAT tag releases in Area 2B in 2008, is investigating migratory behavior and environmental conditions experienced by two components of stock: small adult (primarily male) and late pre-recruit halibut, as well as larger adults including reproductive females. The work is a complement to earlier PAT tagging studies and seeks to expand our knowledge to components of the population that have not been studied with PAT tags due to apparent size constraints (i.e., males and pre-recruits) and to obtain multi-year data for larger fish. The objectives for each stock component are slightly different, but do not require separate studies. Externally attached, rather than surgically implanted, archival tags are being used. The tags were applied to all females above 90 cm and all fish above 100 cm during August-September 2008 in Area 2B. Project costs in 2011 are for the anticipated recoveries. Premium rewards are being offered to encourage recoveries.

9. Archival tags: Holding tank experiments examining mounting protocols

Start Date: 2009
Anticipated ending: 2011
Personnel: T. Loher

For 2010, 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. The 2008 releases in Area 2B were our first experience with using an external mount, and that process suggested some revisions and improvements could be possible which would reduce any effect the tags may have on the fish's behavior. Additional improvements to tag design may also be helpful in creating a different mounting device. 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. Expenses for 2010 involve the care and feeding of the

fish at OCA.

10. Archival tags: 2009 releases of dummy test tags

Start Date: 2009
Anticipated ending: 2010
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. To date, a single tagged fish has been recaptured; it had received an internal implant, and both of its tags were recovered. FY11 expenses consist of tag rewards.

11. Archival tags: Preparation for coastwide release

Start Date: 2012
Anticipated ending: Continuing
Personnel: T. Loher, B. Leaman, R. Webster, J. Forsberg

In preparation for a coastwide release of archival tags in 2012, 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 is planned for 2011, Lotek is continuing their work on our requirements and construction. Results from the 2009 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.

12. Archival tags: Site selection in Area 4B

Start date: 2010
Anticipated ending: 2010 for tag releases; 2012 for tag recoveries
Personnel: T. Loher, J. Forsberg, survey team

In 2009, we tagged approximately 900 fish in Area 4B to evaluate tag recovery rates of Area 4B releases 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. Our goal is to locate at least two release sites which will yield a sufficient number of recoveries. To date, only a single wire tag has been recovered, which his low but not completely unexpected for the period immediately following release. In 2010, additional recoveries are expected and the budget is to pay for the necessary rewards.

Proposed New Research

1. Area 2A assessment survey pilot expansion

Start Date: 2011
Anticipated ending: 2011
Personnel: R. Webster, C. Dykstra, S. Hare, survey team

The setline weight per unit effort (WPUE) in Area 2A is estimated with much poorer relative precision than in other regulatory areas, with coefficients of variation (CV) averaging over 30% in recent years. The CV in all other areas has been consistently under 20% with the present survey design. The poor precision of the Area 2A estimate means that it is more likely to differ by a large amount from the true WPUE than is the case in other areas. While this is not important for the coastwide stock assessment, the use of WPUE as an abundance index for apportionment means there is valid concern that Area 2A's share of coastwide biomass could be quite different from that estimated using the survey data.

Further, parts of Area 2A are not included in the current survey, meaning that WPUE estimates may be biased. Inside waters have never been surveyed, although they do include areas within the current survey's 20-275 fm depth range and the survey catch rate from the sampled areas is applied to these unsampled areas (as is the case for all regulatory areas). Some potential stations on the 10 nm grid are also excluded for logistical reasons; were they to be included in the survey, they would improve the estimates of mean WPUE for Area 2A.

Finally, given evidence from commercial catches that many halibut are found in significant numbers at depths outside the survey range, staff is considering expanding the survey down to depths of 400 fm, and into shallower waters to 10 fm. In all regulatory areas, this expansion will increase the proportion of the halibut population covered by the survey, and thereby improve survey WPUE as an index of area halibut density. In Area 2A in particular, a significant number of new stations would be added, and we would achieve a greater increase in the precision of WPUE estimates in that area. Thus, we are proposing piloting the survey expansion first in this area.

2. Comparison of alternative baits for use in assessment survey

Start Date: 2011
Anticipated ending: 2011
Personnel: R. Webster, S. Kaimmer, C. Dykstra, survey team

Chum salmon (*Onchorynchus keta*) is the bait currently used for the annual setline assessment survey. With the price of chum increasing and availability decreasing, we wish to consider alternative baits. Before replacing the current bait, it is important that we compare it with possible alternatives to ensure that the survey index will not be affected by the change, or to estimate a correction factor to apply if there is an effect on the index. This study will be a small-scale pilot study with the goal of estimating variability and determining required sample sizes for a larger-scale bait comparison experiment. We are currently planning on conducting this test in eastern Area 3A and in Area 3B, using chum salmon, pollock (*Theragra chalcogramma),* herring (*Clupea pallasii*), and pink salmon (*Onchorynchus gorbuscha*) in late summer, depending on

vessel availability.

3. Pilot study to test geomagnetic tag performance in the Gulf of Alaska

Start Date: 2011
Anticipated ending: 2011
Personnel: T. Loher, J. Nielsen (UAF Juneau)

We are proposing a pilot study to tag a small number of halibut with three tag-mount configurations (tethered, external hard-mount, surgical implantation) of geomagnetic archival tags in two regions (2B, western 3A) where magnetic field lines are oriented differently relative to the coastline and where our prior pilot releases have experienced relatively high fishery recovery rates, as well as in a captive setting (n=2) at Oregon Coast Aquarium. Data will be used to assess suitability of mounting protocols and relative data quality between tag manufacturers and in varying geomagnetic environments.

4. Use of genetic techniques for partitioning commercial catch by gender

Start Date: 2011
Anticipated ending: 2011
Personnel: T. Loher, L. Hauser (UW)

For 2011, we are proposing to continue collecting samples of commercially-caught fish, which began in 2010, for the purposes of comparing genetic sex identification to the survey length-at-age method presently employed in the stock assessment. In 2010, sufficient samples were only collected from Areas 2B and 3A; hence, we wish to expand this effort to an additional area to further investigate the potential of this approach.

Other 2011 Research – Contracts and Grants

1. Alaska port sampling

Granting agency: NMFS
Start Date: 2002
Anticipated ending: Continuing
Personnel: H. Gilroy, M. Larsen, L. Erikson

The commercial fishery port sampling program hires samplers to collect otoliths, halibut lengths, fishing logbook information and landed weight data. The U.S. program includes staffing eight Alaskan ports and Bellingham, Washington. The samplers act as the liaison between the fishing industry and the Commission staff in Seattle. The Commission is responsible for the overall assessment and management of the halibut fishery and the data collected are necessary for stock assessment. The U.S. government adopted the Individual Fishing Quota (IFQ) allocation program in 1995. This grant provides funds to the IPHC for the incremental cost to the Commission sampling program due to the IFQ program. The grant is generated from the NMFS IFQ Fee Collection Program.

2. Water column profiler project (Coastwide)

Start date: 2009

Anticipated ending: Continuing
Personnel: L. Sadorus, S. Hare, 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 (#610.11). A second profiler was added to the program in 2007 (#610.12). 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.

3. Alaska catcher vessel logbook and sablefish data collection

Contracting agency: NMFS
Start Date: 1999
Anticipated ending: Continuing
Personnel: L. Erikson, H. Gilroy, A. Taheri, port samplers

IPHC and NMFS Auke Bay Lab (ABL) have a sablefish data collection program. The program was reviewed and modified in 2003/2004 to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work, NMFS contracted IPHC staff to interview the IFQ fishers to review and collect the sablefish information in addition to the halibut information. Logbook data are entered by IPHC staff, matched with landings records, and provided electronically with a summary to the ABL scientists. In the summarized data, the vessels are assigned a unique code to preserve confidentiality.

Assessment and Harvest Policy Studies

1. The stock assessment

Budget: Staff salaries
Personnel: S. Hare, J. Valero, R. Webster

The annual stock assessment process comprises a large amount of work including preparation of IPHC data, estimation of bycatch by length in other fisheries, model development and validation, model fitting, examination of residuals, comparison of alternative model specifications, sensitivity tests, evaluation of harvest strategy, incidental analyses, and reporting.

2. The IPHC setline stock assessment survey

Budget: Staff salaries, costs of enhancing survey differ by region
Personnel: S. Hare, J. Valero, R. Webster, C. Dykstra

The current IPHC setline stock assessment survey (SSA) was designed in the late 1990s and has remained essentially unchanged since that time. The survey assesses stock status in waters between 20 and 275 fathoms. Recent data indicate that commercial fishing operations now take

place in deeper and shallower regions. The apportionment procedure currently extends density estimates for the surveyed depths to the broader depths (0-20 and 275-400 fathoms). There is potential bias in extending these densities to non-surveyed depths, and we anticipate expanding the survey accordingly. Numerous statistical and logistical questions arise and we will work with industry and other staff to tailor the survey expansion. In 2011, a pilot project will investigate expansion of the survey in 2A; other regions should follow in subsequent years.

3. Development of IPHC harvest policy

Budget: Staff salaries
Personnel: J. Valero, S. Hare

Since 2004, the IPHC harvest policy has been based on maintaining coastwide spawning biomass above a reference level, with options in place to reduce the harvest rate should that level be crossed. Work is continuous, with refinements to calculation of the optimum harvest rate itself in light of our present understanding of stock dynamics, fish movement, new information on commercial length-specific selectivity coming from the PIT tag experiment, and impacts of bycatch mortality when accounting for migration. In a broader sense, our harvest policy should also be robust to the many uncertainties inherent in the assessment and management of a broadly distributed and continually migrating stock, particularly one with individual regulatory area catch limits. A formal approach to evaluate such harvest policy is thru Management Strategy Evaluation (MSE). An explicit aim of our MSE project is to develop a procedure for deriving catch limit recommendations that would achieve the desired harvest policy, potentially relying on much simpler calculations and at the same time effective across a range of uncertainties about stock, fishery and management behavior. Such procedures have been developed for other fisheries and it is appropriate to investigate their application to halibut management. In addition, we will examine potential effects of fishing on life history traits.

4. Ongoing analytical and statistical studies in support of halibut management

Budget: Staff salaries
Personnel: S. Hare, J. Valero, R. Webster

Every year, the analytical staff engages in a broad range of studies, many unanticipated at the onset of each year, to support halibut management. Examples of recent work include spatio-temporal modeling of setline WPUE, adjustments to the “Slow Up Fast Down” catch quotas, methods of accounting for U32 bycatch and wastage mortality, estimation of bycatch impacts on lost yield, surplus production trends, participation and preparation of materials for workshops (apportionment, bycatch, commissioner retreats, etc.), improvements to port sampling programs, among many others. We fully anticipate these side projects to continue to increase in number and scope. For example, in 2011, reworking of bycatch estimation is anticipated to receive a full review.

Other Research

1. Seabird occurrence project

Budget: Staff salaries
Start Date: 2002
Anticipated ending: Continuing

Personnel: T. Geernaert, Washington State Sea Grant

During the stock assessment surveys, sea samplers count the number of seabirds in the vicinity of the vessels following gear retrieval. Sampling after the haul addresses the question of where and when certain seabird species occur. These data have been used to identify appropriate seabird deterrent requirements in certain geographic locations. Data have also been collected, using the same protocol, on the NMFS and ADF&G sablefish surveys. IPHC has developed a database to store IPHC seabird occurrence data and the collection project is ongoing.

2. Bering Sea age validation study utilizing 14C radiocarbon (Project 624.12)

Budget: Staff salaries
Start Date: 2009
Anticipated ending: 2011
Personnel: S. Wischniowski, NMFS personnel

Radiocarbon, or ^{14}C bomb carbon, has been used successfully in the past on several fish species as a validation of absolute age assignment. This project is a collaborative study between IPHC and the NMFS Alaska Fishery Science Center as a follow-up to the 2003 aging study conducted on Gulf of Alaska halibut otoliths. Work began in late 2009 with otolith selection, and the mass spectrometry work occurred in early 2010. During 2011, analyses of the results and report preparation are planned.

3. Species identification of amphipods frequenting Pacific halibut (Project 653.00)

Budget: Staff salaries
Start Date: 2006
Anticipated ending: Continuing
Personnel: B. Leaman, E. Soderlund

The project intends to document the occurrence and virulence of attacks by predatory amphipods on halibut caught on IPHC surveys and, by inference, the commercial fishery. The commercial industry suffers annual losses of product due to amphipod predation and must adjust its fishing locations and practices in response to predation. Harvester discussions indicate that predation sites are both known and ephemeral, and the virulence may vary interannually at a given site. The specific identity of the amphipods has not been established and it is probable that more than one species is involved. Harvesters are interested in both documentation of predation areas for avoidance, as well as gaining an understanding of the dynamics of the species at given sites, i.e., whether there are cycles of abundance that respond to other factors. Data were collected on all stations during the 2004, 2005, and 2006 stock assessment surveys as part of standard protocol, recording incidence of sand flea predation, and the extent and virulence of the predation. The last year of data collection for this stage of the project was 2006. The 2007 summer intern performed initial analysis of interannual occurrence and virulence. Additional work will be directed at correlated variables.

4. Estimates of bycatch on the assessment surveys

Budget: Staff Salaries

Revenue: To be determined
Start Date: 2003
Anticipated ending: Continuing
Personnel: C. Dykstra, T. Geernaert, E. Soderlund, E. White, sea samplers, agency staff

Area 2A
Since 2002, the IPHC has worked cooperatively with both the Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) to collect rockfish bycatch data. All rockfish caught on operations in 2A are retained and marked externally with a Floy T-bar anchor tag and the tag number is recorded with the set and skate of capture (since 2006) information. All marked fish are retained so state biologists can collect additional data shore-side. Marketable fish are sold. The IPHC then provides each agency with the effort information collected as part of the normal survey data collection.

Area 2B
In 2011, IPHC will continue to work with the Department of Fisheries and Oceans Canada (DFO) to provide a third biologist on IPHC survey vessels to collect hook-by-hook occupancy information for all species. Otoliths, maturities, round weights, and lengths were collected for all rockfish except thornyheads. This is the eighth year of this cooperative program and continued collaboration is anticipated.

Area 2C and eastern 3A
Collection of whole-haul catch data for yelloweye rockfish capture is expected to continue in 2011, at the request of the Alaska Department of Fish and Game (ADFG), for survey vessels operating in the Fairweather, Sitka, Ommaney, and Ketchikan charter regions. The 2009 work was scaled back from what was done in 2008, which required an additional sampler to collect hook-by-hook occupancy information for all species, plus otoliths, sex, and lengths for all yelloweye rockfish. This project built upon cooperative work started with ADFG in 2007 and future collaboration is anticipated.

Area 4
Length frequency data on incidentally-caught Pacific cod were collected in 2009 in the 4A Edge and 4D Edge charter regions. This project was initiated at the request of NMFS-AFSC Pacific cod assessment team and is part of a developing effort to collect bycatch information on Pacific cod in the western regions of our survey, where it makes up the largest component of our survey bycatch. The work was discontinued in 2010 at NMFS' request but is expected to resume in 2011.

5. Electronic reporting project for commercial landings in Alaska

Budget: $ 27,000 (covered under Catch Statistics budget: A30-7131-30)
Start Date: 2002
Anticipated ending: Continuing
Personnel: H. Gilroy, L. Erikson, T. Kong, A. Tesfatsion, H. Tran

IPHC, ADF&G, and NMFS staffs have continued to refine the web-based Interagency Electronic Reporting System (IERS). For halibut, the system reduces duplicative reporting resulting from

the current requirements of completing ADF&G fish tickets and NMFS/RAM quota share reports, and has been operational since May 2006. The application (eLandings) records data elements required by regulations, prints fish tickets, and connects with the NMFS quota share database. The appropriate data from IERS is being sent to the agencies for their internal databases. The application is continuously being modified, including the incorporation of additional fisheries and tender landings. Agency staffs attend annual workshops and provide training to processors. Costs represent system maintenance costs, software purchase and development, steering committee meetings, and travel costs.

6. Electronic logbooks and technology

Budget: $ 50,000 (Covered under Catch Statistics budget: A10-7131-30)
Start: 2010 (postponed from 2008)
End Date: Pilot project
Personnel: H. Gilroy, L. Erikson, K. MacTavish

In 2010, the staff started to work on a technology plan for data collection within the port sampling program but no funds were spent. The project will continue and collaborating with other agencies will occur to determine the feasibility of an electronic logbook, which geographic location would work best, and to establish the specifications needed for contractors.