2012 IPHC Research Report for TSC

Review of 2011 Projects and Proposals for 2012

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 2011, and the third section presents the preliminary staff research proposals for 2012 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.

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 FY2011) 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 2011;

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:
STAFFING UPDATES

In late 2011 the IPHC hired an Assistant Director: Steve Keith. This position had been phased out over a decade earlier, but is now reinstated. There currently are several positions open: Database Administrator (newly created), lead Stock Assessment Scientist (Dr. Hare departing effective May 1), Survey Operations Technician (Evangeline White departing end of June), and a Front Office Administrative Assistant (currently vacant). These are in addition to some standard turnover seen in both the port and field sampling seasonal positions.

SECTION II:
REVIEW OF RESEARCH CONDUCTED IN 2011

Biological research conducted by the IPHC staff continued in three basic areas: life history, fish movements, and stock composition. Other work addressed fishery management issues, while the assessment group focused on a variety of analyses examining the commercial fishery minimum size limit, effects of bycatch on stock yield, assessment survey design, and harvest policy performance. Most of this was conducted as part of the normal staff duties. Funding for projects outside of staff salaries came from supplemental funding; these and other studies from 2011 are outlined below.

Overview of 2011

Genetic research continued in 2011, focusing primarily on use of genetic analyses for sex identification and also working to complete the population genetics studies begun in 2002. With respect to the former, a manuscript was published in January detailing sex-linkage in three microsatellite markers, suggesting the possibility that genetic techniques might be used to partition commercial catch via the IPHC's port sampling program. During the 2011 commercial fishing season, samplers were placed aboard commercial vessels to collect samples that will be used in a formal analysis of the accuracy of genetic methods relative to the numerical sex partitioning technique presently used in the IPHC stock assessment (see following paragraph). These samples, and others collected by the 2010 undergraduate intern, will be analyzed at the University of Washington's Marine Molecular Biology Laboratory (MMBL) under the supervision of Dr. Lorenz Hauser. In addition, laboratory analyses were conducted in 2011 to add western Aleutian Island and Sea of Okhotsk samples to existing microsatellite- and mitochondrial DNA-based analyses of population structure. Significant genetic population structure has not been detected using samples that span from the Queen Charlotte Islands through the southeast Bering Sea and eastern Aleutian Islands. This is in contrast to a recent publication in which significant Pacific halibut stock structure was reported using samples collected in the western Aleutians, however that analysis did not account for the sex-specific microsatellite marker presence in the samples. Formal statistical analysis and publication of the full results is anticipated in 2012.

The current sex-specific assessment requires information on the sex composition of the population, which is proxied by data from the surveys. We've recently been interested in the potential for sampling the commercial landings for obtaining direct observations of the sex

composition of the catch to confirm or correct the current statistical estimation of the sex composition of commercial landings. A pilot study was undertaken in 2010 for this purpose, collecting tissue samples which would be analyzed for genetic sex markers. The results showed it was possible to obtain the necessary samples, but a sufficient number were collected only from Areas 2B and 3A. Additional collections were undertaken in 2011 in additional areas (2B, 3B, 4A, and 4B) to further investigate the potential of this approach. Sample analysis is being conducted under the supervision of Dr. Hauser (MMBL), with results expected later this winter.

IPHC has been engaged for several years in projects examining halibut migrations via tagging. Past studies have used PAT tags to obtain general movement patterns but these have been insufficient in providing data to estimate migration rates and daily movements. Since 2006, IPHC has been testing the suitability of archival tags for halibut, specifically examining different tag types, attachment configurations and tag designs. This work has included small releases of test tags in Areas 2B (2008) and 3A (2009). In addition, since 2009 IPHC has had a long term holding study at the Oregon Coast Aquarium (OCA) of ~30 animals to test different attachment protocols. In 2011, we began looking at the applicability of geomagnetic tags for tracking halibut movements. Geomag tags hold promise for providing much greater movement detail over a greater time horizon but there are as-yet unresolved issues regarding effects on location data by variations in the magnetic field in the north Pacific. Work conducted in 2011 focused on assessing the accuracy of the data recorded by geomag tags by setting out geomag tags at preselected stationary locations in Area 3A.

The collaborative study between the IPHC and the NMFS Alaska Fisheries Science Center (NMFS/AFSC) has concluded that eastern Bering Sea (BS) bomb radiocarbon concentrations during the years of 1944 to 1981 were different from those of the Gulf of Alaska (GOA) during the same time. Based on analysis of otoliths from the BS and GOA, the results suggest the onset of atmospheric ^{14}C in the BS indeed preceded the GOA in both time and signal strength. The BS curve displays an earlier and more rapid increase in ^{14}C, a substantially higher ^{14}C peak, and an exponential post-peak decay that is much less pronounced in the GOA. It is hypothesized that, because of its unique oceanographic conditions, the BS responded differently than the GOA during the peak times of nuclear atmospheric testing in regard to the uptake of atmospheric ^{14}C. The rate at which ^{14}C moves through a body of water may be attributed to factors such as current, wind, ^{14}C reservoirs, and water depth. It is further hypothesized that the atmospheric ^{14}C signature may have traveled through the BS at a faster rate than it did through the GOA, resulting in an earlier ^{14}C pulse which was incorporated into all BS species alive at that time.

Water column profilers were deployed in 2011 on all IPHC survey vessels. This effort 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 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 this year. Data from the first two years of this project, 2009 and 2010, are posted for public use and 2011 data processing is in progress.

A pilot study comparing the IPHC standard survey bait of chum salmon with three alternative bait species was conducted in Area 3A in 2011. The goals were to select one of two competing

experimental designs, and to provide information on variance for use in designing a large scale experiment to be carried out in 2012. Alternative baits fished included herring, pollock, and pink salmon. Data analyses showed evidence that the setline weight per unit effort (WPUE) was different among baits, that U32 catch is affected by bait type, and that catch of common species of bycatch was higher using chum salmon than the alternative baits. There is also some concern that the alternative bait types, e.g., herring, are more likely to fall off the hook than chum salmon. A positive result was that the experimental design using a mixed-bait set could be used in the primary experiment, which will greatly improve efficiency and statistical power.

Cooperative data collection continued on the assessment surveys in 2011. Activities took place in almost all surveys regions:

- 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 conduct 100% hook counts for all stations in the Salish Sea.
- On the Area 2B survey vessels, a third biologist collected hook-by-hook occupancy information for all species, and otoliths, maturities, and lengths for rockfish (except thornyheads) and data were provided to the Canadian Department of Fisheries and Oceans (DFO).
- 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.
- In 2011 we began a two-year effort to length and sex the first five spiny dogfish at stations coastwide, exceptions being first three dogfish in B.C. and all dogfish in the Bering Sea). This project began as a request from NMFS/AFSC focused on Alaska and was expanded coastwide to enhance the project.
- Pacific cod subsampling on Bering Sea stations was resumed in 2011 at the request of NMFS/AFSC. Additional information was also collected on lamprey scarring on the cod being sampled.

Also on the assessment surveys, data collection continued in 2011 to increase our understanding of the scope and impact of toothed whale interactions with longline gear, and in particular the impact on setline surveys. Gear damage occurrence was assessed 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 attempting to quantify the impact of sperm whale depredation on their surveys.

For several years, IPHC has been contracted by NMFS Auke Bay Lab (ABL) to assist with their sablefish data collection program (Project 617.00). 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 in length. Under a Statement of Work (SOW), NMFS contracts IPHC to collect and review information on sablefish catches 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. In 2011, the Auke Bay scientists came to Seattle to attend a portion of port sampler training to meet the samplers and provided direct training. The SOW was renewed for 2012.

IPHC also received several grants in 2011. NMFS provided a grant for the incremental increase in port sampling costs due to the IFQ program (Project 300.00-81).

For the 2011 undergraduate internship, a study was undertaken to evaluate the need to re-examine the length/weight relationship used by IPHC. Ms. Danielle Courcelles, an Environmental Science major from Simon Fraser University (Burnaby, B.C.), joined the staff for the summer to design, carry out, and report on her analysis of length/weight data she collected in Area 3A. Her sampling of 193 fish of all sizes from Portlock-Seward Gully grounds of Area 3A showed a significant difference in length/weight for fish caught on those grounds, similar to a small study conducted in 1989 by the IPHC staff. The full results will be included in this year's RARA.

Other field activities in 2011 included (1) placing staff aboard the NMFS/AFSC trawl surveys in the Gulf of Alaska 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.

On the quantitative side, the staff of the Assessment Program annually produces the stock assessment, which forms the basis for 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 are summarized to highlight the nature of analytical work in the Assessment Program.

a. The current commercial minimum size limit (MSL) of 32 inches (81.3 cm) has been in place since 1974 when it was increased from 26 inches (66 cm), which had been the MSL since 1940. The change in 1974 was implemented during a time when halibut size-at-age was much greater than is presently the case. The topic of changing (i.e., lowering) the MSL in response to reduced size-at-age arises annually. An analysis was conducted to estimate the biological and fishery impacts of lowering the size limit anywhere from 1 to 16 cm.

b. The North Pacific Fishery Management Council is considering reducing the Pacific halibut Prohibited Species Catch (PSC) limits for the Gulf of Alaska groundfish fisheries. Staff conducted an analysis to estimate the potential directed yield and female spawning biomass impacts from reducing the PSC limits for both trawl and longline fisheries.

c. Data from commercial landings have demonstrated that halibut can occur at depths outside of the 20-275 fathom range of the current setline survey. In addition, within the current depth range there exist areas which for various reasons have no survey stations. In 2011, the IPHC conducted an expanded survey in Area 2A, which included stations from

10-400 fathoms, and for the first time fished stations within the inland waters of the Salish Sea in WA. This study was a test of survey fishing in deep and shallow waters, but the expansion of stations within the existing 20-275 fathoms grid also examined means to improve the precision of the survey's WPUE index in Area 2A, by increasing sample size.

d. Following a request from Canadian commissioners, staff reviewed the data from the 1995-97 setline surveys in Area 2B, which yielded much higher WPUE values than in subsequent or previous years. The survey design was slightly different in those years, although the range of the survey was similar. We found no evidence that the design was a factor in the higher WPUE values; rather, it was the recruitment of two strong year classes into the fishery. In fact, the design in those years included several stations located outside of the current survey depth range on Dogfish Bank, stations which had very little halibut catch, and these are now excluded from WPUE calculation for reasons of consistency. In addition, examination of adjacent regulatory areas found similar features of the WPUE time series as seen in Area 2B.

e. Work on the harvest policy included updates, potential changes and considerations of its performance in the context of current stock trends and status. Ongoing work on the Management Strategy Evaluation (MSE) included setting up of the general evaluation framework and development of simulation, observation, and estimation components.

f. In previous years, projections of exploitable biomass assumed no changes in population processes and revisions of past population estimates. Alternative assumptions and methods were included in alternative projections that account for potential future changes in size-at-age and ongoing downward revisions of past recruitment estimates and the initial numbers of the projections.

g. An analysis of recent and historical changes in size-at-age was conducted, along with potential mechanisms and implications for the harvest policy.

h. A comprehensive review of the history of IPHC tagging programs was conducted with a focus on halibut migration. The most important finding was the consistency among results of historical and modern tagging programs regarding extensive halibut migratory patterns throughout their life. Implications for harvest policy, bycatch impacts, and stock assessment are discussed in the report.

i. A draft journal paper on the analysis of data from the PIT tag study was also prepared. Model results show that ontogenetic migration in a broadly eastward and southward direction continues for larger fish, when in the recent history of the IPHC, the assumption had been that only smaller, younger fish migrated. Differences in fishing mortality and exploitation rates among areas support the view that exploitation was much heavier in eastern areas than western areas prior to the introduction of a coastwide stock assessment in 2007.

j. An analysis was prepared on criteria and a potential framework for evaluation, along with pros and cons, of a proposed alternative apportionment method.

k.

2011 Research Publications
IPHC staff noted in **Bold** type.

Erikson, L. M. and **Kong, T. M.** Changes in commercial catch sampling for Pacific halibut 1994 to 2009. Int. Pac. Halibut Comm. Tech. Rep. 54. 35 p.

Galindo, H. M., **Loher, T.**, and Hauser, L. 2011. Genetic sex identification and the potential evolution of sex determination in Pacific halibut (*Hippoglossus stenolepis*). Mar. Biotechnol. 13:1027–1037.

Gilroy, H. L., **Kong, T. M.**, and **MacTavish, K. A.** 2011. Regulations and management decisions of the Pacific halibut fisheries, 1993-2009. Int. Pac. Halibut Comm. Tech. Rep. 55. 112 p.

Kaimmer, S. M. 2011. Special setline experiments 1985-1994 objectives, data formats, and collections. Int. Pac. Halibut Comm. Tech. Rep. 53. 33 p.

Loher, T. 2011. Analysis of match–mismatch between commercial fishing periods and spawning ecology of Pacific halibut (*Hippoglossus stenolepis*), based on winter surveys and behavioural data from electronic archival tags. ICES J. Mar. Sci. 68(10):2240-2251.

Loher, T. and Rensmeyer, R. 2011. Physiological responses of Pacific halibut, *Hippoglossus stenolepis*, to intracoelomic implantation of electronic archival tags, with a review of tag implantation techniques employed in flatfishes. Rev. Fish Biol. Fish. 21(1):97-115.

Loher, T., and **Hobden, J.C.** *In press*. Small-scale spatial structure in longline catches of Pacific halibut (*Hippoglossus stenolepis*): influence of fish length and sex. *Fishery Bulletin* **110**:xxx-xxx.

Loher, T., and **Stephens, S. M.** *In press*. Use of veterinary ultrasound to identify sex and assess female maturity of Pacific Halibut in nonspawning condition. *N. Amer. J. Fish. Mgmt.* (scheduled for publication in the November 2011 issue).

Seitz, A. C., **Loher, T.**, Norcross, B. L., Nielsen, J. L. 2011. Dispersal and behavior of Pacific halibut *Hippoglossus stenolepis* in the Bering Sea and Aleutian Islands region. Aquat. Biol. 12: 225–239.

West, Catherine F., **Wischniowski, S.** and C. Johnston. 2011. Little Ice Age Climate: *Gadus macrocephalus* otoliths as a measure of local variability. In *The Archaeology of North Pacific Fisheries*, edited by Madonna Moss and Aubrey Cannon. University of Alaska Press, Fairbanks.

Section III:
Research Proposed for 2012 - Overview

Projects to be carried out in 2012 consist of new research as well as the continuation of several projects currently underway.

New Research for 2012

1. Prevalence of *Ichthyophonus* in halibut

In 2011 the IPHC and USGS Marrowstone Marine Field Station conducted a pilot survey to determine prevalence of the parasite *Ichthyophonus* in Pacific halibut sourced from three geographically disparate areas. *Ichthyophonus* was detected in 26.6, 33.8, and 76.7% of halibut sampled from the northern Bering Sea, Oregon coast, and Prince William Sound respectively. Prevalence in Prince William Sound is the highest reported for any Northeast Pacific marine fish species, and is indicative of an epizootic. It is not clear if these infection patterns are unusual, or what effect if any *Ichthyophonus* may be having on Pacific halibut population (mortality) or growth dynamics.

This study will further characterize *Ichthyophonus* prevalence across the Pacific halibut's range, to determine overall prevalence rates and to see if the Prince William Sound results are repeatable. Twelve sites will be targeted, spread out over the assessment survey ranging from Oregon to the northern Bering Sea. As there is knowledge regarding herring infection rates in Prince William Sound, Sitka Sound area, and Lynn Canal, these areas are likely to be included in the primary target areas for sample collection. The study may be modified to do a more intensive sampling (stratified by age or size) in the Bering Sea and/or Aleutian Islands where we may be able to source samples from smaller fish from the NMFS trawl survey. IPHC will collect the samples, and the USGS lab in Marrowstone will conduct the culture and testing component. The study will provide a bigger sample size to further understand any differences in prevalence rates based on halibut size, age, and sex.

2. Rockfish bycatch reduction with whisker hooks

Rockfish bycatch is a limiting factor in many areas for the directed halibut fishery. Modified hooks, with a wire appendage sticking out the back of the hook, are finding success in pelagic longlines to reduce turtle bycatch. "Weedless" hooks have been around for some time. The wire is strong enough to reduce light forces (weeds) but light enough to bend out of the way during a forceful hook attack. Applying this technology, spring wires rigged across the hook gap of the typical halibut 16/0 circle hook might reduce the hooking success of rockfish. By varying the spring tension on the wires (using differing wire diameters), we theorize that rockfish catches could be reduced without changing the hooking success for halibut. For this initial work, observations on hooking success would be gathered with a video camera using single hooks deployed probably in southeast Alaska.

3. Growth increment studies on halibut otoliths

IPHC's extensive otolith archive holds a wealth of information about otolith growth. Changes in the annual growth increments over time would be measured and compiled, going back as far as

possible into the archives (1920). Otoliths covering a broad set of ages and time periods will be selected, and photographed under high magnification, enabling measurements of annual incremental growth. The measurements will be complied and analyzed to identify if any patterns or trends exit. While not necessarily linked to changes in fish growth, changes in otolith growth may provide insights into processes which affect the growth of halibut.

Continuing Research in 2012

1. PIT tagging study: Double tag experiment

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. Three rewards were paid in 2011, and a similar number are anticipated in 2012.

2. NMFS trawl survey: At-sea data collection

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 were deployed on the NMFS Gulf of Alaska and Bering Sea surveys. For 2012, samplers will be deployed in the Bering Sea and Aleutian Island surveys.

3. Water column profiler project (General survey and coastwide)

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 capability. 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

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. The report is usually included in the RARA.

5. Genetic techniques for partitioning commercial catch by gender

For 2011, samples of commercially-caught fish were collected 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 collected only from Areas 2B and 3A. In 2011, additional samples were collected from Areas 2B, 3B, 4A, and 4D to further investigate the potential of this approach. In 2012, sample analysis will occur under the supervision of Dr. Lorenz Hauser, of the University of Washington's Marine Molecular Biology Laboratory (MMBL).

6. Histology: Analysis of gonad staging

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 2012, 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

The staff plans on continuing our collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2012, 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 1,527 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. In 2011, samples were acquired from the Yakutat/Fairweather inshore, northern Portlock and St. Matthew regions. In 2012, data analysis and writing will be the primary focus. Sampling in 2012 is focused on the Semidi, Seward, Washington and Oregon regions.

8. Archival tags:

Holding tank experiments examining mounting protocols

For 2012, 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 2012 involve the care and feeding of the fish at OCA.

2009 releases of dummy test tags

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. Expenses in 2012 consist of tag rewards.

Preparation for coastwide release

In preparation for a coastwide release of archival tags in 2013, 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 2012, 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.

Archival tags: Site selection in Area 4B

In 2009, we tagged 773 fish 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. Our goal is to locate at least two

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

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. Recoveries are expected in 2012 to enable testing of the hypothesis; project expenses are for the rewards.

10. Comparison of alternative baits for assessment survey

Rising bait prices and potentially unstable supplies has prompted the staff to consider alternative baits for the assessment survey. The 2011 pilot study conducted in Area 3A provided a design for a broader study proposed for 2012 to more fully examine catch rate differences between our standard #2 semi-bright chum salmon and other bait types (pollock, pink salmon). A study design is still being prepared but results from the pilot study showed that a mixed-bait set could be used in the experiment, which will greatly improve efficiency and statistical power. Initial plans call for this to be conducted at all stations in the coastwide assessment survey.

Other 2012 Research – Contracts and Grants

1. Alaska port sampling

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 (#300.00-81) provides funds to the IPHC for the incremental cost increase 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)

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 through Sept. 2011. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center. The IPHC received a no-cost extension to the grant for 2012.

3. Alaska catcher vessel logbook and sablefish data collection

IPHC and NMFS Auke Bay Lab (ABL) have a sablefish data collection program (#617.00). 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

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. Development of IPHC harvest policy

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 through 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.

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

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, 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.

Other Research

1. Seabird occurrence project

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. Species identification of amphipods frequenting Pacific halibut

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.

3. Bycatch sampling on the assessment surveys

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 2012, 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 ninth 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 2012, 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. 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 2011 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 resumed in 2011 and is anticipated to continue in 2012. We are also collecting lamprey scarring records on Pacific cod in these regions as well as on halibut in Washington and Oregon.

All Areas

This coming year will be the second of a two year (2011-2012) effort to collect size and gender data from spiny dogfish bycatch on the assessment survey. This project began as a request from NMFS/AFSC and has been expanded coastwide to enhance the project. Sampling entails obtaining length and sex data on the first five spiny dogfish at all survey stations coastwide, with the exception of B.C., where the first three dogfish are sampled, and in the Bering Sea survey regions, where all dogfish are sampled.

4. Electronic reporting project for commercial landings in Alaska

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.

5. Electronic logbooks

In 2011, no funds were spent but the staff provided feedback to NMFS on the electronic logbook program under development for Alaska. The current NMFS logbook program is for a small portion of the fleet and is expected to be available in 2012/2013. The staff will continue to explore options and collaborate with other agencies to determine the feasibility of an electronic logbook in other areas.

6. Electronic data capture

In 2012 further work will be done developing pilot level data acquisition systems for both our port and sea sampling collection efforts. A scoping document has been developed and basic groundwork is now being put in place to launch this effort.