

IPHC Research Program: Review of 2004 Projects and Proposals for 2005

The International Pacific Halibut Commission Staff
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Introduction

This document reviews research conducted by the IPHC staff in the past year and proposed for the upcoming year. The report is divided into two sections, with the first section reviewing the status of research projects conducted 2004. The second section presents the staff research proposals for 2005. 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 cash outlay is possible under the basic \$2.407 million (as of 2004) 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 revenues generated by survey fishing in 2005, and/or carry-over from 2004;
- 2) **Contract 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 with internal funding:** Necessary research projects of high priority that can be conducted under the basic \$2.407 million 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.

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SECTION I: REVIEW OF RESEARCH CONDUCTED IN 2004

Research conducted by the IPHC staff during 2004 covered a myriad of subjects, from the coast-wide PIT tagging project, archival tags, collection of tissue and otolith samples, to issues that bear on the stock assessment. 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.

Funded Research in 2004

The staff completed several projects during 2004, but most of the work was on long-term projects which will continue past 2004. Substantial time was applied to the PIT tagging project, which included releasing tags from the assessment survey vessels in Areas 2B and 3A to provide information for estimating annual survival. Releases totaled 3,086 in Area 2B and 20,351 in Area 3A, for an overall total of 23,427 tags. As in 2003, the 2004 tags were released in proportion to abundance by fishing an additional three skates on each survey station.

The dockside detection program by IPHC Scan Samplers continued in 2004. This past year marked the first full season of scanning by samplers in eight Alaskan and four B.C. ports. Additionally, IPHC received state and tribal assistance in scanning efforts in nine west coast ports. Through 31 October, over 31 million pounds (45% of total landings) have been scanned. The number of recovered tags totals 386 from the 2003 primary experiment, 35 from the 2004 releases, and 198 from the September 2003 double tag experiment (2,662 PIT tags released). The latter project was conducted to confirm the PIT tag shedding rates observed during earlier holding experiments in Seward.

The otolith elemental project (project 620) continued in 2004 with the additional collection of age 1 and 2-yr old halibut from the Sitka/Shelikof Bay area in August. Juvenile halibut from the Bering Sea were obtained from the NMFS trawl survey to assess temporal stability of elemental signatures within nursery habitats. Temporal stability must be understood in order to establish future sampling designs. Lab work at the Woods Hole Oceanographic Institute (WHOI) on age-2 halibut suggests that otolith elemental signatures can be used to successfully distinguish and classify individuals within general geographic regions (southeast Bering versus west-Central Gulf), with 75-80% accuracy. Additional lab work will add more physical variables (oxygen and carbon isotope ratios) to the existing statistical model, hopefully increasing the accuracy of these classifications.

Studies on the genetic population structure moved forward in 2004 with tissue samples collected on charters in January-February, 2004, at spawning locations near Queen Charlotte Island, Portlock Bank, and Pribilof Canyon. These collections were made to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. As a portion of this work, a preliminary population analysis was conducted comparing Adak and St. Paul Island to Newport, Oregon. The results were intriguing, suggesting potential reproductive isolation in the western Aleutians. However, sample sizes were low, so a more thorough analysis is warranted. Thus, ~1500 tissue samples were collected from 18 sites during the 2003 setline survey and port

sampling program. These sites will be re-sampled in 2005 in order to examine temporal stability in genetic signatures.

During the 2004 summer setline survey, 12 PSATs were deployed at each of two Aleutian Islands: Atka and Attu (Project 622). These tags are programmed to release from the fish and report their location and data during mid-February 2005. The goal of the project is the identification of potential spawning areas utilized by Area 4B fish.

In 2003, preliminary histological work on the female gonads was initiated (Project 636). Based on the results, staff developed a sampling design and collection protocols for the 2004 surveys. During the 2004 winter and summer surveys, female gonads from three different regions, in each stage of development, were collected. Three different histological subsamples have been prepared and we are presently standardizing the sample sites on the gonad for the final slide preparation. We have collected nearly 240 gonad pairs and will be analyzing multiple sites from each sample.

Project 638, investigating whether species richness and evenness (i.e., species diversity) is correlated with bottom temperature and depth, got underway in 2004. Historical data from several survey regions in British Columbia and Alaska were examined and data from a directed field experiment were analyzed. Survey vessels in selected regions deployed temperature and depth recorders on each skate of gear in 2004. In addition, electronic monitoring equipment was installed on one vessel to record a sequential tally of all catch for each station (hook by hook data). A video analyst reviewed the video data, determining the numbers and species encountered. On the remaining vessels, Archipelago Marine Research (AMR) field staff recorded hook by hook data in-season. The final analysis will examine the spatial distribution and relative abundance of species relative to the temperature and depth profiles.

IPHC also continued working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples on the assessment surveys for analysis of heavy metal and organic pollutant loading. In 2003 the principal results from the 2002 collection led the Alaska Division of Public Health to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are 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. 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. Sampling continued in 2004 with a targeted collection of 60 samples (30 from fish weighing between 20 – 40 lbs. and 30 from fish weighing between 40 – 100 lbs.) from each of three regions (SE Alaska, Shumagin Islands, and the Aleutian Islands) during the setline survey. Results will be published as they become available.

As in past years, IPHC placed staff on the 2004 NMFS Bering Sea trawl survey (Project 604) to collect fishery-independent data 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 expanded to estimates of relative abundance and age/size composition by IPHC area.

Use of the water column profiler on selected assessment survey vessels continued in 2004 (Project 610). This work began in 2001, with the successful deployment of a SeaBird SBE-19 water column profiler. The program has been conducted on board six vessels fishing selected areas since 2001. Only one profiler was used in 2004, due to a lack of external funding. The work is in collaboration with the Pacific Marine Environmental Lab (PMEL).

Finally, IPHC hired one intern (project 618) and one graduate student (Project 607) in 2004. Mr. Christopher Clarke (University of Victoria, BC) worked May-August on a project examining prior hooking injuries, which also gave him an opportunity to spend time on a survey vessel collecting data. Mr. Rob Ames (Royal Roads University, Victoria, BC) conducted graduate work on the potential for using video monitoring systems for enumerating the hook by hook catch on the stock assessment survey vessels. He will be completing his Master's degree requirements this winter.

2004 Contract Research

Since 2002, IPHC port samplers in BC have interviewed skippers about the bycatch of other species during halibut fishing (Project 376). These data were entered into the IPHC log database tables. The latitude/longitude location was converted using Geographical Information Systems (GIS) to DFO statistical areas and vessels were assigned a unique identifier to maintain the confidentiality of the vessels. In 2003, the 2002 bycatch catch and discard information from the logbooks was summarized and electronically provided to DFO. (The data provided had a skipper's signature acknowledging that IPHC would provide the information to DFO.) The 2003 and 2004 data will similarly be provided to DFO with additional bycatch landing weights collected by port samplers at the time of the log interview. This information may assist DFO with validation of the log data.

IPHC and NMFS Auke Bay Lab (ABL) have a sablefish data collection program (Project 628). 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. Data are entered by IPHC staff with an electronic summary provided to the NMFS ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality.

Staff continued in 2004 a study with the Central Bering Sea Fishermen's Association (CBSFA) examining the effects of oceanographic conditions on halibut catches and CPUE (Project 629). The objective of the project is to see if temporal trends in CPUE can be isolated and correlated with changing water temperature. With the cooperation of local fishers and funding from the CBSFA, IPHC began deploying temperature loggers on longline gear during fishery operations in 2002. A total of five vessels participated, providing temperature observations from just over 100 longline sets. In 2003, with funding from an external granting agency (NPRB), the study was expanded to include 11 vessels, providing data from just over 250 sets. While the 2004 data have not yet been processed, the 2002-03 data clearly demonstrate seasonal temperature patterns in the

region, short-term temperature variability, and interannual variability in daily maximum temperatures.

2004 Research Publications

IPHC staff noted in **Bold** type.

Chen, D.G. 2004. Bias and bias correction in fish recruitment prediction. *N. Am. J. Fish. Mgmt.*, 24:724-730.

Chen, D.G., Xie, Y., Mulligan, T.J. and MacLennan, D.N. 2004. Optimal partition of effort between observations of fish density and migration speed for a riverine hydro-acoustic duration-in-beam sampling method. *Fish. Res.*, 67:275-282.

Clark, W.G. In press. Nonparametric estimates of age misclassification from paired readings. *Can. J. Fish. Aquat. Sci.*

Clark, W. G. and **Hare, S. R.** 2004. A conditional constant catch policy for managing the Pacific halibut fishery. *N. Am. J. Fish. Mgmt* 24: 106-113.

deBruin, J-P, Gosden, R.G., Finch, C.E., and **Leaman, B.M.** 2004. Ovarian aging in two species of long-lived rockfish, *Sebastes aleutianus* and *S. alutus*. *Biol. Reprod.* 71(4):1036-1042.

Kaimmer, S. M. 2004. 1998 gear and bait experiments. *Int. Pac. Halibut Comm.*, Technical Report 48. 36 p.

Kong, T.M., **Gilroy, H.L.**, and **Leickly, R.C.** 2004. Definition of IPHC statistical areas. *Int. Pac. Halibut Comm.*, Technical Report 49. 72 p.

Piner, K.R. and **Wischniowski, S.G.** 2004. Pacific halibut chronology of bomb radiocarbon in otoliths from 1944 to 1981 and a validation of ageing methods. *J. Fish Biol.*, 64:1060-1071

Section II: Research Proposed for 2005

Projects proposed for 2005 consist of a continuation of several projects currently underway and four new projects. PIT tag recovery efforts will continue in 2005 with the scan sampling program. No changes are planned for port coverage or duration of sampling. Planning for this activity is based on a March 1 – November 15 season.

For other continuing projects, staff is proposing continuing the otolith elemental fingerprinting (OEF) work (Project 620). Repeat sampling of our southeast Alaska nursery sites in 2005 will complete a 3-year time series from this region. Laboratory analysis of accumulated samples will continue during FY 2005, and samples collected from southeast Alaska will be analyzed during winter 2005-06.

The study of the population genetic structure (Project 622) is also proposed to continue in 2005. The samples collected in 2004 will be subjected to genetic testing during winter-spring 2005 by Dr. Lorenz Hauser (UW Marine Molecular Biology Laboratory), screening for allele frequencies in a suite of nuclear microsatellites that were isolated in Pacific halibut in 2003. Eighteen sites sampled during the 2003 setline survey and port sampling program will be re-sampled in 2005 in order to examine temporal stability in genetic signatures; analysis is likely to occur in 2006.

PSAT work will also continue in 2005, with the expected pop-up in May of the 2004 releases (Project 622). In addition, staff is proposing to releases PSATs in Areas 2B, 2C, 3A and 3B from the 2005 assessment surveys, with the tags programmed to pop-up in late spring 2006 (Project 640). The goal of this new set of releases is to gain information on winter migration timing of fish in these areas.

The species richness project (#638) will conclude in 2005, with completion of the video analysis and thesis.

The gonad staging/histology project (#636) will continue in 2005 with analysis of the 2004 samples and microscopy work. No additional sampling is expected.

Staff will also continue with several long-standing projects in 2005. These include placing staff on the NMFS trawl surveys (#604), data collections with water column profilers on the assessment surveys (#610), and the undergraduate internship program (#618). The otolith marginal increment analysis (#626) is expected to be completed in 2005. Finally, the investigation of sleeper shark population structure and development of an aging technique (#630) will focus on lab work and genetic testing of samples.

Four new projects are proposed for 2005. Another summer release of PSATs was described earlier (Project 640). The staff is also proposing to enhance the water column profiler with an additional measuring device to monitor dissolved oxygen (DO). It is believed that low levels of DO contribute to localized reductions in abundance of many fish species. Staff would like to add the additional hardware to the profiler and monitor DO for correlations with halibut CPUE. Finally, the staff is proposing a major gear experiment (Project 641) to examine the effect of

hook spacing and size on halibut catch rates. Previous experiments on these factors were conducted many years ago on J hooks, and the conclusions from that study are likely not applicable to the current circle hooks and spacings used by the IQ fisheries in Alaska and Canada. Additional details on these projects can be found later in the document.

Projects conducted under contract to other agencies will be continued in 2005. IPHC port samplers in Alaska will collect sablefish logbook data for the NMFS Auke Bay lab, and port samplers in Canada will collect data on the bycatch of other species for DFO. Finally, Project 629, examining the water temperature gradients around the Pribilof Islands and the effect on the catch and distribution of halibut, will continue with another year of data collection by local fishermen during 2005.

Funded Research

Project 413: Pit tagging study: Third year of tag recovery and scanning

Cost: \$ 405,520

Start Date: 2003

Anticipated ending: 2006

Personnel: Williams, Kaimmer, Geernaert, Chen, Clark, Blood, Forsberg, Dykstra, Van Wormer, Soderlund, Ranta, sea samplers, scan samplers.

The staff is planning on continuing with PIT (Passive Integrated Transponder) tag scanning in 2005. In 2004, scanning occurred in eight Alaskan and four B.C. ports, the latter under contract with AMR. Additionally, IPHC received state and tribal assistance in scanning efforts in nine west coast ports. No changes are planned on coverage or sampling levels in 2005. Scanning is expected to continue through 2007.

Scan samplers also conduct experiments with Stock Assessment survey offloads which seek to a) confirm their ability to accurately count the number of fish in their scan sample by comparing their counts on survey offloads to counts made by vessel samplers, and b) test their ability to find tags by scanning the survey offloads looking for halibut that have been seeded with PIT tags. These experiments were started in 2003, continued in 2004, and are a standard part of the scan sampler duties.

Project costs are expected to increase moderately in FY2005, primarily due to (a) higher salaries for returning samplers, (b) taking on scanner repair costs which were covered by warranty up to now, (c) anticipated increase in contract with AMR for sampling BC, and (c) new leases for GSA vehicles needed for sampler transportation in selected ports.

Project 604: NMFS trawl survey: At-sea data collection and data base management

Cost: \$ 19,507

Start Date: 1996

Anticipated ending: Continuing

Personnel: Sadorus, Ranta, Clark

A series of NMFS trawl survey data on halibut, parallel to our setline data, is extremely valuable to IPHC 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 a copy 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 entail personnel and travel.

Project 610: Water column profiler project

Cost: \$ 1,000

Start date: 2000

Anticipated ending: Continuing

Personnel: Hare, Loher, Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the north Pacific. This platform offers 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. Use of this platform for oceanographic data collection capabilities not only would benefit the scientific community at large, but demonstration of sampling feasibility may also create other funding opportunities for collaborative research. In 2001 and 2002, the IPHC successfully deployed a SeaBird SBE-19 water column profiler from a commercial fishing vessel participating in the annual stock assessment survey. The profiler has been used on selected survey trips each season since. Project cost is directed towards annual maintenance of the profiler.

Project 618: Undergraduate Internships

Cost: \$ 25,816 (two interns)

Start Date: 2002

Anticipated duration: Continuing

Personnel: Sadorus, Van Wormer, Chen, Vienneau, other staff support as needed

Two undergraduates 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.

Project 620: Analysis of spatial recruitment dynamics in Pacific halibut using otolith elemental fingerprints (OEF): Phase 2

Cost: \$ 36,669

Start Date: 2002

Anticipated Ending: Continuing

Personnel: Loher, Wischniowski, temporary staff

Preliminary lab results using age-2 halibut suggest that otolith elemental signatures can be used to successfully distinguish and classify individuals within general geographic regions (southeast Bering versus west-Central Gulf), with 75-80% accuracy. Additional lab work will add more physical variables (oxygen and carbon isotope ratios) to the existing statistical model, hopefully increasing the accuracy of these classifications. This will complete Phase I of the project, which was simply a "proof of concept". The second phase of the project will seek to establish appropriate protocols and sampling sites so that a coastwide nursery "otolith element map" can be developed. Due to contingency budgets during fiscal year 2004, the scope of fieldwork was

reduced relative to our original intent, and no new sites were visited. However, additional samples were obtained from the NMFS Bering Sea trawl survey, and samples were collected by IPHC from southeast Alaska to assess temporal stability of elemental signatures within nursery habitats. Temporal stability must be understood in order to establish future sampling designs. Repeat sampling of our southeast Alaska nursery sites in 2005 will complete a 3-year time series from this region. Laboratory analysis of accumulated samples will continue during FY 2005, and samples collected from southeast Alaska will be analyzed during winter 2005-06.

Project 621: Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity

Cost: \$ 28,600

Start: 2002

Anticipated Ending: 2005

Personnel: Loher, L. Hauser (UW-MMBL), other staff

Tissue collections were made during winter charters in 2004, at spawning locations near Queen Charlotte Island, Portlock Bank, and Pribilof Canyon. Male and female halibut were sampled at all sites, resulting in sample sizes of 157-200 mature fish per site. These collections were made to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. Samples will be subjected to genetic testing during winter-spring 2005 by Dr. Lorenz Hauser (UW - Marine Molecular Biology Laboratory), screening for allele frequencies in a suite of nuclear microsatellites that were isolated in Pacific halibut in 2003. The results of the initial screening have been submitted as an IPHC internal report; publication is expected this winter. As a portion of that work, a preliminary population analysis was conducted comparing Adak and St. Paul Island to Newport, Oregon. The results were intriguing, suggesting potential reproductive isolation in the Aleutians. However, sample sizes were low and results tenuous, so a more thorough analysis is warranted. Thus, ~1500 tissue samples were collected from 18 sites during the 2003 setline survey and port sampling program. These sites will be re-sampled in 2005 in order to examine temporal stability in genetic signatures; the present budget does not include future analysis of these samples.

Project 622: Pop-up, satellite-transmitting archival tags (PSATs) to study halibut movements

Cost: \$8,200

Start: 2002

Anticipated Ending: Continuing

Personnel: Loher, A. Seitz (UAF), sea samplers

Electronic pop-up, satellite-transmitting archival tags (PSTATs) can record ambient temperature, depth, and light level (used to estimate longitude under certain conditions) while attached to fish. The tags are programmed to release from the fish on a pre-determined date, float to the surface, and emit a satellite signal that indicates the tag location and downloads all of the environmental data to the satellite. The result is a record of the fish's final location, along with important environmental and behavioral data throughout the fish's time at liberty.

During the 2004 summer setline survey, 12 PSTATs were deployed at each of two Aleutian Islands: Atka and Attu. These tags are programmed to release from the fish and report their location and data during mid-February 2005. Costs for 2005 are for the expected satellite transmission fees when the 2004 releases pop to the surface and begin transmitting.

Project 626: Otolith marginal increment analysis

Cost: \$ 500

Star Date: 1999

Anticipated ending: 2005

Personnel: Blood, Wischniowski, Forsberg

This project has the objective of improving reliability of the age determination for Pacific halibut. Timing of annulus formation was first studied in the 1930s by Dunlop. Recent research on halibut age validation suggests Dunlop's early results were incomplete. Timing of annulus formation is critical to assigning accurate age and prevents smearing of strong year classes over weak ones. Collected otoliths will be used to note the timing of deposition of annual growth rings. The variability in this timing by area and sex will also be examined. Data collection occurred in 1999-2001, with otolith processing currently ongoing. Analysis will occur in late 2005. Project costs consist of lab supplies.

Project 630: Sleeper shark investigations

Cost: \$ 5,006

Start Date: 2003

Anticipated ending: 2005

Personnel: Wischniowski, Williams

During 2003, the Pacific sleeper shark (*Somniosus pacificus*) age determination program collected enough samples to begin the pilot study. Historical ageing studies on this species have been plagued by the lack of visible microstructure within the centra of the vertebrae. An attempt will be made to expose any growth increments by way of an etching and staining experiment. All materials and structures required for this experiment have been collected, or purchased. Lab work began in winter of 2004.

The objective of the second component of this research into Pacific sleeper sharks is to determine if these sharks come from a homogenetic population. The population dynamics of sleeper sharks within the northeast Pacific is not well documented. Preliminary tagging studies have indicated that at least some sleeper sharks display a resident behaviour, and likely have relatively small home ranges. To test this assumption tissue samples were collected from live sharks by way of biopsy darting during the 2004 Stock Assessment Survey. A simple test of homogeneity will compare samples collected from regions of high occurrence to peripheral regions of lesser occurrence. All tissue samples for this project have been collected, and no further are need for this experiment. This portion of the research proposal will specifically target the analysis aspect of the study.

Mitochondrial DNA polymorphisms will be used as the initial genetic marker system to investigate population differentiation among the three sampling locations. We will initially attempt amplification using primers located within the proline tRNA and 12S rRNA regions of the mitochondria. These primers have been used to examine population genetic structure across a similar geographic range in blacktip sharks and yielded sufficient information to differentiate among nurseries of this species. Statistical analysis will be by way of and AMOVA probabilities of haplotype homogeneity across sampling sites. As the name suggests, Analysis of Molecular Variance (AMOVA) is a method for studying molecular variation within a species.

Project 636: Analysis of gonad staging on IPHC setline surveys (Histology)

Cost: \$ 19,595

Start: 2004

Anticipated Ending: 2005

Personnel: Geernaert, Leaman (other staff as needed)

The IPHC Stock Assessment surveys assess maturity of halibut based on visual criteria established in the early 1990's 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 could question this assumption. Mature females are seen as small as legal size (82 cm) but, area-wide, there have been several large 100+ cm females whose gonadal characteristics classify them as immature (never spawned). The SSA survey data also suggest that fish in the southern latitudes (Area 2B) mature earlier and possibly spawn earlier than fish in the northern latitudes (Area 3A and west). The timing and duration of these events are not clearly understood. We would like to re-evaluate our classification criteria and examine the stages and gonadal tissue development more closely.

In 2003 preliminary histological work on the female gonads was initiated. We developed a sampling design and collection protocols for the 2004 surveys. In 2004, during winter and summer surveys, female gonads from three different regions, in each stage of development, were collected. Three different histological subsamples have been prepared and we are presently standardizing the sample sites on the gonad for the final slide preparation. We have collected nearly 240 gonad pairs and will be analyzing multiple sites from each sample in 2005.

Project 638: Associating environmental variables with species richness and evenness: A case study

Cost: \$ 30,734

Start: 2004

Anticipated ending: 2005

Personnel: Van Wormer, Leaman (other staff as needed)

The study will investigate whether species richness and evenness (i.e., species diversity) is correlated with bottom temperature and depth. Historical data from the stock assessment survey (SSA) and data from a directed field experiment will be analyzed. The SSA charter regions investigated include Goose Island, St. James, and Charlotte in British Columbia as well as 4A Edge, 4D Edge, and Attu in Alaska. During the 2004 SSA, vessels were chosen to deploy temperature and depth recorders on each skate of gear. In addition, electronic monitoring equipment was installed on one vessel to record a sequential tally of all catch for each station (hook by hook data). A video analyst determined the numbers and species encountered. On the remaining vessels, Archipelago Marine Research (AMR) field staff recorded hook by hook data in season. Project costs in 2005 are for the video analyst and equipment rental from AMR. The final analysis will examine the spatial distribution and relative abundance of species relative to the temperature and depth profiles.

Project 639: Dissolved oxygen monitoring on setline surveys

Cost: \$ 6,500

Start Date: 2005

Anticipated ending: 2005

Personnel: Sadorus, Hare, Survey team

In 2000, the IPHC purchased a water column profiler to record measurements of conductivity, temperature, and depth at various stations in the IPHC setline surveys. The idea was to gain a better understanding of halibut habitat, and to contribute to the larger oceanographic picture that multiple agencies were working to build. Understanding of oceanographic conditions can lead to a better understanding of the factors driving growth and recruitment of fish populations. An obvious addition to this data set is the collection of dissolved oxygen measurements at a time of year when primary and secondary production is peaking (i.e. summer). By revisiting the same stations over several years, it will be possible to identify variations in time and space related to this parameter.

In relation to halibut per se, being a deep water species, halibut may possibly exist routinely near the low oxygen threshold, but that also may mean that small variations in oxygen could cause variations in distribution and/or health. Over the long term, it may be possible to construct a profile of oceanographic ranges of which halibut are tolerant. Gathering this information may also lead to some new ways of thinking about existing problems. During a staff discussion, it was pointed out that low DO may be, for instance, the stressor that has remained elusive in identifying why fish turn chalky.

While it's possible we may see some correlation to specific halibut issues as pointed out in the previous paragraph, this proposal's justification is primarily based on the larger picture gathering of basic oceanographic data. DO recording is a cheap addition to the SeaBird unit already deployed.

Project 640: Summer PSAT tagging: Areas 2B, 2C, 3A and 3B releases

Cost: \$ 176,640

Start Date: 2005

Anticipated ending: 2006

Personnel: Loher, sea samplers

This study is intended to investigate the preliminary observation that adult (presumably female) halibut tagged in the Gulf of Alaska at southeasterly and southwesterly locations (Areas 2B, 2C and 3B) may have shorter residence times on their summer feeding grounds than fish found in Area 3A. In particular, Gulf PSAT data from 2002 suggest that southerly fish may begin their fall migration as early as September, as evidenced by an increase in depths visited, which may indicate movement away from their summer feeding locations to the shelf-break. We have no information regarding timing of the spring return-migration from the shelf-break back to shallower coastal waters.

The project proposes to tag 48 fish in Areas 2B, 2C, 3A and 3B during the 2005 setline survey. The study entails tagging six fish at each of eight general locations: lower Queen Charlotte Sound and northern Queen Charlottes in Area 2B, western Baranof-Chichagof Islands (Area 2C), Yakutat and central and western Area 3A, and Semidi and Sanak Islands in Area 3B. Tags will be programmed to pop-up during the last week of May, 2006.

Project 641: Hook spacing and size impacts on length selectivity and CPUE

Cost: \$ 208,735

Start: 2005

Anticipated ending: 2005

Personnel: Leaman, Gilroy, Chen, Clark, Survey team

The adoption of IQ management for halibut and sablefish, together with coincident seasons for these species, has resulted in an increased amount of mixed-target or combination fishing for both halibut and sablefish in Alaska. The optimum gear for the two species is quite different, with sablefish gear using smaller 13/0 or 14/0 hooks and short 36-48" spacing, while optimum gear for halibut may be larger 16/0 hooks with 15-18' spacing. IPHC assessments make corrections for hook spacing relative to the IPHC standard 1800-ft 100-hook skate. However, the adjustment is based on a relationship developed in the 1970s from spacing experiments using J-hooks. No adjustment of CPUE for hook size is made. There is concern that smaller hooks may affect size selectivity, hence CPUE. This study will address potential differences in CPUE and size selectivity of selected combinations of hook size and spacing in the commercial fishery relative to the configuration of the standard IPHC survey skate. The project will consist of a one-month charter in Area 3A. Two sea samplers will be required to staff the vessel. The experiment will be a randomized block design, with two factors, hook size and hook spacing. The four levels of hook size will be 13/0 – 16/0 hooks (alternate designations are hook sizes 6 – 3). The four spacing levels will be 18, 12, 9, and 3.5 feet. The individual treatments from the 4 x 4 treatment matrix will be assigned randomly within strings.

Project 642: Preliminary assessment of mercury incidence in Pacific halibut

Cost: \$ 200

Start Date: 2002

Anticipated ending: Continuing

Personnel: Dykstra, Alaska Department of Environmental Conservation (ADEC)

For the last few years, health officials and media have raised the profile of pollutant contamination in fish (methyl mercury, PCB's, pesticides). Since 2002, the IPHC has been working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples to be analyzed for heavy metal and organic pollutant loading. In 2003 the principal results from the 2002 collection led the Alaska Division of Public Health to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are 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 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.

Sampling continued in 2004 with a targeted collection of 60 samples (30 from fish weighing between 20–40 lbs. and 30 from fish weighing between 40–100 lbs.) from each of three regions (SE Alaska, Shumagin Islands, and the Aleutian Islands) during the setline survey. Results will be published as they become available.

ADEC has expressed interest in further assessments of contaminant occurrence in halibut in 2005.

Other 2005 Research – Contracts and Grants

Project 375: NMFS port sampling grant

Cost: Staff salaries

Revenue: \$ 125,311

Start Date: FY2002

Anticipated ending: Continuing

Personnel: Gilroy, Larsen, Hutton

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, which started 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 part of the NMFS IFQ Fee Collection Program.

Project 376: Area 2B expanded logbook program

Cost: Staff salaries

Contract Amount: \$ 16,320 (estimated, based on survey bycatch revenues)

Start Date: 2002

Anticipated ending: Continuing

Personnel: Geernaert, Gilroy

IPHC expanded the B.C. port sampler's tasks to include interviewing skippers and edit information on the bycatch of other species during halibut fishing. These data were entered into the IPHC log database tables. The latitude/longitude location was converted using Geographical Information Systems (GIS) to DFO statistical areas and vessels were assigned a unique identifier to maintain the confidentiality of the vessels. In 2004, the 2003 bycatch catch and discard information from the logbooks and bycatch landed weight information was summarized and provided electronically to DFO. The data provided had a skipper's signature acknowledging that IPHC would provide the information to DFO. The 2004 data included additional bycatch landing weights collected by port samplers at the time of the log interview to assist DFO with validation of the log data.

Project 628: NMFS catcher vessel logbook and sablefish data collection

Cost: Staff salaries

Contract Amount: \$ 46,700 (new contract in 2004 which includes implementation costs)

Start Date: 1999

Anticipated ending: Continuing

Personnel: Hutton, Gilroy, 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. Data are entered by IPHC staff with an electronic summary provided to the NMFS ABL scientists. In the summarized data, the vessels are assigned a unique code to preserve confidentiality.

Project 629: Correlating catch trends and variable oceanographic conditions in a local coastal fishery (Area 4C)

Cost: Staff salaries

Contract Amount: \$27,300

Start Date: 2003

Anticipated ending: 2005

Personnel: Loher, Central Bering Sea Fishermen's Association, port sampler

For many western Alaska communities, halibut represents a major component of the local economy, and any substantial reduction in abundance or catchability can have large consequences. Over the past four years, catches in Area 4C have demonstrated a marked decline, with the local fishery unable to meet the established quotas. The 2003 combined CDQ and IFQ allocations were set at 2.03 million pounds, but the total harvest was only about 0.89 millions pounds, or less than 45% of allowable catch. This was the largest harvest shortfall in the last 10 years, and a cause of considerable concern that might represent substantial local depletion. If true, it follows that the region's fish must be relatively faithful to the Pribilof shallows and may not mix substantially with fish elsewhere in the southeast Bering Sea. Alternatively, changes in CPUE may simply reflect changes in movement patterns of fish near the islands. Halibut are known to spend the winter in deep shelf-edge waters to the south and west of the Pribilof Islands in order to spawn, and move into shallow waters of the southeast Bering Sea shelf east of the Pribilofs for summer feeding. The 4C fishery is seasonal: fish typically move into the waters around the islands in late June, and depart at the onset of winter. We hypothesize that the timing of these migrations, and hence the general characteristics of the fishery, may be governed to some degree by temperature patterns. Regional ocean conditions can vary considerably from year-to-year, thus lower CPUE might also represent reduced residence time within the shallows due altered bottom conditions, or use of different migratory pathways to move from the shelf-edge to the shallows and back.

During the course of this project, catch data from the 4C fishery will be analyzed to attempt to isolate temporal trends in CPUE and attempt to determine whether trends correlate with changing water temperature. With the cooperation of local fishers and funding from the CBSFA, the IPHC began deploying temperature-loggers on longline gear during normal fishery operations in 2002. A total of five vessels participated in 2002, providing temperature observations from just over 100 longline sets. In 2003, with funding from an external granting agency (NPRB), the study was expanded to include 11 vessels, providing data from just over 250 sets. The study is ongoing at present, with vessels just ending their season and returning data for analyses. While the 2004 data have not yet been processed, the 2002-03 data clearly demonstrate

seasonal temperature patterns in the region, short-term temperature variability, and interannual variability in daily maximum temperatures. We plan to continue monitoring local conditions in future years, and correlation with catch trends is scheduled to begin this winter.

Project 375: Seabird data repository

Contract Amount: \$ 14,000 (maximum)

Start Date: 2005

Anticipated ending: Continuing

Personnel: Van Wormer, Geernaert

This grant supports the entry, data management, and storage by IPHC of various types of seabird data collected on agency surveys, including the seabird occurrence project conducted on the assessment surveys. Although IPHC has been collecting these data on its assessment survey since 2002, other agencies are just beginning the same procedure. IPHC's head-start with these types of data led other programs to seek the efficiencies provided by IPHC in data management for optimal use by analysts and managers. The grant is with Washington Sea Grant.

Research Conducted With Internal Funding

1. Seabird occurrence project

Cost: Staff salaries

Start Date: 2002

Anticipated ending: Continuing

Personnel: Van Wormer, Geernaert, Washington State Sea Grant

During the 2004 stock assessment surveys, sea samplers counted the number of seabirds in the vicinity of the vessels following gear retrieval. This is the third year the seabird occurrence data were collected on IPHC surveys. Sampling after the haul addresses the question of where and when certain seabird species occur. Ultimately, these data might be used to identify appropriate seabird deterrent requirements in certain geographic locations, especially for the halibut fleet. IPHC has developed a database to store seabird occurrence data from the IPHC stock assessment surveys, as well as the NMFS and ADF&G sablefish surveys. The data are currently being analyzed. IPHC, in coordination with Washington Sea Grant, will be writing a joint paper on the results for the 2002-2004 data. The collection project is ongoing.

2. Estimates of bycatch on the setline surveys in Area 2B

Cost: Staff Salaries

Start Date: 2003

Anticipated ending: Continuing

Personnel: Dykstra, Survey Team, and DFO personnel

Rockfish bycatch in the halibut fishery can be a constraint in conducting halibut fishing in some areas. In 2004, IPHC worked with DFO to allow a third biologist on IPHC survey vessels to sample rockfish and sablefish bycatch. The program was funded by industry (Canadian Sablefish Association and Pacific Halibut Management Authority). Data collected included hook by hook information, otoliths, maturities, and lengths for rockfish and sablefish.

3. Amphipod distribution and predation on survey halibut

Cost: Staff Salaries

Start Date: 2004

Anticipated ending: 2005

Personnel: Leaman, Van Wormer, 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., are there cycles of abundance that respond to other factors. Data were collected on all stations during the 2004 stock assessment survey as part of standard protocol, recording incidence of sand flea predation, and the extent and virulence of the predation. Analysis is expected to occur in the spring, 2005.

4. Review of port sampling, 1994 to present

Cost: Staff salaries

Start Date: 2002 (Deferred in 2004)

Anticipated ending: 2006

Personnel: Hutton

Report on the changes that have occurred in the commercial catch sampling and port sampling program from 1994 to the present. For example, the report will review the changes made to the program due to the implementation of the IFQ fishery in Alaska, the changes in the method of logbook data collection in the U.S., as well as changes in the Canadian program. This is an update of Technical Report 32.

5. Development of a cooperative interagency electronic fishery information collection and management program in Alaska

Cost: Staff salaries

Start Date: 2002

Anticipated ending: 2006

Personnel: Gilroy, Vienneau, Hutton, Kong

IPHC, ADF&G, and NMFS staffs are involved in the development of a cooperative interagency electronic fishery information collection and management program in Alaska. For halibut, the system could be used to jointly report quota share and fish ticket landing information. In 2004, the Agency Directors met to review a Draft Memorandum of Understanding (MOU) describing the framework and program structure necessary for meeting agency recording and reporting requirements. The MOU was prepared by the steering committee and is still under review by the individual agencies. Additionally, the interagency steering committee worked with Pacific States Marine Fisheries Commission (PSMFC) to complete a Request for Proposal for design and implement for the electronic reporting system. A contractor was hired in July 2004. In August, a two-day meeting was held involving agency users and experts on landing reports to provide feedback on the project. By late 2004, design and programming was initiated with a goal for completion in June 2005. The Bering Sea/Aleutian Island (BSAI) rationalized crab fishery should by using this system in August 2006 with the remaining BSAI crab, groundfish, and halibut fisheries using it starting in January 2006.

6. The 2004 stock assessment

Cost: Staff salaries

Start Date: 1926

Anticipated ending: Ongoing
Personnel: Clark, Hare, Chen

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.

7. Development of IPHC harvest policy

Cost: Staff salaries
Start Date: 2001
Anticipated ending: Continuing
Personnel: Hare, Clark

Staff quota recommendations are calculated by applying a judiciously chosen harvest rate to an estimate of present exploitable biomass. The constant harvest rate policy was developed on the basis of its performance over a long time horizon and with the explicit goal of avoiding reaching the minimum stock sizes seen in the 1930s and 1970s. In 2003 the staff proposed a conditional constant catch policy under which total removals would be capped at a chosen ceiling level at high biomass levels, while a constant harvest rate policy would continue to be employed at low and intermediate stock levels. The Commission did not adopt the proposed policy at the 2004 annual meeting, and a staff/industry workshop on harvest policy alternatives in September 2004 showed general satisfaction with the present policy, as mediated in practice by the judgement exercised by the Director in developing staff recommendations and by the Commission in finally setting catch limits. Some elements of the proposed policy - an explicit lower limit on spawning biomass and a threshold below which the harvest rate will be reduced - will be added to the constant harvest rate policy. The staff will continue to evaluate the constant harvest rate policy. In particular, we will recalculate the optimum harvest rate itself in light of our present understanding of stock dynamics and new information on commercial length-specific selectivity coming from the PIT tag experiment.

8. Development of a formal medium-term recruitment forecast

Cost: Staff salaries
Start Date: 2002
Anticipated ending: Ongoing
Personnel: Hare, Clark, Chen

Confidence in projected safe harvest levels over the medium term requires confidence in projections of expected recruitment over the next 1-7 years. Industry and stakeholders also have great interest in the IPHC recruitment predictions. A number of new methods of predicting recruitment have been developed over the past few years. The goal of this project is to create a forum for assembling and describing these models and evaluate them in a formal time series analysis framework. It is expected that an official IPHC best guess recruitment forecast will be produced along with associated confidence bounds. This project was deferred in 2004.

9. Estimation of halibut abundance from mark-recapture data

Cost: Staff salaries (analysis only)

Start Date: 2001

Anticipated ending: Ongoing for several years at least

Personnel: Chen, Clark, Leaman

The IPHC has conducted many tagging programs since the 1920s. IPHC has also conducted at least five reviews of these programs, again with differing objectives. However, many of these reviews did not account for the issues of non-reporting or differential reporting of tags by areas, fishing effort effects on recovery probabilities, the relationship of initial tag releases and the density of fish in given areas, and the effect of seasonal migratory patterns on the analysis of recoveries were not always considered. A changed paradigm for the area-specific impacts of juvenile bycatch, questions concerning the effects of changing seasonal distribution of fishing effort, potential halibut distribution changes with climatic shifts, and the utility of juvenile surveys in specific areas have all prompted concerns about halibut movements.

During 2004 work was completed on a detailed simulation of the experiment to investigate the behavior of the proposed estimation methods. Preliminary analysis of the 2004 recovery data (estimation of selectivity schedules, harvest rates, and migration rates) was also done in 2004 and will continue in 2005 and later.

10. Density-dependent and independent control of halibut growth and recruitment

Cost: Staff salaries, some travel

Start Date: 1998

Anticipated ending: Ongoing

Personnel: Hare, Clark, Loher

The specific mechanisms driving the observed interdecadal trends in halibut growth and recruitment remain largely unexplained though more specific hypotheses have been developed in the past two years. Work towards better understanding whether density-dependent (intra- or inter-specific) or density-independent factors are responsible continues and remains the core research focus of the fisheries oceanography project. In keeping with the NOAA movement towards ecosystem considerations in fisheries management, we will attempt to derive a framework whereby the results of fisheries oceanography investigations can provide useful input for management purposes, such as determining safe harvest levels or forecasting near-term recruitment. Part of this project includes maintenance of the near bottom "Ocean Bottom Properties" database, first assembled in 1997 (and described in the 1997 RARA) and maintained and updated as additional data become available. This database has proven to be extremely useful to researchers around the north Pacific.