TERMS OF REFERENCE: Halibut Bycatch Management Research.

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The terms of reference herein contain three components. For components one and two, each product should be up to 25 pages typed 12-point text (not including figures, tables, or references). Work products one and two are due on or before April 16, 2012 at the office of the Alaska Groundfish Data Bank, Kodiak, Alaska (address below) as a Portable Document Format (PDF) electronic file. Component three requires participation in a halibut bycatch workshop in Seattle, Washington on April 24-25, 2012.

**Component One:**

Effects of halibut bycatch and wastage in the GOA and BSAI fisheries on halibut yield and spawning biomass

Key Research Question:

What are the impacts of bycatch and wastage reductions on future estimates of halibut biomass, yield, spawning biomass and wastage by age–size categories of a fifteen year time horizon?

Component one requires simulations of halibut biomass, yield, spawning biomass, and wastage by age and size categories over a fifteen-year future period under alternative fishery and stock characteristics. The simuations shall be made using an annual, age-structured, split-sex model of the coast-wide Pacific halibut stock that captures halibut recruitment, growth, maturity and mortality, both natural and fishing. Fishing mortality should be determined using fishery catchability and selectivity relationships like those estimated in recent stock assessments. The model must be dynamic, in the sense that it can generate short and medium-term future projections of stock and yield characteristics under alternative natural mortality rates and average fish-weight trends (“Simulation Model” specifications below).

The IPHC recently produced several research reports that describe investigations into the effects of halibut bycatch mortality in the Alaska groundfish fisheries. The effects are measured on halibut set-line-fishery yields and spawning biomass (Hare 2010, Hare et al. 2012). The investigations rely on recent size distributions of halibut bycatch in the Alaska groundfish fisheries and wastage in the set-line fishery. The size distributions are converted to catch proportions by age and sex, and these age and sex proportions at length are assumed to characterize various proposed bycatch reductions. The bycatch and wastage amounts are then projected forward in time using a standard population dynamics model. Growth is reflected by (regulatory-area) mean-size at age, and yield is determined using a fishery selectivity-at-age from the stock assessment model and recent harvest rates. The investigations did not consider halibut migration.

The cumulative yield over a thirty-year future projection from bycatch halibut is termed the yield loss, and a yield-loss ratio is calculated by dividing the projected cumulative future yield by the weight of the bycatch reduction. Due to the algorithm the IPHC uses to determine fishery yields, these studies generate estimates of bycatch effects (and wastage) on the halibut stock mainly for halibut less than 26 inches long (Valero and Hare 2010, Hare et al. 2012) or less than 32 inches long (Hare 2010 [updated Hare 2012]). Halibut bycatch and wastage larger than 32 inches is converted to fishery yield pound for pound. The IPHC studies also tend to consider spawning biomass changes in the same way as yield changes. But evaluating spawning biomass changes this way does not reflect the role that spawning biomass plays in managing fishery yield, and no connection is made to effects on stock recruitment.

***The objective of component-one is to provide an alternative investigation into the effects of halibut bycatch and wastage in the GOA and BSAI groundfish fisheries.*** Like the IPHC study, the investigation should consider recent size distributions of halibut bycatch in the Alaska groundfish fisheries as characteristic of the reduced bycatch amounts. But in contrast with the IPHC study, the simulation model should include all sizes of halibut in the bycatch and wastage, and future yields from these halibut. Future halibut growth trends should be represented by the average fish-weight in the yield, with yield determined using the commercial-fishery selectivity-at-age in the stock assessment model and harvest rates set according to IPHC harvest policy. The investigation would not consider halibut migration.

The component one work product shall be in the form of a short report that includes: (1) a description of the simulation model equations and structure; (2) tables and figures that contain the simulated future biomass and yield characteristics of the bycatch and wastage reductions; (3) a comparison of halibut bycatch and wastage effects in the BSAI and GOA fisheries; and (4) a discussion of the results and the weakest and most robust aspects of the simulation model. The comparisons should develop loss and gain ratios using the same methods used by the IPHC. The results discussion should include an assessment of the sensitivity of the simulations and loss ratios to different values for natural mortality and trends in the average fish-weight in the yield. The discussion should also consider when projected changes in spawning stock biomass affect fishery yield rates and whether such changes could be considered to affect recruitment. To carry out the component-one analysis, bycatch reductions of 350 tons in the BSAI and 175 tons in the GOA should be investigated. Wastage reduction amounts should be set at an average wastage amount from recent years.

**Component Two:**

Effects of reduced minimum-size limits on halibut biomass, yield, spawning biomass, and wastage.

Key Research Question:

What are the short-term and long-term consequences of adopting a smaller size limit (26 inches or 66 cm) on the halibut spawning and exploitable biomass, yield, and wastage?

Component two requires projections of halibut biomass, yield, spawning biomass, and wastage by age and size categories over a fifteen-year future period under alternative fishery management measures. The simulations shall be made using an annual, age-structured, split-sex model of the coast-wide Pacific halibut stock that captures halibut recruitment, growth, maturity and mortality, both natural and fishing. Fishing mortality should be determined using fishery catchability and selectivity relationships like those estimated in recent stock assessments. The model must be dynamic, in the sense that it can generate short and medium-term future projections of stock and yield characteristics under alternative natural mortality rates and average fish-weight trends (“Simulation model” specifications below).

The IPHC has recently produced a research report that describes an investigation into the effects of reducing the minimum-size limit in the commercial set-line fishery (Valero and Hare 2011). The investigation assumes “steady-state or equilibrium conditions” instead of dynamic projections of stock characteristics based on asymptotic parameter estimates from the stock assessment model. The catch equation (as described in Valero and Hare 2011) in the equilibrium model does not directly account for bycatch mortality rates and thus the adjustments in the fishing mortality rates to obtain a target F that reduces the SPR to 0.35 is biased. Furthermore, one-year-ahead forecasts of exploitable biomass from the halibut assessment model have proven unreliable (Valero and Hare 2011).

The IPHC study also considers adjusting the target harvest rate with the objective of maintaining a spawn biomass per recruit ratio of 35%. This requirement is adopted even though IPHC harvest policy does not mandate an unchanging spawning stock. Also, no estimate of the time required for the stock to reach its new equilibrium is provided and no explicit consideration is given to the commercial gains from reduced wastage.

The component-two work product is intended to provide an alternative, more straight-forward investigation of the effects of reducing the minimum-size limit in the commercial set-line fishery. To accomplish this, three alternative management scenarios should be simulated. The first scenario represents the status quo and describes future stock and yield characteristics with a 32-inch minimum-size limit. Two additional scenarios would include: (1) a minimum-size limit reduced to 26 inches in one year; and (2) a minimum-size limit reduced by two inches every other year until the limit is 26 inches. All scenarios should be compared using fifteen-year-ahead projections of stock and yield characteristics.

The component two work product shall be in the form of a short report that includes: (1) a description of the simulation model equations and structure; (2) tables and figures that contain the simulated stock and yield characteristics; (3) a comparison of the current and reduced-size-limit scenarios; and (4) a discussion of the results and the weakest and most robust aspects of the simulation model. The comparisons should include stock and spawning biomass and yield, the age and length composition of the stock and yield, other removals and wastage. Characteristics of these simulations should be available by sex. Average amounts from any of the reduced minimum-size scenarios could be compared to the average of the status quo scenario as a loss or gain ratio. The results discussion should include an assessment of the sensitivity of the simulations to different values of natural mortality and trends in the average fish-weight in the yield. The discussion should also consider whether projected changes in spawning biomass would affect fishery yield rates and whether such changes would affect recruitment.

**Simulation Model Specifications:**

The stock-assessment projection model is intended to be a policy exploration tool that allows “what if”–type questions to be addressed. To the extent that input data can be made available from the IPHC, the model must capture the important characteristics of Pacific halibut growth, maturity, mortality, and recruitment, and these should be consistent with the relationships used in the most recent halibut stock assessments (2010 and 2011). Ideally, the simulation model must provide annual estimates of coast-wide stock and catch characteristics from 1996 to 2011 as well as annual projections of these variables for fifteen years into the future. The model must employ, as far as practicable, estimates of the following variables and relationships during 1996-2011 as those shown in the recent stock assessments: recruitment, natural mortality, and maturity at age; commercial set-line catchability and selectivity at length; catch-at-age by sex, catch average weight and age trends, and bycatch and wastage at age; and other removals. The simulation model will utilize parameter estimates from the most recent stock assessment to initialize the model between 1996 and 2011. This simulation model is not a stock assessment model and will not be fit to historical time-series data.

Model projections should be made using fishing mortality rates determined from the IPHC harvest policy (Figure 3, Hare and Clark 2008, first two policy characteristics, P. 177 of Hare 2011). The harvest policy first determines the fishing mortality rate based on the size of the female spawning biomass. This fishing mortality rate is further modified by a “slow-up-full-down” adjustment (Hare 2011). This policy may be contrasted with a policy that selects the harvest rate based on the spawning biomass without any further adjustment. Because biomass amounts from the coast-wide assessment are less variable than for the prior closed-area assessments, it may be that fishing mortality rates selected without adjustment will not differ too much from those selected based on the “slow-up-full-down” adjustment. However, for each research component a set of model projections should be calculated using both of these harvest-policy variants.

The coast-wide, annual model simulations should include yield, biomass, harvest rate, other removals, and bycatch and wastage of halibut from 26 to 32 inches as illustrated in scenarios tabulated by Hare (2011; pages 188-189). The simulations should incorporate observation errors of a magnitude consistent with the 2010 and 2011 assessments. Future projections that require recruitments beyond the 2004 year class should be made using an average recruitment value for the period 1999-2004. The model structure also should to be flexible enough such that, at minimum, it is possible to generate projections with changed natural mortality rates, and with changes in the trend of length at age.

catch numbers at age by sex (Figures 19, 25a,b, Hare 2012)

catch average weight trend (Figure 20, Hare 2012)

catch average age trend (Figure 20, Hare 2012)

set-line catchability (Figure 23, Hare 2012)

set-line selectivity at length and age (Figure 2,Valero and Hare 2012)

**Component Three:**

Present the main results of work products one and two at a two-day workshop about Pacific halibut bycatch management, and serve on a workshop panel to discuss management of halibut bycatch. The workshop will occur in Seattle on April 24-25, at the Crown Plaza Hotel, and will be open to the public. The workshop will be co-sponsored by the North Pacific Fishery Management Council and the International Pacific Halibut Commission.

The main results from component one shall be presented at the workshop with topic: “Impacts of halibut bycatch and wastage in the GOA and BSAI fisheries on halibut coast-wide yield and spawning biomass.” The main results of component two shall be presented as: “Effects of reduced minimum-size limits on halibut biomass, yield, spawning biomass, and wastage.” The panel discussion will be moderated and is intended to synthesize workshop results and stakeholder views into a set of recommendations to improve halibut management and halibut bycatch management. Presentation development should be coordinated with IPHC staff.

**References**

Clark, W.G. and S.R. Hare. 2006. Assessment and management of Pacific halibut: data, methods, and policy. Scientific Report No. 83.

Hare, S.R. 2010. Estimates of halibut total annual surplus production, and yield and egg production losses due to under-32 inch bycatch and wastage. Report of Assessment and Research Activities 2009.

Hare, S.R. 2012. Assessment of the Pacific halibut stock at the end of 2011.

Report of Assessment and Research Activities 2011.

Hare, S.R. and W.G. Clark. 2008. 2007 IPHC harvest policy analysis: past, present, and future considerations. Report of Assessment and Research Activities 2007.

Hare, S.R., Williams, G.H., Valero, J.L. and B.M. Leaman. 2012. Potential yield and female spawning biomass gains from proposed Pacific halibut prohibited species catch limit reductions in Gulf of Alaska groundfish fisheries. Report of Assessment and Research Activities 2011.

Valero, J.L. and S.R. Hare. 2010. Effects of migration on yield, spawning biomass and egg production losses due to U32 bycatch and U32 wastage of Pacific halibut. Report of Assessment and Research Activities 2009: 307-322.

Valero, J.L. and S.R. Hare. 2012. Harvest policy considerations for re-evaluating the minimum size limit in the Pacific halibut commercial fishery. Report of Assessment and Research Activities 2011.



Example of the tradeoffs on fishing mortality and size limits, with a discard mortality rate of 0.17 per year for spawning biomass per recruit, equilibrium yield, total discarded yield and the yield loss ratio. In the yield loss ratio figure, the isopleth of 1.0 (black lines) corresponds to the combinations of fishing mortality and size limits where one pound of discard corresponds to one pound of lost yield to the directed fishery. Note that lowering the size limits would result in less wastage (red lines), or increased efficiency (yield/(yield+discards)).

**Description of work and estimated costs:**

The following is a brief description of the work involved and estimated costs to perform the work. Based on the nature of the proposed simulation model in the terms of reference above, this work will require considerable collaboration with IPHC staff to obtain detailed parameter estimates in order to correctly specify the simulation model such that it can reproduce estimates of spawning and exploitable biomass.

Budget details:

An existing age-structured model called iSCAM (integrated statistical catch-age model) will be modified to accommodate the two-sex model for the halibut simulation model. The code changes are relatively minor requiring approximately 1.5 days to implement, verify and check. The assembly of input parameters and data for the simulation model will require roughly 3 days of time. Ideally if the report files and parameter files from the Halibut assessment are made available by the IPHC staff, then it should be fairly straightforward to create a simulation input data file for the halibut simulation model. If these report files and parameter files are not available, then attempts to assemble this information from reports etc. will be made. Obviously time is limiting before the bycatch workshop, so best efforts will be made to do this in an expedited manner.

The bycatch analysis (Component 1), will require an estimated 7 days to conduct, write the model descriptions and summarize and discuss simulation results. Similarly the size limit analysis (Component 2) will require and estimated 7 days to conduct and write up. All work for components 1 and 2 will be conducted in the city of Seattle beginning in early March til mid April and estimated costs for accommodations is $5,100 (quote from Sea to Sky Rentals, <http://www.seatoskyrentals.com/>). Note that as of April 15, my family and I are moving to Hawaii for other prior commitments.

For Component 3 I have budgeted 5 days for (2) travel, (1) preparation, and (2) participation at the two day Halibut bycatch management workshop in Seattle Washington at the Crown Plaza Hotel in Seattle WA. Hotel and incidentals at $900 (4 nights at $170 per night + $55 per diem) and airfare ~$700 Maui return on Alaskan Air.

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| Details | Time (Days) | Cost |
| Code changes to iSCAM for two sex model | 1.5 | $1,500 |
| Assembling input parameters/data for model | 3 | $3,000 |
| Bycatch analysis and write up | 7 | $7,000 |
| Size limit analysis and write up | 7 | $7,000 |
| Presentation and workshop participation | 5 | $5,000 |
| Airfare (OGG <-> SEA) |  | $700 |
| Hotel & per diem |  | $900 |
| Seattle Accommodations |  | $5,100 |
| TOTAL |  | $30,200.00 |