INITIAL DRAFT

Analysis of Potential Halibut Accounting and Management Measures

Discussion Paper for the North Pacific Fishery Management Council, March-April 2012

Scott Meyer, Alaska Department of Fish and Game
February 16, 2012

Introduction

In December 2011 the North Pacific Fishery Management Council approved a motion that included initiation of a discussion paper analyzing the following items for potential use in future charter halibut management:

1. The use of ADF&G logbooks as the official measure of charter harvest in Alaska.
2. Annual limits allowing for retention of at least one fish of any size.
3. Trip limits (limit the number of trips per vessel per day).
4. Reverse slot size limits.
5. Two fish bag limit with maximum size on both fish.

The Council also asked for analysis of restricting captain and crew retention, but the Catch Sharing Plan (CSP) contains a provision prohibiting retention of halibut by captain and crew, so this measure was not analyzed.

Additionally, the Council asked for analysis of the use of common pool purchase of quota share by the charter sector and long-term management measures under Tier 1 of the CSP as identified in the Charter Halibut Implementation Committee report from December 2011. Both of these items were deferred and will not be analyzed in this paper.

The Council motion asked that the measures examined in this paper be analyzed for their potential use for charter management under the CSP. It is unknown which of these measures may be incorporated into the regulatory structure (matrix) of the CSP, or how they would be incorporated. Unlike previous analyses that project harvest or harvest reduction associated with specific measures and compare projections to an explicit allocation, there was a nearly infinite range of possible scenarios of combined catch limit, current effort, current harvest rate, current size composition, etc. Therefore, this analysis is focused on data availability, methods of projecting harvest under each measure, and implementation issues. This initial draft is meant to solicit input and feedback from the charter industry and regulatory agencies, and help focus the next draft of the discussion paper.

ADF&G Charter Logbooks for Harvest Reporting

Description of Statewide Harvest Survey:

Since the mid- 1990s, ADF&G has provided the IPHC and Council with estimates of charter yield (harvest in pounds) that are based in part on estimates from the department's Statewide Harvest Survey (SWHS). The department also provided reports to the IPHC summarizing creel survey harvest estimates from several ports in Southeast Alaska, but only the SWHS provided comprehensive, year-round estimates of harvest for the sport fishery.

The SWHS is a mail survey that employs stratified random sampling of households containing at least one licensed angler. Survey respondents are asked to report the numbers of fish caught and kept by all members of the entire household, and the data are expanded to cover all households. Up to three mailings may be used to increase the response rate and correct for nonresponse bias.

The SWHS has used two types of survey questionnaires. Approximately equal numbers of each type were mailed. The standard questionnaire did not break out guided and unguided harvest except for Kenai Peninsula fisheries (Area P). An alternate questionnaire, used since 1992, requested anglers to report effort, catch, and harvest for guided and unguided trips. Starting in 1996, for all areas except Area P, charter harvest was estimated by applying the guided proportions from the alternate questionnaire to the total estimate from both survey types. A single questionnaire that captures guided and unguided harvest statewide will be used to estimate starting in 2011.

Description of Logbook Program:

ADF&G initiated a mandatory charter boat logbook program in 1998. The logbook program was an outgrowth of several years of mandatory annual registration of sport fishing guides and businesses. The logbook program was intended to provide information on actual participation and harvest by individual charter vessels and businesses in various regions of the state. This information was needed by the Alaska Board of Fisheries for allocation and management of state managed species such as Chinook salmon, rockfish, lingcod, and by the North Pacific Fisheries Management Council for allocation of halibut.

Since 1998, the logbook design has undergone annual revisions, driven primarily by changing information needs, particularly with respect to halibut and rockfish. Halibut data were collected each year during the period 1998-2001, dropped during the period 2002-2005, and resumed in 2006. Additional fields and requirements were added or removed in recent years to help facilitate management and enforcement of the charter halibut fishery.

During the early years of the program, the department was concerned about the quality of information collected in the logbook. During this time, the Council was considering incorporating the charter fishery into the existing individual fishery quota (IFQ) management system for the commercial fleet. The department conducted an initial evaluation of the 1998-2000 logbook data in September 2001 (Bingham 2001). This evaluation compared Statewide Harvest Survey (SWHS) estimates of harvests of several species with reported harvests from the logbook, and compared logbook data to interview data from on-site sampling in Southeast and Southcentral Alaska. Halibut harvests reported in the logbook were close to the SWHS estimates in 1998 but were substantially higher in subsequent years. Results for other species were variable. Comparisons with onsite interviews indicated that halibut harvest reported in the logbook was close, on average, to numbers reported in interviews. For Southeast Alaska, the halibut harvests reported in logbooks and interviews were within one fish for 90-91% of the trips. For Southcentral Alaska, only 58-74% of the trips were within one halibut, but the percentage increased each year.

ADF&G dropped the halibut reporting requirement beginning in 2002 following passage of a motion by the NPFMC to include charter harvest into the existing IFQ system. The reporting requirement was dropped because there no longer appeared to be a reason for the State of Alaska to collect halibut data. The Council decided that initial allocation of quota share would be based on 1998-1999 logbook data. The Council also decided that the ADF&G logbook would not be used to track IFQ harvest, and federal agencies indicated clearly that they would develop a separate, possibly electronic, reporting system for charter halibut IFQ harvest (e.g., Wostmann & Associates 2003). The department decided to discontinue collection of questionable data from the halibut fishery and use the logbook program to continue to monitor participation in state-managed fisheries. As a result, no halibut information was collected in the logbook from 2002 through 2005.

The NPFMC rescinded the IFQ motion in December 2005. At that time, the ADF&G Commissioner pledged to resume the halibut reporting requirement for the charter logbook, and do it in a manner that improved the quality of the data collected. A number of new measures were implemented in 2006 to monitor and improve the quality of logbook data (Meyer and Powers 2009). The most significant changes, in terms of improving data quality, were that:

1. Charter operators were required to report the fishing license number and residency of each licensed angler, and the numbers of fish kept and released by each angler on the vessel (including crew).
2. The logbook data entry staff increased telephone contacts to charter operators to correct logbook data that was recorded improperly, to request missing data, and to answer questions about how to complete logbooks.
3. An additional technician was added in Southcentral Alaska to conduct interviews and count (verify) halibut harvest only in the Homer, Anchor Point, Deep Creek, and Seward fisheries. Referred to as the "roving tech," this position was added in 2006 only to increase the percentage of charter trips with verified halibut harvest. This technician also conducted courtesy logbook inspections early in the season.

Logbook Evaluation for 2006-2008:

Following improvements to the logbook program, ADF&G sought to determine whether the quality of logbook data had in fact improved and whether logbook data should be used to monitor and manage the charter halibut fishery. ADF&G presented a report evaluating the 2006-2008 logbook data at the October 2009 Council meeting. The report included summaries of missing or invalid data, timeliness of logbook submissions, frequency of client fishing license numbers and youth anglers, comparisons of logbook data to a post-season survey of charter clients for a single day of fishing, comparison of annual logbook data with SWHS estimates of harvest at the IPHC area and subarea levels, comparison of annual halibut harvest recorded for individual anglers in logbooks to those angler's mail survey responses, comparisons of reported logbook effort and harvest per boat trip to dockside interview data, and comparisons of reported annual logbook harvest for selected ports to onsite creel survey estimates (Meyer and Powers 2009).

Results of the comparison of logbook and SWHS estimates were mixed. Annual effort indicated by logbook data and SWHS estimates were very similar most years. Logbook effort ranged from 2% lower to 5% higher than the SWHS effort in Area 2C, and from 10% lower to 0.4% higher in Area 3A. The logbook estimates were consistently within the confidence intervals of the SWHS estimates except in 2007 in Area 3A. Halibut harvest reported in the logbook was consistently higher than the SWHS estimates, but more so in Area 3A than in Area 2C. Most of the discrepancy in halibut harvest estimates in Area 2C was the result of differences in the Prince of Wales area. For Area 3A, most of the differences were in the Prince William Sound/North Gulf and Cook Inlet numbers.

In an attempt to understand the cause of harvest discrepancies, ADF&G compared reported 2008 annual harvest for individual licensed anglers to their responses to the SWHS questionnaire. Only SWHS responses from anglers from single-angler households could be compared, because anglers were asked to report household-wide harvests. Logbook SWHS data were matched for 847 anglers in Area 2C and 1,132 anglers in Area 3A. There was no difference between annual harvest reported in logbooks and the SWHS in 53percent of the Area 2C records and 66 percent of the Area 3A records. Differences ranged from -16 fish (logbook lower) to +10 fish. However, the average difference was only -0.14 halibut/angler in Area 2C and +0.07 fish/angler in Area 3A. The net result for only the anglers in the comparison was that total harvest was 6% lower in the logbook than in the SWHS in Area 2C, and 3% higher in the logbook than in the SWHS in Area 3A. It isn't possible to know whether logbooks or SWHS were more accurate.

There was concern that some SWHS data handling procedures may cause bias in harvest estimation. In particular, ADF&G routinely edits SWHS responses that include harvests in excess of daily bag limits, as long as those differences are small. Large differences are investigated and edited only in consultation with area managers. The theory is that anglers may be reporting harvests in excess of the bag limit due to recall or prestige bias. Halibut harvest estimates for 2006 were re-computed using the raw responses without

bag limit edits. The re-computed estimates were about 7% larger in Area 2C and Area 3A, indicating that bag limit edits potentially bias the harvest estimates low. However, a systematic difference is not observed in fishing effort reported in logbooks and the SWHS, suggesting that anglers are reporting effort correctly. If so, the bag limit edits might in some cases be correcting for erroneous data. On the other hand, they might be truncating illegal harvest that should still be estimated as part of the removals.

The results of other comparisons were also mixed. Some of the comparisons were difficult to make and results may have suffered due to surveys not being completely comparable. For example, the comparisons of logbook and post-season survey data indicated that about 4-7percent of anglers whose license numbers were recorded in charter logbooks reported that they never made a charter trip. While it is possible that some license numbers were fabricated, there are other possible explanations. For example, it is likely that some of the 7-digit license numbers were transposed, or that some surveyed clients have a different understanding of the term "charter," or that some surveyed anglers were actually "comps" (anglers that fished for free).

From 2006 to 2008, the number of halibut reported harvested for individual anglers in logbooks and in the post-season survey agreed 63-67 percent of the time in Area 2C. Agreement was higher in Area 3A (75-77%). The distribution of differences was skewed in both areas, with a substantial portion of anglers reporting harvests of more than two halibut per day (the bag limit) in the post season survey. This was assumed to be due to anglers reporting for their entire household, or for multiple days, rather than for themselves only and for a single day as explained in the directions.

Comparisons of logbook data and dockside interview data were favorable. The average difference in reported harvest and harvest observed and counted dockside by ADF&G technicians was -0.08 halibut per boat-trip for Area 2C and -0.21 halibut per boat-trip for Area 3A. Large differences were not expected because interviews were conducted within minutes of when logbooks were required to be completed. On the other hand, technicians didn't always share their counts with the charter operators, and differences (logbook minus interview) ranged from -35 fish to +10 fish. Some of the large differences could have been caused by date errors on logbooks or miscoding of vessel identifiers.

Following presentation of the report, the SSC indicated in its minutes that it concurred that logbook data offers clear advantages relative to the SWHS, and encouraged additional research. The Council made no specific motion on the use of logbooks at the October 2009 meeting.

Updated Comparisons Through 2010:

Since the 2006-2008 report, ADF&G has updated comparisons of logbook data and SWHS estimates of annual charter effort (for all species), charter halibut harvest (numbers of fish), and charter halibut yield (harvest in pounds net weight) through 2010 (Figure 1). The comparisons will be updated again when the 2011 SWHS estimates become available in September, 2012.

Implementation:

There are differences in the reported halibut harvest in logbooks and the estimated harvest from the SWHS. We did multiple comparisons with other data sources to try to diagnose the quality of reported logbook harvest, and potentially find the source of the differences. The differences, however, did not follow a consistent pattern among different data sources (EOS, SWHS, single-angler households, and creel surveys). For example, the discrepancies in halibut harvest between logbook data and SWHS

estimates were larger in Area 3A than in Area 2C. To date we are unable to find the cause(s) of these discrepancies. They may be caused by anglers from multi-angler households not reporting for the entire household in the mail survey, recall bias in the mail survey, bag limit edits in processing mail survey responses, incomplete reporting of crew harvest in the mail survey, inflation of harvest in logbooks, or a combination of factors, some of which are still unidentified.

Since the true harvest is unknown, there is no way to know whether logbook data or SWHS estimates are closer to the true harvest. For Area 2C, estimates of charter halibut yield based on logbook data averaged 5.6% higher than yield based on SWHS estimates (range -5% to +15%). For Area 3A, logbook-based estimates of yield averaged 15.9% higher than the SWHS-based estimates (range +5.7% to 28.0%). Although there are only five years of comparisons to look at, it does not appear that the estimates are converging. Therefore, we could probably expect to see a similar range of differences in future years, unless there is a significant change in data collection methods that affects harvest reporting.

There are several clear advantages of using logbooks for monitoring and managing charter halibut harvest in Areas 2C and 3A:

1. Logbook data is required to be submitted by the guide at the end of each charter trip. Therefore, logbooks ideally represent a complete census of harvest without recall bias, avidity bias, or sampling error, factors that can affect the accuracy of SWHS estimates.
2. Catch and harvest information from logbooks is much more specific than SWHS estimates. Mail survey estimates are annual and can be summarized for the charter sector at the level of IPHC area, subarea, or site (a well-known location such as Sitka Sound or Kachemak Bay). On the other hand, logbook data can be summarized daily at the level of IPHC area, subarea or SWHS reporting area, port of landing, ADF&G statistical area, charter business, charter vessel, individual angler, and any combination of the above. This allows fairly comprehensive analysis of the effects of potential regulatory measures, such as bag limits and annual limits, at various scales.
3. Charter anglers that harvest halibut in Area 2C are required to sign logbooks to verify that the halibut data reported for them was correct. Under the Catch Sharing Plan, this signature requirement will be extended to Area 3A. The signature requirement is generally believed to improve the accuracy of reported logbook data.
4. Although logbook data are potentially subject to strategic misreporting or nonreporting, ADF&G will continue onsite interviews and sampling for halibut size, as well as compilation of charter harvest estimates from the SWHS. Data from these programs can be used for ongoing monitoring. If it appears from onsite interviews that a significant portion of charter trips are not being logged, the reported logbook harvest could be corrected.
5. Logbook data are timelier than the SWHS. Logbooks are required to be submitted on a weekly basis beginning in April. Data for trips through July are generally entered and available for projections by late October. Final logbook data are usually available by February or March of the following year. In comparison, SWHS estimates are not available until September of the year following harvest.
6. Projections of logbook-reported harvest for the current year are more accurate than projections of SWHS estimates for the current year. The reason is that logbook data itself are used to make the projection, and the proportion of harvest that occurs through any particular date is relatively stable from year to year. The stability in the distribution of harvest over time could be affected, however, if the Council were to adopt seasonal closures or seasonal changes in bag limits.

Annual Limit of at Least One Fish of Any Size

Analysis:

The charter industry requested analysis of the potential use of a measure that would allow retention of at least one fish per angler per year of any size. This provision is presumably intended to be implemented when there is a maximum size limit that prevents harvest of large fish. The measure preserves the charter industry's ability to market the opportunity for charter vessel anglers to retain a fish larger than the maximum size limit. For example, under a one-fish bag limit with a 45-inch maximum size limit, the angler would be allowed to harvest one fish per year that was not constrained by the size limit. Presumably this exemption would not be needed if there was no maximum size limit, or if a reverse slot limit was in place, because both of those measures allow the opportunity to harvest large fish.

ADF&G logbooks provide information on the numbers of halibut harvested annually by individual licensed charter anglers (Table 1). Onsite creel survey programs in Areas 2C and 3A provide samples of length measurements from the sport halibut harvest, from which average weight is estimated. The length data are associated with vessel-trips but not individual anglers.

It was not possible with available data to quantitatively evaluate the impact of an annual exemption to a maximum size limit. In order to determine harvest savings under this measure, the analyst would need to project harvests and compare them to harvest without the measure under a range of maximum size limits (assuming one fish bag limit). In order to project charter harvest under this measure, the analyst would need to project the number of fish and average weight of fish that would be harvested under the annual exemption limit, and the number of fish and average weight for fish harvested under the maximum size limit. There is no past experience with this management measure, so there are no data from which to infer how many anglers would take advantage of the exemption or be successful. The probability of catching a fish in excess of the size limit cannot be calculated without size data from all halibut caught, but no data are available on the sizes of fish caught and released. Some portion of anglers might catch a fish in excess of the maximum size limit but release it in favor of a larger fish, but ultimately be unsuccessful in catching that larger fish. There are also no previous size data from a fishery under this regulation from which to infer the average weight of fish harvested under the annual exemption. Presumably anglers utilizing this annual exemption would harvest fish in excess of the size limit, but may opt to high-grade to a greater degree than they would when unconstrained by a maximum size limit (in order to benefit from the exemption).

To further complicate the analysis, the opportunity to harvest a large fish afforded by this measure would likely change the frequency distribution of annual harvests. For example, under a one-fish bag limit and maximum size limit, an angler might harvest four 15-pound halibut in a 5-day stay, for a total of about 30 pounds of meat. But if, on the second day, the angler harvests a 120-pound halibut under his annual exemption, he may be unlikely to harvest three more halibut. It is possible that some, but not all, anglers desire to harvest a specific amount or minimum amount of halibut meat. Without size data linked to individual anglers, we can't know the distribution of the total weight of those anglers' annual harvests. Additionally, without annual harvest data from a previous year with an annual limit, we have no basis to predict how the distribution of annual harvest would change.

Lacking a quantitative analysis, some general qualitative statements can be made regarding annual limits that are exemptions from size limits. First, the probability of an angler being able to harvest a fish in excess of the size limit would vary by area. Although the size distributions of the charter halibut catch (kept and released fish) are unknown, the size distributions of harvest vary by area when unconstrained by a size limit (e.g., see Fig. 1 in Meyer 2011B). Presumably these differences are due to real differences in the availability of fish of different sizes, and not to differences in fishing gear or angler behavior that would affect selectivity. Second, there are also differences among areas in the distributions of annual halibut harvest by individual anglers (Table 1). Therefore, if a way is found to project harvest under these annual limits, it will probably have to be done on an area-by-area basis. The net effect of allowing an

angler to harvest at least one fish per year that is larger than the size limit depends on the size of the fish and the degree to which harvest of larger fish affects the number of fish harvested. Both of those factors cannot be predicted with available data.

The opportunity to harvest at least one fish of exception size would be expected to have a positive demand effect, at least relative to years in which the fishery is managed under a size limit. As mentioned above, harvest of exceptionally large fish

Implementation:

Once a fish that is intended to count toward the person's annual limit is harvested, there would need to be some record created to prevent the angler from harvesting additional fish above the annual limit.

The Council first approved annual limits as a GHL management tool in 2000. Annual limits were considered in conjunction with trip limits and prohibitions on crew harvest for management of the Area 2C and 3A charter fisheries under the GHL in 2006 (NPFMC 2006). In June 2006, NOAA Fisheries presented a letter to the Council reporting that current federal and state laws do not allow the use of State reporting documents by Federal enforcement personnel for the Council's preferred alternative to implement a 5-fish annual limit for charter anglers in Area 2C. NOAA determined that the proposed annual limit would require a federal charter vessel halibut angler permit and a federal charter vessel halibut logbook. They also noted that the cost of implementing federal reporting could be substantial and redundant to state reporting requirements (NPFMC June 2006 Newsletter).

Trip Limits

The Council asked that trip limits be analyzed as a potential measure to control charter harvest. This analysis assumes the term "trip limits" to refer to limits on the number of trips a charter vessel can make per calendar day. This is the standard terminology used by the Council in the past.

The Council first approved trip limits as a potential management tool in 2000. Trip limits were again considered, in conjunction with annual limits and prohibitions on crew harvest, for management of the Area 2C and 3A charter fisheries under the GHL from 2006 to 2008 (NPFMC 2006, NPFMC 2007, NPFMC 2008). Using 2006 logbook data, charter harvest from trips in excess of one trip per day were estimated to have accounted for 1.8-2.4% of the total harvest in Area 2C (NPFMC 2007) and 5.5-6.3% of the total harvest in Area 3A (NPFMC 2008). The range of estimates resulted from calculations based on dropping either the least successful of the trips or the "average trip." Logbook data used for the analysis included only trips with effort for bottomfish, but it is unclear whether harvest was tallied for clients and crew or clients only.

The effect of trip limits was re-examined using 2010 logbook data counting only client and comp harvest. It is assumed that crew harvest will not be allowed under the CSP. Excluding crew harvest will not alter the analysis for Area 2C because crew harvest was prohibited in Area 2C in 2010. The analysis was also limited to logbook trips with bottomfish effort or trips where effort was for salmon but halibut were harvested. The reasoning for including salmon trips with halibut harvest is that, if multiple trips were prohibited, federal authority would extend only to trips with halibut harvest. In other words, a federal law could not prohibit multiple trips per day for state-managed species. This analysis did not attempt to bracket a range of estimates by excluding, say, the least successful of average trip. Instead, estimates of the potential harvest reduction were based only on harvest from trips after the first trip of the day. The difference between the minimum and maximum harvest reductions from previous analyses were less than one percent.

In 2010, charter vessels made up to four bottomfish trips or trips with halibut harvest per day in Area 2C and up to three trips per day in Area 3A (Table 2). Harvest on trips beyond the first trip of the day accounted for 2.0% of the charter harvest in Area 2C and 7.0% of the harvest in Area 3A. These percentages represent the expected reductions in the number of fish harvested if vessels were limited to one trip per calendar day. Assuming no systematic difference in the sizes of fish harvested on the first, second, etc. trip of each day, these percentages also represent the harvest savings in pounds. The percentage for 2C is similar to the 2006 estimate of 1.8-2.4%, but the Area 3A value represents a slight increase over the 2006 level of 5.5-6.3%.

As noted in previous analyses, the estimated effect of trip limits may be overstated. One reason is that there is still considerable excess capacity in the charter fleets in Areas 2C and 3A. The trip limit will reduce the number of seat-days available to be booked, but if charter anglers can still book a trip on another vessel, there will be no reduction in harvest. This is not straightforward to analyze because there may be multiple business models that offer multiple trips per day. For example, some vessels specifically offer half-day trips at a reduced rate, while others operate two full-rate trips per day. Some operations that offer multiple trips may only do so for a portion of the season, e.g., when tides are right, when effort is high, or when fishing is good. Another reason that the estimated effect of trip limits may be overstated is that businesses that currently operate vessels below capacity may choose to operate at capacity if limited to one trip per day.

Reverse Slot Limits

Reverse slot limits have been considered by the Council before. They were first discussed as measures to manage the Area 2C and 3A charter fisheries within their respective GHLs. The two options considered for both areas were allowing harvest of fish under 32 inches and over 45 inches (U32O45) and fish under 32 inches and over 50 inches (U32O50). The reverse slot was being considered to apply only to the second fish in a two-fish bag limit (NPFMC 2007, NPFMC 2008).

A reverse slot was most recently considered for managing the Area 2C charter halibut fishery in 2012 as an alternative to a 37-inch maximum size limit (Meyer 2011B). Unlike a maximum size limit, a reverse slot limit provides the opportunity to harvest an exceptionally large fish under a one-fish bag limit. The charter industry suggested the reverse slot limit in order to market charter trips and lodge stays to anglers motivated to catch large fish.

Methods:

For this analysis, a reverse slot is assumed to be adopted when the fishery is managed under a one fish bag limit, primarily as an alternative to a maximum size limit. Similar to Meyer (2011B), the projected average weight is based on size data from the most recent year for which the fishery was not constrained by a size limit (the reference year). Because size composition varies among subareas of each IPHC area, the average weight associated with each prospective length limit was calculated for each subarea as:

$$\hat{\bar{w}} = \left(\hat{p}_L \hat{\bar{w}}_L\right) + \left(\mathrm{h}\hat{p}_U \hat{\bar{w}}_U\right) + \left(\frac{\hat{p}_L}{\hat{p}_T}\,\hat{p}_C \hat{\bar{w}}_L\right) + \left(\frac{\mathrm{h}\hat{p}_U}{\hat{p}_T}\,\hat{p}_C \hat{\bar{w}}_U\right)$$

where

$\hat{p}_L$ = proportion of harvest (in numbers) ≤ the lower maximum length limit,

$\hat{\bar{w}}_L$ = the estimated average weight of fish ≤ the lower maximum length limit,

$\hat{p}_U$ = proportion of harvest (in numbers) ≥ the upper minimum length limit,

h = a multiplier to specify the degree of high-grading above the upper limit,

$\hat{\bar{w}}_U$ = the estimated average weight of fish ≥ the upper minimum length limit,

$\hat{p}_T$ = the total proportion of harvest ≤ the lower maximum length limit and ≥ the upper minimum length limit, or $\hat{p}_L + \mathrm{h}\hat{p}_U$, and

$\hat{p}_C$ = the proportion of harvest in the center of the distribution between the lower length limit and the upper length limit, or 1- $\hat{p}_T$.

Charter yield in pounds under each prospective slot limit is estimated by multiplying the average weight by a projected number of fish harvested in each subarea, then summing over all subareas to obtain the IPHC area total.

This approach assumes that the proportions of harvest above or below the prospective upper and lower size limits will be the same as they were in the reference year. It further assumes that there will be no decrease in harvest; all fish caught between the upper and lower size limits will be released and replaced in the harvest by fish above or below the size limits. With a high-grading multiplier of 1.0, the harvest between the limits is redistributed to the upper and lower tails proportional to their relative proportions of the harvest in the reference year. It is possible that, under a reverse slot limit, anglers will have added incentive to harvest a large halibut that is above the upper minimum size limit. For example, using a high-grading multiplier of 1.15 inflates the proportion of harvest in the upper tail, making it 15% higher than in the reference year. It should be noted, however, that the multiplier so far is hypothetical. We do not yet have any length data from a halibut fishery managed under reverse slot limits. Once we do have those data, we still may not be able to discern the effect of high-grading from other factors such as changes in stock composition.

Example:

Charter yield was calculated using the equations above for the Area 2C charter fishery for 2012 (Meyer 2011B). Yield was calculated for two alternative levels of harvest, and for scenarios with no additional high-grading and 20% additional high-grading (h = 1.20). In each of these four scenarios, yield was calculated for combinations of lower limits ranging from 35 to 45 inches (U35-U45) and upper limits ranging from 50 to 76 inches (O50-O76). The full range of size limits considered was therefore U35O50 to U45O76. A table was produced for each harvest/high-grading scenario. In each table, projected charter yield varied over a wide range. For example, for the scenario with a projected harvest of 45,338 fish and 20% additional high-grading, projected charter yield ranged from 0.685 to 1.447 M lb (Table 3). The tables can be produced for any range of length limits; the limits chosen in this case bracketed the Area 2C GHL. Calculations for Area 3A would be done using the same equation and data sources.

Implementation:

The National Marine Fisheries Service has advised the Council that, in order to comply with the Administrative Procedures Act, the management measures in the CSP have to be applied in a prescriptive manner (see CSP proposed rule 76FR44156). For example, in June 2011 the Council approved and recommended to NMFS a specific algorithm for calculating maximum size limits under the CSP. The equation presented above provides the necessary structure to support prescriptive implementation of reverse slot limits. However, for any given projected halibut harvest (in numbers of fish), reverse slot limits can produce a wide range of projected yield (harvest in pounds) depending on the choice of upper and lower limits and degree of high-grading expected. When the Council recommended a U45O68 reverse slot limit for the Area 2C charter fishery for 2012, they had to decide on a lower limit, upper limit,

and whether to incorporate additional high-grading. The Council also chose a higher upper length limit (68 inches) than necessary in order to add an additional buffer for uncertainty. In order for reverse slot limits to be a feasible management alternative to a maximum size limit under the CSP, the Council would have to remove all but one of these factors in order to remove subjectivity from the choice of a reverse slot limit.

One way to make the choice prescriptive would be to fix the high-grading multiplier and either the upper or lower length limit in the CSP. Data are not yet available upon which to base an estimate of high-grading, but the Council could adopt a specific value of the high-grading multiplier for purposes of risk aversion. Given a projected halibut harvest in numbers of fish, this would allow projection of charter yield over a one dimensional range of either upper or lower length limits (whichever was not fixed). The length limit that produces a yield closest to the allocation without exceeding it could automatically be chosen.

One concern associated with using reverse slot limits is that it is difficult to measure large fish without removing them from the water. The Council and stakeholders have noted this concern previously. For example, in April 2007 the Council rejected sub-options for minimum lengths of 55 and 60 inches on the second fish in the bag because of concern for the difficulty of measuring large fish without bringing them aboard. The Council, IPHC, and stakeholders also discussed the practicality of measuring large fish with respect to implementation of the U45O68 reverse slot limit recommended for Area 2C for 2012.

Methods for measuring fish while they are still in the water have been developed in other fisheries, but most are for smaller, easily handled fish. At least two methods are used for approximate measurements of large pelagic marine fish such as sharks and billfish. One method used in Australia is to attach a tape measure to a tennis ball and, when the fish is alongside the boat, float the tennis ball to the fork of the tail and read the length at the tip of the snout.[1] Another method is to use a device similar to a "billfish belt." A billfish belt is a tape measure attached to a D-ring. The D-ring is slipped over the bill of the fish and the tape flags (drifts out) alongside the fish. A simple modification would be to attach a tape or line of a length equal to the limit to a snap that could be slid down the leader to the hook. The length of the fish could be quickly assessed relative to the length limit. A correction would have to be made for the fact that the hook will be in the corner of the mouth rather than the tip of the snout. Some forward progress of the boat may be required for both methods in order to get the fish to lay flat and feed out the tape. Although these methods would not provide a precise measurement, if used with caution they might be used to harvest fish of a legal size with a minimum of handling. Other methods may already be used or are yet to be developed.

A related concern with reverse slot limits is the discard mortality from handling and release of large halibut associated with compliance with the length limits. Under a reverse slot limit, some fish that are caught would be released because they are smaller than the size of fish the angler desires, and some fish would be released because the regulation requires it. The total amount of discard mortality is difficult to estimate without length data from released fish. However, it may be possible to compare the relative mortality associated with various reverse slot limits by assuming that the "too small" portion of the catch is similar among limits and ignoring it. Mortality could be estimated only for fish that are required to be released by the regulation by applying an assumed discard mortality rate to an estimated number of fish released, then multiplying by an average weight. The number of fish released and average weight could be derived from the length-frequency distribution of harvest for the most recent year in which there was no size limit.

[1] http://www.dpi.nsw.gov.au/fisheries/recreational/saltwater/gamefish-tagging

Two Fish of a Maximum Size

Analysis:

This regulation could be used as an alternative to several regulations, including bag limits of one fish any size, two fish any size, or two fish with one under 32 inches. These are all measures currently included in the CSP motion. This option provides greater control to fine tune charter harvest, and could potentially be used as an intermediate step between one-fish and two-fish bag limits without size limits. Unlike the annual limit and reverse slot limit alternatives discussed above, this option does not provide for harvest of exceptionally large fish. The conditions under which a two fish bag limit with maximum size limit on both fish would be more marketable to charter clients than a reverse slot limit are unknown.

Intuitively, given a projected harvest under a two-fish bag limit, placing a maximum size limit on both fish will reduce the average weight and total yield in the harvest. Whether yield would be greater under a limit of two fish of a maximum size than one fish of any size would depend on where the maximum size limit was set.

Since this option involves a size limit, it is presumed that it could only be implemented in a prescriptive manner under the CSP. One way to do that might be to adopt the same method used to set maximum size limits under a one-fish bag limit. The Council most recently approved the "hybrid method" for setting size limits in conjunction with a one fish bag limit under the proposed CSP. Like the reverse slot limit procedure, the hybrid method relies on length data from a previous year in which the fishery was not constrained by a size limit (reference year). It could conceivably also be based on data from a year in which a less constraining (higher) maximum size limit was in place.

The hybrid method assumes that under a size limit in the coming year, (a) the proportion of the halibut harvest that will be smaller than the size limit will equal the proportion that were under that length in the previous year, (b) the average weight of fish smaller than the size limit will remain unchanged from the previous year, and (c) the portion of the previous year's harvest that was larger than the prospective maximum size limit will be exactly equal to the size limit in the coming year.

The hybrid method would calculate charter removals over a range of prospective size limits using equation 1, with the average weight for each subarea w_S calculated as follows (Meyer 2011A):

$$w_S = (p_{UL} w_{UL}) + (p_{OL} w_{OL}) \quad (5)$$

where

p_{UL} = the proportion of halibut in the previous year's creel survey sample from subarea *S* that were less than or equal in length to the prospective length limit L_{in},

w_{UL} = the average weight of halibut in the previous year's sample from subarea *S* that were less than or equal in length to the prospective length limit L_{in},

p_{OL} = the proportion of halibut in the previous year's creel survey sample from subarea *S* that were greater in length to the prospective length limit L_{in} (p_{UL}+p_{OL} = 1), and

w_{OL} = the average weight of a halibut of length L_{in}, predicted from the IPHC length-weight relationship (equation 4).

The average weight for each subarea is multiplied by the estimated number of fish harvested to estimate the yield associated with various maximum size limits. The approach to estimating yield is the same under a one-fish or two-fish bag limit. The only difference is that a higher harvest would be projected under a two-fish bag limit.

Implementation:

Once a projected yield was associated with each potential maximum size limit, the largest size limit in whole inches that results in a projected charter yield that is less than or equal to the annual catch limit for the charter sector would be selected. This procedure would represent the prescriptive approach needed for implementation of the regulation under the CSP. As with all size limits, regulations would need to be implemented to require that all fish be landed whole, or the carcasses be retained until the fish are brought to shore and offloaded.

Summary

Most, if not all, of the management measures reviewed seem at least conceptually feasible. There wasn't sufficient information to determine a method to project yield under annual limits, or annual exemptions to size limits. Quantitative analysis of the measures was premature and impractical without knowledge of whether or how these measures would fit into the existing CSP management matrix. Should candidate measures be selected and their purpose and function identified, it will likely then be possible to compare the utility of these measures by projecting yield over a range of combined catch limits and comparing regulatory outcomes. This analysis will benefit from industry, agency, and stakeholder input, and hopefully that discussion will focus future analysis efforts.

References

Meyer, S. and B. Powers. 2009. Evaluation of Alaska charter logbook data for 2006-2008: A report to the North Pacific Fishery Management Council, September 2009. Alaska Department of Fish and Game, Anchorage.

Meyer, S. 2011A. Methods for establishing maximum size limits for the charter fishery under the halibut Catch Sharing Plan: A report to the North Pacific Fishery Management Council, June 2011. Alaska Department of Fish and Game, Anchorage.

Meyer, S. 2011B. Analysis of management options for the Area 2C charter halibut fishery for 2012: A report to the North Pacific Fishery Management Council, December 2011. Alaska Department of Fish and Game, Anchorage.

NPFMC 2006. Environmental assessment/regulatory impact review/initial regulatory flexibility analysis for a regulatory amendment to implement guideline harvest level measures in the halibut charter fisheries in IPHC Regulatory Areas 2C and 3A. Public Review Draft, March 13, 2006.

NPFMC 2007. Environmental assessment/regulatory impact review/initial regulatory flexibility analysis for a regulatory amendment to implement guideline harvest level measures in the halibut charter fisheries in IPHC Regulatory Area 2C. Draft for Public Review, May 4, 2007.

NPFMC 2008. Environmental assessment/regulatory impact review/initial regulatory flexibility analysis for a regulatory amendment to implement guideline harvest level measures in the halibut charter fisheries in IPHC Regulatory Area 3A. Draft for Public Review, August 28, 2008.

Wostmann & Associates, 2003. Halibut guided charter data collection; conceptual design. Report for National Marine Fisheries Service, Division of Sustainable Fisheries, November 2003.

Table 1. Frequency distributions of annual harvests of halibut by licensed charter anglers in Areas 2C and 3A, 2010. Tables indicate the number of anglers in each subarea that harvested one, two, three, etc., up to 10 or more halibut per year. The Area 2C fishery was managed under a one-fish bag limit in 2010 with no size limit. The Area 3A fishery had a bag limit of two fish of any size per day in 2010.

Area 2C	Number of Anglers by Subarea							
Halibut Kept	Ketchikan	Prince of Wales. Island	Petersburg-Wrangell	Sitka	Juneau	Haines-Skagway	Glacier Bay	Total Area 2C
1	1,703	1,921	422	3,426	1,716	99	1,442	10,515
2	559	1,662	252	2,459	428	7	807	6,159
3	257	1,362	199	1,411	294	0	633	4,165
4	67	484	102	229	153	0	412	1,466
5	25	83	24	20	75	0	206	455
6	9	29	3	4	13	0	68	130
7	1	8	1	0	5	0	54	70
8	0	5	0	0	1	0	53	59
9	0	2	0	0	0	0	18	20
10+	2	2	0	0	0	0	21	25

Area 3A	Number of Anglers by Subarea							
Halibut Kept	Yakutat	Eastern PWS	Western PWS	North Gulf	Lower Cook Inlet	Central Cook Inlet	Kodiak	Total Area 3A
1	315	647	499	1,572	1,106	482	633	4,862
2	694	2,279	1,616	15,559	22,293	16,163	1,588	55,469
3	117	75	64	287	283	137	352	1,544
4	138	202	114	1,470	4,030	2,377	517	9,831
5	42	27	10	85	95	79	204	662
6	49	33	22	301	799	550	278	2,433
7	10	10	1	23	27	34	125	273
8	9	10	3	74	187	227	148	788
9	3	6	1	7	15	19	43	101
10+	3	23	6	122	212	273	92	802

Table 2. Numbers of halibut harvested by clients and comps on charter trips after the first charter trip of the day in 2010, and estimated harvest reduction associated with a limit of one charter trip per day.

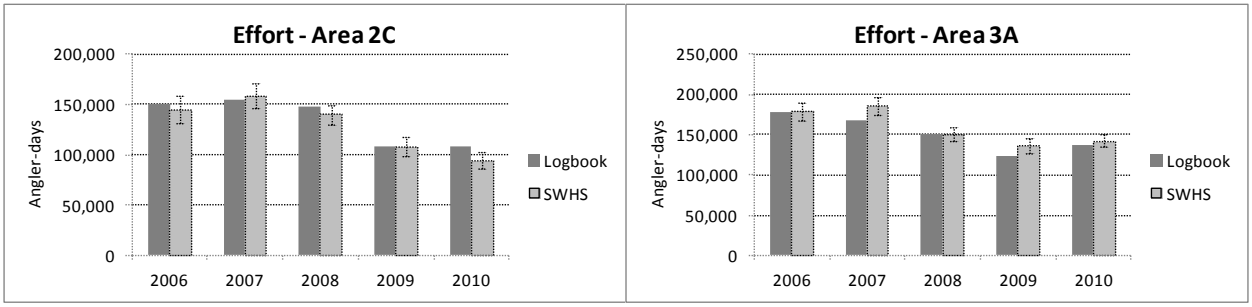
Measure	Area 2C	Area 3A
Total Harvest on All Trips (number of fish)	47,496	204,080
Harvest on Trips After the First Trip	967	14,266
Estimated Harvest Reduction	2.0%	7.0%

Table 3. Example of projected charter yield (M lb net weight) of halibut in Area 2C under various reverse slot length limits. Results are shown for a projected harvest of 45,338 halibut under a scenario of 20% additional high-grading.

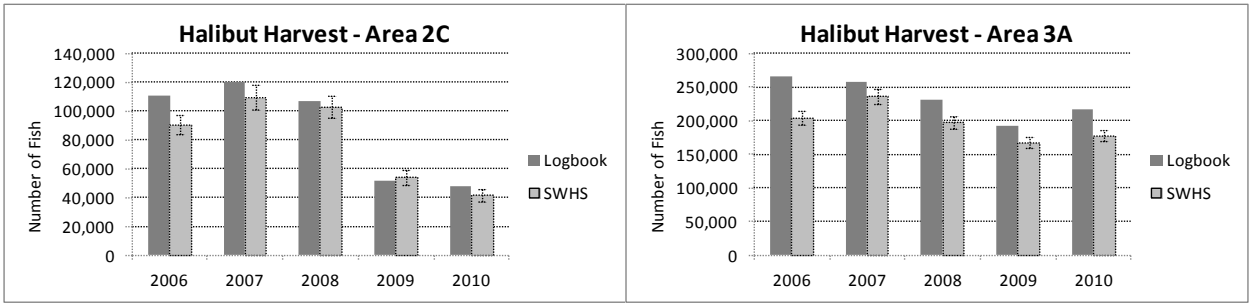
Harvest Level = 45,338, 20% additional high-grading.

Upper (minimum) Size Limit (in)	Lower (maximum) Size Limit (in)										
	35	36	37	38	39	40	41	42	43	44	45
50	1.447	1.395	1.366	1.331	1.314	1.291	1.273	1.258	1.249	1.243	1.242
52	1.442	1.383	1.350	1.311	1.292	1.266	1.245	1.229	1.219	1.214	1.213
54	1.420	1.356	1.321	1.279	1.260	1.233	1.211	1.195	1.185	1.181	1.181
56	1.374	1.308	1.273	1.231	1.212	1.184	1.163	1.148	1.139	1.136	1.138
58	1.336	1.267	1.230	1.187	1.168	1.141	1.121	1.106	1.098	1.097	1.100
60	1.294	1.223	1.185	1.141	1.123	1.098	1.079	1.065	1.058	1.058	1.063
62	1.221	1.152	1.116	1.073	1.058	1.034	1.017	1.005	1.000	1.002	1.009
64	1.114	1.051	1.018	0.981	0.969	0.951	0.938	0.930	0.929	0.934	0.944
66	1.046	0.990	0.959	0.927	0.918	0.904	0.894	0.888	0.888	0.895	0.907
68	0.961	0.917	0.891	0.865	0.862	0.853	0.847	0.844	0.847	0.857	0.871
70	0.884	0.850	0.827	0.808	0.808	0.803	0.801	0.801	0.806	0.818	0.833
72	0.827	0.804	0.785	0.771	0.773	0.772	0.772	0.774	0.781	0.793	0.810
74	0.743	0.736	0.723	0.717	0.724	0.728	0.732	0.736	0.746	0.760	0.779
76	0.702	0.699	0.688	0.685	0.694	0.700	0.706	0.712	0.722	0.738	0.757

Effort



Harvest (numbers of Fish)



Yield (Harvest in M lb)

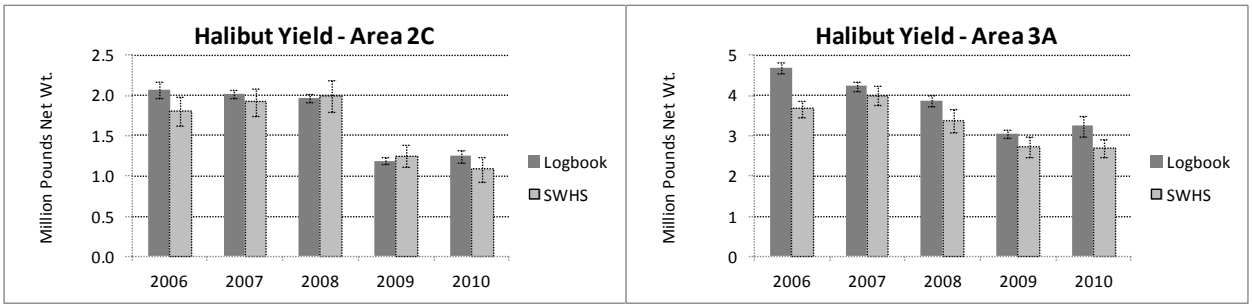


Figure 1. Comparison of effort for all species (angler-days) and halibut harvest (numbers of fish) reported in logbooks and estimated by the ADF&G Statewide Harvest Survey, 2006-2010.