Issues in Selecting a Maximum Length Limit to Manage Charter Halibut Harvest in Times of Low Abundance

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Introduction

In October 2008 the North Pacific Fishery Management Council selected its preferred alternative to replace the current Guideline Harvest Level Program with a catch-sharing plan that establishes an allocation between the charter sector and commercial setline sector in Area 2C and Area 3A.[1] Under the plan, the Council would annually request that the International Pacific Halibut Commission (IPHC) set a combined charter and setline catch limit (CCL). The CCL, along with projected charter harvests, would determine the daily bag limit and/or size-limit regulations governing charter clients. It is the Council's intent that the bag limit and/or maximum size limits be implemented with annual IPHC regulations, and not be subject to separate Council review/action and NMFS rulemaking. Therefore, these tiers would be implemented in NMFS regulations under the Council's October 2008 preferred alternative and published in an annual notice prior to the start of the charter halibut fishery. The regulations, therefore, need to explicitly describe the tiers, the resulting management measure, and how the management measure was selected.[2] No action would be required by the IPHC other than to set a combined charter and commercial catch limit. NMFS would identify the management measures to be in effect for the charter sector in the next season based on the projected charter sector harvest as a percentage of the combined catch limit and the tiers with corresponding management measures that would have been published in regulations.

The management measures fall into four tiers for each IPHC area. While the daily bag limit and size limit regulations in Tiers 3 and 4 are specific, the maximum size regulations in Tiers 1 and 2 are undefined as the Council intends to provide flexibility to fishery managers in time of low abundance by reducing harvest while having the least effect on the charter industry and its clients. The Council's language states that under both Tier 1 and 2, the Charter Fishery will operate under a one-fish daily bag limit. However, if the charter harvest as a percentage of the combined charter and setline catch limit exceeds a specified percentage in either Tier *then a maximum size limit will be implemented to reduce the projected harvest level to be lower than x.x%*[3] *of the combined charter and setline catch limit* (See Table 1 and Table 2).

Table 1 Area 2C Proposed Management Regulations

Tier	Combined Catch Limit (million lb)	Allocation	Charter Fishery Bag & Size Limit Regulations		
			If charter harvest within allocation range	If charter harvest projected to exceed allocation range	If charter harvest projected to be below allocation range
1	<5	Comm alloc = 82.7% Charter alloc = 17.3% Charter range = 13.8-20.8%	One Fish	Maximum size limit imposed that brings harvest to 17.3%	One Fish
2	≥5 - <9	Comm alloc = 84.9% Charter alloc = 15.1% Charter range = 11.6-18.6%	One Fish	Maximum size limit imposed that brings harvest to 15.1%	Two fish, but one must be less than 32" in length
3	≥9 - <14	Comm alloc = 84.9% Charter alloc = 15.1% Charter range = 11.6-18.6%	Two fish, one must be less than 32" in length	One Fish	Two Fish
4	≥14	Comm alloc = 84.9% Charter alloc = 15.1% Charter range = 11.6-18.6%	Two Fish	Two fish, but one must be less than 32" in length	Two Fish

Source: Prepared by Scott Meyer, ADF&G, 2008.

[1] The Council's motion is attached to the end of this document.
[2] The regulations will also need to describe how the charter halibut projections would be determined, but that will be the subject of a separate discussion paper.
[3] This number changes with IPHC Area and Tier. In Area 2C this number is equal to 17.3 percent in Tier 1 and 15.1 percent in Tier 2. In Area 3A this number is equal to 15.4 percent for Tier 1 and 14.0 percent for Tier 2.

Table 2 Area 3A Proposed Management Regulations

Tier	Combined Catch Limit (million lb)	Allocation	Charter Fishery Bag & Size Limit Regulations		
			If charter harvest within allocation range	If charter harvest projected to exceed allocation range	If charter harvest projected to be below allocation range
1	<10	Comm alloc = 84.6% Charter alloc = 15.4% Charter range = 11.9-18.9%	One Fish	Maximum size limit imposed that brings harvest to 15.4%	One Fish
2	≥10 - <20	Comm alloc = 86.0% Charter alloc = 14.0% Charter range = 10.5-17.5%	One Fish	Maximum size limit imposed that brings harvest to 14.0%	Two fish, but one must be less than 32" in length
3	≥20 - <27	Comm alloc = 86.0% Charter alloc = 14.0% Charter range = 10.5-17.5%	Two fish, one must be less than 32" in length	One Fish	Two Fish
4	≥27	Comm alloc = 86.0% Charter alloc = 14.0% Charter range = 10.5-17.5%	Two Fish	Two fish, but one must be less than 32" in length	Two Fish

Source: Prepared by Scott Meyer, ADF&G, 2008.

The lack of a specific length in the length limit language in Tiers 1 and 2 raises important technical questions about how to implement this component of the preferred alternative. The following issues/questions are posed to the Scientific and Statistical Committee (SSC) so that its guidance can be incorporated into the Secretarial Review draft of the analysis of the Council's preferred alternative. This guidance will be presented to the Council as part of the NMFS report to the Council (Agenda B-2) on the CSP implementation plan at a future Council meeting.

Key Technical Questions

Which Analytical Method?

What method should the analyst use to determine the effect of the each potential length limit? Analyses conducted for the NPFMC in 2007 and 2008 and NMFS in 2008 used two different methods:

a) Method A: Use creel survey data to assume that anglers would keep the average fish previously kept under the bag limit. We have empirical evidence that this method overestimated the effect of the management measure in the context of a two-fish bag limit.

b) Method B: Assume that all anglers could high-grade up to the maximum length limit. This second method resulted after Method A underestimated anglers' ability to high-grade. We also note that the lower the size limit, the easier it will be for anglers to high-grade to the size limit. This method would be the preferred method for ensuring that the analysis accounted for as much high-grading as possible given recent evidence that anglers may be better at high grading than was previously estimated.

We provide examples showing the differences between these two methods following this section.

Which Maximum Length?

There will likely be a number of maximum lengths that reduce the harvest to below the stated target. Which size limit should be chosen? Given the relative risk of over or under-harvest by the charter industry, discussed later, it might seem advisable to have a different rule for selecting the appropriate maximum length, depending on the estimation method. Under Method A, where the probability of over-harvest is highest, it might be advisable to select a more conservative maximum length, but by what rule? Under Method B, where under-harvest will be a greater concern for industry, it may make sense to select the largest length limit that "best guarantees" the charter industry will not exceed its allocation under the estimated harvest and effort levels.

In the examples for each estimation method below, we use the "closest without going over" rule.

Demand (client effort) Reductions

Should the estimation account for a reduction in angler demand for charter trips because of the length-restricted one-fish bag limit? If so, what magnitude of demand reduction will be used? We have consistently noted the lack of data on reductions in demand. Assuming a one-fish bag limit is in place in Area 2C in 2009, we may begin to gather some data on the effect of that measure on demand for charter trips, but we will have no data on the additional effect a size limit, particularly under a one-fish bag limit, could have on charter demand. We assume that the initial projection the analyst makes may include some adjustment for demand, but would the analyst have to make another projection of the number of fish harvested/effort because of the size limit? If yes, what parameters would guide that adjustment?

Availability of Smaller Fish

ADF&G staff members have suggested that finding smaller fish could be difficult in some areas under certain size limits. However, there are very limited data on this issue. During the 2008 Area 2C charter fishery, approximately ten percent of the Area harvest was under 23 inches, but angler retention of fish of lower sizes is not likely to be a good predictor of relative abundance given that anglers will likely keep larger fish whenever possible. In addition, ADF&G does not regularly collect data on the length of released fish. Harvest data do show that size frequencies and harvest vary within an IPHC Area and we expect that this means a length limit will have differing effects on angler success depending on the sub-Area fished. In spite of this expectation, we note the lack of data required to develop an accurate iterative process that adjusts harvest per unit of effort (HPUE) estimates for small fish availability.

Predicting Out-of-Sample

How will the analyst calculate an average weight for an "unrestricted" fish if the fishery has been operating under a length limit restriction? For example, the analyst may be asked to predict mean weight under a one-fish bag limit when the fishery has been operating under a one-fish bag limit with a maximum size limit. Alternately, the analyst may be asked to predict weight under a two-fish bag limit when the fishery has been operating under a two-fish bag limit with maximum length on one fish. It is not possible for ADF&G to distinguish length data between "first" and "second" fish in a daily bag limit. The analyst may be forced to use the long-term average or median in the fishery when the fishery was unrestricted if no other data are available. In the examples we use the long-term average for Area 2C (see Table 3).[4] One possible solution beyond the use of the long-term average or median is to use the most recent IPHC survey data; these data have been shown in past years to closely match the size composition of the sport (charter + unguided) harvest when there were no size limits. It might be possible to predict charter from longline if there is a consistent relationship.

[4] For these examples we assume an unrestricted mean weight of 19.3 lb based on 1999-2006 harvests, and size composition based on 2006. However, all that base data was from years where the fishery had a two-fish bag limit without size limits. We suspect that size composition will be different under a one-fish bag limit. If the size distribution keeps its shape but shifts to the right in 2009 under a one-fish limit (no size restriction), then higher size limits than the ones predicted using 2006 data will achieve the necessary harvest reductions. However, we suspect that under a one-fish bag limit the size distribution will simply broaden (same floor, mode shifts to the right). While using the 2006 tables may be the best solution for these examples, the best long-term practice would be to use distribution data from the most recent year without a length limit. For example, if a size limit were needed in 2010 to stay within the allocation, you would start with, say, the 2009 size distribution (one-fish bag limit, no size limit).

Table 3. Average Weight per Harvested Halibut in the Area 2C Charter Fishery 1999-2006

Year	1999	2000	2001	2002	2003	2004	2005	2006	Average
Average Weight (lb.)	17.8	19.8	18.1	19.7	19.1	20.7	19.1	19.9	19.3

Source: Alaska Department of Fish and Game, 2008.

Estimation Examples

For discussion purposes, the following section contains two examples of how the analyst might calculate the effect of moving from a one-fish bag limit with a fish of any size to a one-fish bag limit with a maximum size limit. In both cases, we assume that the analyst is starting from a position of having previously made an estimate of harvest under the one-fish bag limit.[5] The two examples use the methods described in 2a and 2b above.

Example 1: Weight of the Average Fish Under the Limit (Creel Survey Based Distribution)

This example shows how Method A, described above, could work. This method replicates the analytical method used in June 2007 when NMFS instituted an emergency rule for the charter halibut fishery in Area 2C. The rule maintained the two-fish daily bag limit, but limited the second fish in an angler's daily bag limit to a length equal to or less than 32 inches. The analysis for this rule assumed that anglers would catch and keep the average fish anglers had kept below 32 inches prior to the institution of the rule. The calculation of the "average" fish below the limit was based on 2006 creel survey data collected by ADF&G. This scenario meant there were no adjustments for high-grading behavior on the part of anglers or changes in stock composition. Data from the 2007 fishery suggest that this method overestimated the effect of the maximum size limit and that anglers were able to high-grade their catch to a length closer to the limit. However, as ADF&G does not collect creel data on the "first fish, second fish" level, it is impossible to know what the actual length was of the "second" fish kept by anglers.[6]

For this example, let us assume that the IPHC has set the Area 2C combined catch limit at 5.5 Mlb. This limit would place the charter sector in Tier 2 at a one-fish bag limit. The analyst has taken this information and projected a harvest under the one-fish bag limit of 1.6 Mlb for the upcoming season. This amount equals 29.0 percent of the combined catch limit and exceeds the 18.6 percent limit in Tier 2 of the preferred alternative. A projection that the charter industry will exceed the 18.6 percent limit will result in the imposition of a length limit to reduce harvest to no more than 15.1 percent of the combined catch limit, in this case equal to 803,500 lb. Reducing harvest from 1.6 Mlb to 803,500 lb requires a 48.1 percent reduction in harvest. This level can be stated alternately as reducing harvest to 51.9 percent of the original harvest estimate.

[5] We assume that the analyst will make projection of current year's harvest after the IPHC has released its combined charter/commercial setline limit. The unspecified maximum size limit will come into play i) if the IPHC's combined limit is within Tier 1 or Tier 2 and ii) the initial harvest projection as a percentage of the limit exceeds the maximum specified by the Council.

[6] If all "second fish" in Area 2C in 2007 were exactly the maximum length allowed of 32" (10.7 lb), then mean wt of "first fish" would have to rise from 19.6 lb in 2006 to 21.7 lb in 2007 for the overall Area 2C mean to be 17.5 lb. While it is theoretically possible that the mean weight of unrestricted fish could have risen that much for biological reasons, it is more likely that anglers were successful at high-grading a portion of their "first" fish during the season.

In order to create a "realistic" example, we have to outline the rules the analyst must follow during the analysis. If anything, this list of rules shows how complicated calculating the effect of the maximum size limit may be and the amount of guidance that the analyst will need before moving ahead. A strict set of rules endorsed by the SSC should alleviate concerns of bias by either sector. For this example, let us also assume that the analyst has the following instructions:

- The analysis should assume that anglers keep the average fish caught below the category maximum based on Area 2C 2006 harvest data.
- There are no changes in effort or harvest per unit of effort. This assumption means no change in the number of fish harvested associated with the maximum length regulation. The analyst may have previously predicted year-to-year changes based on other factors (e.g., biology).[7]
- The analyst is to select the least restrictive length limit that brings harvest below the specified level.

The example starts from the point of the analyst having established a harvest or effort estimate for an unrestricted one-fish bag limit. In this case, the estimated effect of the length regulation is the same as the ratio between the maximum expected average weight of the fish under the length regulation and the average weight under the one-fish bag limit. For this example, assume that the analyst has been instructed to assume that the average fish weight in the prior year's "unrestricted" fishery was 19.3 pounds, which is approximately the same as the median average weight seen in the Area 2C fishery between 1999 and 2006. The longest length limit that reduces the average weight of caught halibut to no more than 51.9 percent of the estimated unrestricted harvest weight is the 38" length limit (see Table 6).

Table 4 Estimated Restricted Harvest as a Percentage of Predicted Unrestricted One-Fish Harvest

Max Allowed Fork Length (in)		24	26	28	30	32	34	36	38	40
Average Weight of Fish Below the Max Fork Length (lb.)		3.6	4.5	5.3	6.0	6.9	7.6	8.4	9.2	10.0
Assumed Current Year Average Weight Under A One-Fish Bag Limit	17.5	20.5%	25.8%	30.3%	34.5%	39.2%	43.7%	48.2%	52.8%	57.4%
	17.7	20.3%	25.5%	30.0%	34.1%	38.7%	43.2%	47.7%	52.2%	56.7%
	17.9	20.1%	25.2%	29.6%	33.7%	38.3%	42.7%	47.2%	51.6%	56.1%
	18.1	19.8%	24.9%	29.3%	33.3%	37.9%	42.3%	46.6%	51.1%	55.5%
	18.3	19.6%	24.6%	29.0%	33.0%	37.4%	41.8%	46.1%	50.5%	54.9%
	18.5	19.4%	24.4%	28.7%	32.6%	37.0%	41.3%	45.6%	50.0%	54.3%
	18.7	19.2%	24.1%	28.4%	32.3%	36.6%	40.9%	45.1%	49.4%	53.7%
	18.9	19.0%	23.9%	28.1%	31.9%	36.3%	40.5%	44.7%	48.9%	53.1%
	19.1	18.8%	23.6%	27.8%	31.6%	35.9%	40.0%	44.2%	48.4%	52.6%
	19.3	18.6%	23.4%	27.5%	31.3%	35.5%	39.6%	43.7%	47.9%	52.0%
	19.5	18.4%	23.1%	27.2%	30.9%	35.1%	39.2%	43.3%	47.4%	51.5%
	19.7	18.2%	22.9%	26.9%	30.6%	34.8%	38.8%	42.9%	46.9%	51.0%
	19.9	18.0%	22.7%	26.6%	30.3%	34.4%	38.4%	42.4%	46.4%	50.4%
	20.1	17.9%	22.4%	26.4%	30.0%	34.1%	38.1%	42.0%	46.0%	49.9%
	20.3	17.7%	22.2%	26.1%	29.7%	33.8%	37.7%	41.6%	45.5%	49.4%
	20.5	17.5%	22.0%	25.9%	29.4%	33.4%	37.3%	41.2%	45.1%	49.0%
	20.7	17.3%	21.8%	25.6%	29.1%	33.1%	37.0%	40.8%	44.6%	48.5%
	20.9	17.2%	21.6%	25.4%	28.9%	32.8%	36.6%	40.4%	44.2%	48.0%
	21.1	17.0%	21.4%	25.1%	28.6%	32.5%	36.3%	40.0%	43.8%	47.6%

Source: Northern Economics estimates, 2008.

[7] We note that the analyst does not have to worry about the year to year variation in HPUE because he/she should be starting from a one-fish bag limit estimate that may already incorporate that change. In this case, the angler will need guidance on changes in HPUE associated with targeting a specific portion of the halibut population.

Table 5 shows the same information as measured by "expected harvest reduction" (as opposed to expected harvest as a percentage of original harvest). In other words, which length limit results in at least a 48.1 percent predicted harvest reduction? Again, the 38" limit is the smallest maximum length limit that predicts at least a 48.1 percent harvest reduction. The 40" limit would only reduce estimated harvest by 48.0 percent.[8]

Table 5 Estimated Percent Harvest Reduction Moving From a One-Fish Bag Limit to a One-Fish Bag Limit with a Maximum Length Assuming Anglers Catch the Average Fish Under the Fork Length

Max Allowed Fork Length (in) Average Weight of the Average Fish Below the Max Fork Length (lb.)		24 3.6	26 4.5	28 5.3	30 6.0	32 6.9	34 7.6	36 8.4	38 9.2	40 10.0
Assumed Current Year Average Weight Under A One-Fish Bag Limit	17.5	79.5%	74.2%	69.7%	65.5%	60.8%	56.3%	51.8%	47.2%	42.6%
	17.7	79.7%	74.5%	70.0%	65.9%	61.3%	56.8%	52.3%	47.8%	43.3%
	17.9	79.9%	74.8%	70.4%	66.3%	61.7%	57.3%	52.8%	48.4%	43.9%
	18.1	80.2%	75.1%	70.7%	66.7%	62.1%	57.7%	53.4%	48.9%	44.5%
	18.3	80.4%	75.4%	71.0%	67.0%	62.6%	58.2%	53.9%	49.5%	45.1%
	18.5	80.6%	75.6%	71.3%	67.4%	63.0%	58.7%	54.4%	50.0%	45.7%
	18.7	80.8%	75.9%	71.6%	67.7%	63.4%	59.1%	54.9%	50.6%	46.3%
	18.9	81.0%	76.1%	71.9%	68.1%	63.7%	59.5%	55.3%	51.1%	46.9%
	19.1	81.2%	76.4%	72.2%	68.4%	64.1%	60.0%	55.8%	51.6%	47.4%
	19.3	81.4%	76.6%	72.5%	68.7%	64.5%	60.4%	56.3%	52.1%	48.0%
	19.5	81.6%	76.9%	72.8%	69.1%	64.9%	60.8%	56.7%	52.6%	48.5%
	19.7	81.8%	77.1%	73.1%	69.4%	65.2%	61.2%	57.1%	53.1%	49.0%
	19.9	82.0%	77.3%	73.4%	69.7%	65.6%	61.6%	57.6%	53.6%	49.6%
	20.1	82.1%	77.6%	73.6%	70.0%	65.9%	61.9%	58.0%	54.0%	50.1%
	20.3	82.3%	77.8%	73.9%	70.3%	66.2%	62.3%	58.4%	54.5%	50.6%
	20.5	82.5%	78.0%	74.1%	70.6%	66.6%	62.7%	58.8%	54.9%	51.0%
	20.7	82.7%	78.2%	74.4%	70.9%	66.9%	63.0%	59.2%	55.4%	51.5%
	20.9	82.8%	78.4%	74.6%	71.1%	67.2%	63.4%	59.6%	55.8%	52.0%
	21.1	83.0%	78.6%	74.9%	71.4%	67.5%	63.7%	60.0%	56.2%	52.4%

Source: Northern Economics estimates, 2008.

Example 2: Assumption of Maximum High Grading

As an example of Method B described above (i.e., the assumption of maximum high-grading method), let us make the same assumptions as in example 1. To review, charter harvest must be reduced to no more than 15.1% of the combined catch limit, or 803,500 lb. This limit requires a 48.1% reduction in harvest. The analyst assumes no change in the number of fish harvested, and an average weight of 19.3 lb in an unrestricted fishery.

The only difference in this scenario is that we assume that anglers will high-grade to the maximum length allowed by the management measure.

Again, as we are starting from the point of having a harvest estimate under a one-fish bag limit, the estimated effect of the length regulation is the same as the ratio between the maximum expected average weight of the fish under the length regulation and the average weight under the one-fish bag limit. The

[8] We note that "knife's edge" difference between the reduction required by the Council's language and the estimated reduction associated with the 40" limit. The 40" limit is 0.1% away from meeting the Council's language. We suspect that such close margins will result in consternation in the charter industry given the potential for different size limits to affect the demand for charter trips.

longest length that reduces harvest to no more than 51.9 percent of the predicted unrestricted level is the 30 inch maximum (Table 7).

Table 6 Estimated Restricted Harvest as a Percentage of Predicted Unrestricted One-Fish Harvest s-Maximum Length Method

Max Allowed Fork Length (in)		24	26	28	30	32	34	36	38	40
Projected Average Weight (lb.)		4.2	5.4	6.9	8.7	10.7	13.0	15.6	18.6	22.0
Assumed Current Year Average Weight Under A One-Fish Bag Limit	17.5	24.0%	31.1%	39.6%	49.5%	61.0%	74.3%	89.4%	106.5%	125.7%
	17.7	23.8%	30.8%	39.1%	48.9%	60.3%	73.4%	88.4%	105.3%	124.3%
	17.9	23.5%	30.4%	38.7%	48.4%	59.7%	72.6%	87.4%	104.1%	122.9%
	18.1	23.2%	30.1%	38.3%	47.9%	59.0%	71.8%	86.4%	103.0%	121.6%
	18.3	23.0%	29.8%	37.9%	47.3%	58.4%	71.0%	85.5%	101.8%	120.2%
	18.5	22.7%	29.5%	37.4%	46.8%	57.7%	70.3%	84.5%	100.7%	118.9%
	18.7	22.5%	29.1%	37.0%	46.3%	57.1%	69.5%	83.6%	99.7%	117.7%
	18.9	22.2%	28.8%	36.7%	45.8%	56.5%	68.8%	82.8%	98.6%	116.4%
	19.1	22.0%	28.5%	36.3%	45.4%	55.9%	68.0%	81.9%	97.6%	115.2%
	19.3	21.8%	28.2%	35.9%	44.9%	55.3%	67.3%	81.0%	96.6%	114.0%
	19.5	21.6%	27.9%	35.5%	44.4%	54.8%	66.6%	80.2%	95.6%	112.8%
	19.7	21.3%	27.7%	35.2%	44.0%	54.2%	66.0%	79.4%	94.6%	111.7%
	19.9	21.1%	27.4%	34.8%	43.5%	53.7%	65.3%	78.6%	93.6%	110.6%
	20.1	20.9%	27.1%	34.5%	43.1%	53.1%	64.7%	77.8%	92.7%	109.5%
	20.3	20.7%	26.8%	34.1%	42.7%	52.6%	64.0%	77.0%	91.8%	108.4%
	20.5	20.5%	26.6%	33.8%	42.3%	52.1%	63.4%	76.3%	90.9%	107.3%
	20.7	20.3%	26.3%	33.5%	41.9%	51.6%	62.8%	75.6%	90.0%	106.3%
	20.9	20.1%	26.1%	33.1%	41.5%	51.1%	62.2%	74.8%	89.2%	105.3%
	21.1	19.9%	25.8%	32.8%	41.1%	50.6%	61.6%	74.1%	88.3%	104.3%

Source: Northern Economics estimates, 2008.

Table 7 shows the same information from a different perspective: what is the highest maximum length limit that results in an estimated harvest reduction of at least 48.1 percent? Again, the answer is the 30-inch length limit, as a 32-inch length limit would only reduce estimated harvest by 44.7 percent.

Table 7 Estimated Percent Harvest Reduction Moving From a One-Fish Bag Limit to a One-Fish Bag Limit with a Maximum Length Assuming All Anglers High-Grade to the Maximum Fork Length within the Size Category

Max Allowed Fork Length (in)		24	26	28	30	32	34	36	38	40
Projected Average Weight (lb.)		4.2	5.4	6.9	8.7	10.7	13.0	15.6	18.6	22.0
Assumed Current Year Average Weight Under A One-Fish Bag Limit	17.5	76.0%	68.9%	60.4%	50.5%	39.0%	25.7%	10.6%	-6.5%	-25.7%
	17.7	76.2%	69.2%	60.9%	51.1%	39.7%	26.6%	11.6%	-5.3%	-24.3%
	17.9	76.5%	69.6%	61.3%	51.6%	40.3%	27.4%	12.6%	-4.1%	-22.9%
	18.1	76.8%	69.9%	61.7%	52.1%	41.0%	28.2%	13.6%	-3.0%	-21.6%
	18.3	77.0%	70.2%	62.1%	52.7%	41.6%	29.0%	14.5%	-1.8%	-20.2%
	18.5	77.3%	70.5%	62.6%	53.2%	42.3%	29.7%	15.5%	-0.7%	-18.9%
	18.7	77.5%	70.9%	63.0%	53.7%	42.9%	30.5%	16.4%	0.3%	-17.7%
	18.9	77.8%	71.2%	63.3%	54.2%	43.5%	31.2%	17.2%	1.4%	-16.4%
	19.1	78.0%	71.5%	63.7%	54.6%	44.1%	32.0%	18.1%	2.4%	-15.2%
	19.3	78.2%	71.8%	64.1%	55.1%	44.7%	32.7%	19.0%	3.4%	-14.0%
	19.5	78.4%	72.1%	64.5%	55.6%	45.2%	33.4%	19.8%	4.4%	-12.8%
	19.7	78.7%	72.3%	64.8%	56.0%	45.8%	34.0%	20.6%	5.4%	-11.7%
	19.9	78.9%	72.6%	65.2%	56.5%	46.3%	34.7%	21.4%	6.4%	-10.6%
	20.1	79.1%	72.9%	65.5%	56.9%	46.9%	35.3%	22.2%	7.3%	-9.5%
	20.3	79.3%	73.2%	65.9%	57.3%	47.4%	36.0%	23.0%	8.2%	-8.4%
	20.5	79.5%	73.4%	66.2%	57.7%	47.9%	36.6%	23.7%	9.1%	-7.3%
	20.7	79.7%	73.7%	66.5%	58.1%	48.4%	37.2%	24.4%	10.0%	-6.3%
	20.9	79.9%	73.9%	66.9%	58.5%	48.9%	37.8%	25.2%	10.8%	-5.3%
	21.1	80.1%	74.2%	67.2%	58.9%	49.4%	38.4%	25.9%	11.7%	-4.3%

Source: Northern Economics estimates, 2008.

What is the Functional Difference between the Two Methods?

The functional difference between the two methods is who bears the risk associated with the assumptions. Under Method A (e.g., the average weight method), the risk is primarily born by the halibut stock while under Method B the risk is primarily born by charter anglers and the charter fleet. Data from the 2007 Area 2C halibut fishery suggests that anglers were able to catch fish larger than the average size below the length limit that NMFS instituted in 2007. ADF&G staff discussed these issues at the December 2008 NPFMC meetings. However, those data do not tell us how much anglers were able to high-grade. Additionally, those data also show that changes in HPUE and overall effort can overwhelm changes in average weight. Under Method A, if anglers, on average, are able to high-grade, then the charter fishery will exceed the target allocation under the maximum length limit. For example, in our examples we used an "unrestricted one-fish per day" harvest of 1.6 Mlb with an average weight of 19.3 lbs per fish. These numbers suggest a harvest of 82,900 fish under a one-fish per day fishery.[9] Table 8 shows the potential over-harvest above target levels if Method A is used to set the length limit and anglers are able to high-grade. Example A set a maximum length limit of 38 inches, but the average fish caught in 2006 that was 38 inches or less in length measured less than 32 inches and weighed an average just less than 9.2 pounds (ADF&G 2008). A harvest of 82,900 fish weighing just less than 9.2 pounds will weigh approximately 766,000 pounds (equal to 13.9 percent of the CCL); an under harvest of 37,000 pounds. Remember our

[9] Recent "first fish" harvests have been closer to 55,000 fish.

target is no more than 15.1 percent of the CCL. If anglers are able to high-grade, on average, to the 32-inch length, then the charter fishery will over-harvest by 82,000 pounds or 10.2 percent, and the charter sector's portion of the CCL would violate the 15.1 percent allocation set in the Council's preferred alternative. The more successful anglers are at high grading fish to close to the maximum length allowed by the regulations, the higher the levels of over-harvest. We believe that anglers would be able to high grade successfully above the average below the length limit as the median fish in 2006 Area 2C fishery was between 32 and 34 inches in length while the average fish was over 38 inches.

Table 8. Potential Over-harvest Levels under Example 1/Method A

Over Harvest if the Average fish is...	The Predicted Average of 9.2 lbs	Larger than Predicted: 32" and 10.7 lbs	Larger than Predicted: 34" and 13.0 lbs	Larger than Predicted: 36" and 15.6 lbs	Larger than Predicted: 38" and 18.6 lbs
Pounds	-37,000	82,000	274,000	493,000	741,000
Percentage	-4.6%	10.2%	34.1%	61.4%	92.3%
Charter CCL Portion	13.9%	16.1%	19.6%	23.6%	28.1%

Source: Northern Economics estimates, 2008.

Method B would eliminate the over-harvest risk associated with high grading as it would restrict anglers to a 30-inch maximum length limit. However, it reduces the ability of the charter sector to harvest to their sector allocation in exchange for that reduction in risk.[10] Harvesting 82,900 30-inch fish would result in an approximate total harvest weight just over 718,000 pounds. This amount is slightly greater than 85,000 pounds under the 803,500 allocation to the charter industry; an under-harvest of 10.6 percent (see Table 9). In this situation, the charter industry would be allowed to harvest 13.1 percent of the CCL instead of the 15.1 percent allocated by the Council. We note that if anglers were unable to find 82,900 30-inch fish and had to settle for smaller fish, then the under-harvest would grow substantially. If anglers can only harvest an average of a 28-inch fish, then total harvest will equal 565,800 for an under-harvest of nearly 30 percent.[11]

Table 9. Potential Under-harvest Levels Under Example 2/Method B

Under Harvest if the Average fish is...	The Maximum Allowed: 30" and Weighs 8.7 lbs	Smaller than Allowed: 28" and Weighs 6.9 lbs	Smaller than Allowed: 26" and Weighs 5.4 lbs	Smaller than Allowed: 24" and Weighs 4.2 lbs
Pounds	86,000	229,000	352,000	455,000
Percentage	10.6%	28.5%	43.8%	56.6%
Charter CCL Portion	13.1%	10.4%	8.2%	6.3%

Source: Northern Economics estimates, 2008.

While these examples show the clear difference in risk burden, they do not address the underlying changes that could exacerbate or mitigate the over and under-harvest risk. For example, how many anglers will pay to fish for a 30-inch halibut with a one-fish daily bag limit? Method B, the more biologically conservative, will result comparatively lower length limits than Method A. We presume that lower length limits will result in a higher risk of anglers choosing not to come to Alaska. On the other hand, the risk associated with Method B may be mitigated by the fact that in time of low biological abundance, it may be very difficult for anglers to consistently high-grade. These are unanswered, and currently unanswerable, issues which will make managing the fishery challenging in times of low abundance.

[10] We note that there is still over-harvest risk from changes in demand or HPUE.

[11] We note that the potential for under-harvest could be reduced by managing in one-inch increments instead of two-inch increments.

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