An update on the IPHC Management Strategy Evaluation (MSE)

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PURPOSE

To update the Commission on the task assigned to IPHC staff and the Management Strategy Advisory Board (MSAB) at the 2016 Annual Meeting (AM092) to review and provide recommendations for updating the harvest policy and harvest control rules[1].

BACKGROUND

At the 2013 Annual Meeting (AM89), the International Pacific Halibut Commission (IPHC or Commission) advanced the development of a Management Strategy Evaluation (MSE) program for the Pacific halibut resource. The Commission approved the formation of a Management Strategy Advisory Board (MSAB) to oversee the MSE process and to advise the Commission and Staff on the development and evaluation of candidate objectives and strategies for managing the fishery. The MSE process will help the Commission develop and thoroughly test alternative management procedures, prior to implementing any management changes for the fishery. At the 2016 Annual Meeting (AM092), the Commission specifically tasked the IPHC staff and the MSAB to review and provide recommendations for updating the harvest policy and harvest control rules[1].

Dr. Allan Hicks was hired in April 2016 to replace Dr. Steve Martell as a quantitative scientist at the Commission with a focus on MSE and harvest policy analysis. A 2-year workplan[2] was developed outlining a schedule for implementing a MSE to investigate management procedures for the Pacific halibut fishery. The draft workplan was provided to the MSAB07 in May 2016. The workplan was revised by the MSAB08 meeting in October 2016.

As tasked by the Commission, and described in the workplan, an evaluation of the current harvest policy was undertaken and presented at MSAB08. The current harvest policy is the procedure that takes the coastwide stock assessment as an input and outputs the coastwide Total Constant Exploitation Yield (TCEY) across all Regulatory Areas, as well as the TCEY and FCEY for each Regulatory Area (Fig. 1).

The scaling of the current harvest policy revolves around the concept of exploitable biomass (EBio), which is based on externally derived selectivity curves that are not representative of the current stock assessment results. EBio is apportioned to Regulatory Areas using the apportionment results from the O32 weight-per-unit-effort (WPUE) estimates from the fishery-independent setline survey.

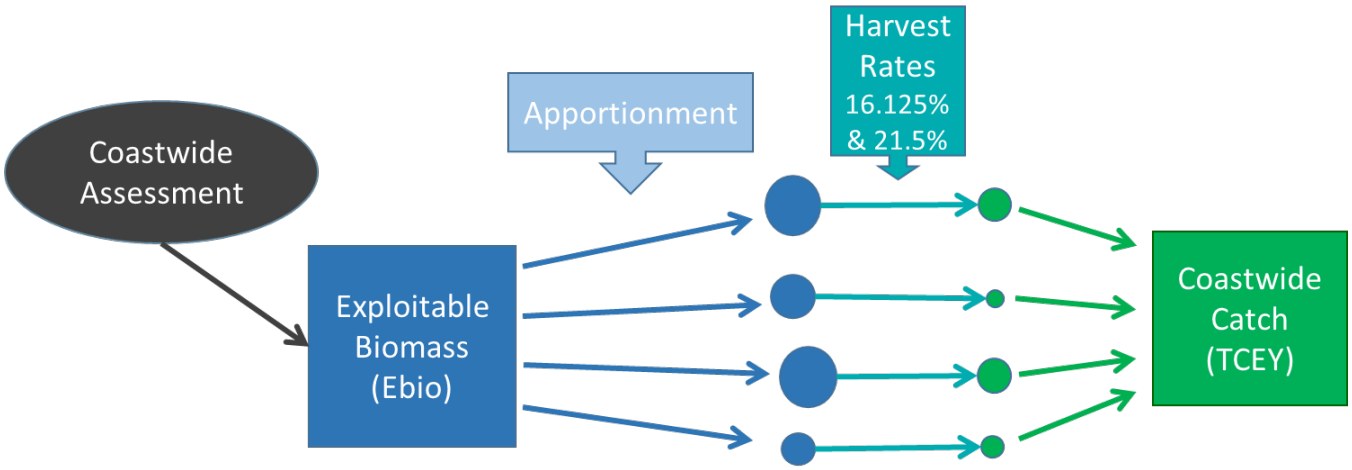

Figure 1. A pictorial description of the current (Blue Line) harvest policy.

Harvest rates are then applied to the EBio in each Regulatory Area to compute the area-specific catch levels (TCEY). A harvest rate of 16.125% is used for western areas (3B, 4A, 4B, and 4CDE) and 21.5% for eastern areas (3A, 2C, 2B, and 2A). These harvest rates are based on O26 fish and are lower in the west due to the presence of small fish, a lower yield-per-recruit and greater uncertainty in historical analyses. These harvest rates are explicitly linked to EBio and one cannot be changed without reconsidering the other.

The harvest rates are reduced via a control rule if the coastwide stock status is below 30% of unfished equilibrium spawning biomass (SB_0), and set to zero if the coastwide stock status is below 20% of SB_0. The unfished equilibrium spawning biomass is determined from estimates of average recruitment during poor environmental conditions and periods of good (large) size-at-age.

The catch levels consistent with this harvest policy are reported as the current Blue Line, which was originally designed to meet five objectives:

1) avoid very low stock sizes;
2) mostly avoid low stock sizes (80% of the time);
3) achieve most of MSY (80% of the time);
4) reduce variability in catch; and
5) distribute removals in proportion to the current stock biomass (i.e. preserve biocomplexity).

It is important to note that unlike management under the Magnuson-Stevens Fishery Conservation and Management Act, there is no target stock size and no overfishing limit.

There are three major problems with the current IPHC harvest policy. First, the current harvest policy begins with a coastwide assessment, apportions into Regulatory Areas, and then sums it all back into a coastwide catch. This confounds the level of fishing intensity (scale) with the distribution of that fishing intensity among Regulatory Areas. Second, as mentioned above, EBio is inconsistent with the current assessment results. Thirdly, the mortality of U26 fish is not

explicitly accounted for in annual calculations, meaning the mortality of U26 fish could increase or decrease without any change to the results of the harvest policy. Instead, the U26 mortality will be indirectly realized when the expected productivity is not realized in later years.

A simple change to the procedure, separating the scale and distribution of fishing mortality, can eliminate these problems. By first defining an acceptable level of fishing mortality that operates on OZero fish (over zero inches), the procedure can be simplified, eliminate EBio, and account for mortality on all sizes of fish. Figure 2 shows this procedure where F_{SPR} (defined below) defines the fishing intensity, apportionment remains the same as in the current harvest policy, and relative harvest rates simply define the relative intensity of fishing in each area (e.g. maintaining higher target fishing intensity in eastern Regulatory Areas).

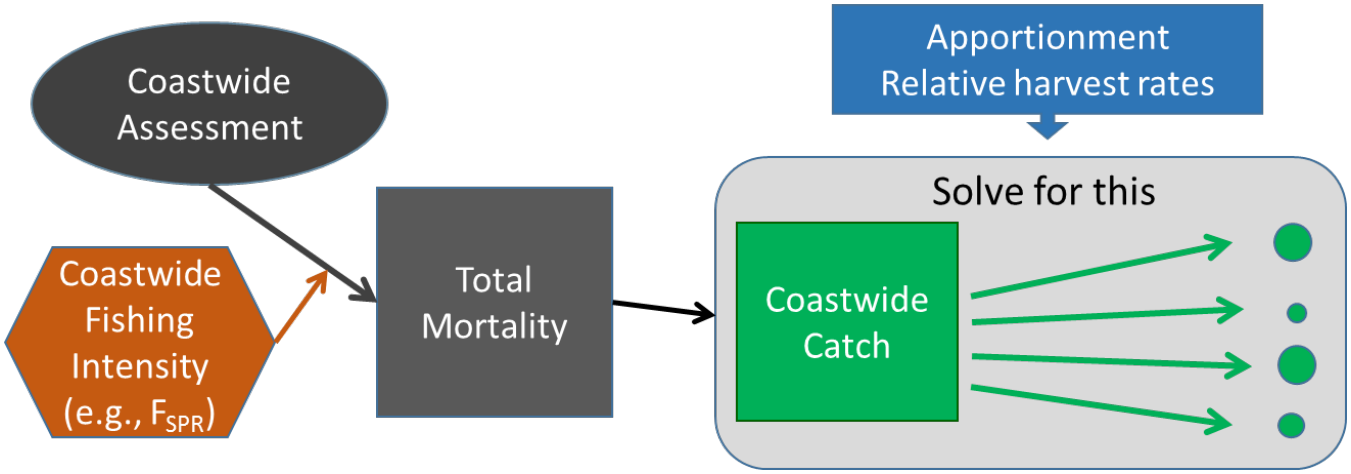

Figure 2. A pictorial description of an improved harvest policy separating the scale (e.g. F_{SPR}) and distribution (e.g. apportionment and relative harvest rates) of fishing mortality.

The Spawning Potential Ratio (SPR) is the percentage of long-term, equilibrium spawners-per-recruit when fishing at F_{SPR}, divided by the long-term, equilibrium spawners-per-recruit with no fishing. In other words, this is a measure of the reduction in long-term spawning potential due to fishing. The higher the fishing intensity (F_{SPR}), the lower the SPR. For example, $F_{SPR=100\%}$ is, by definition, no fishing; and $F_{SPR=40\%}$ is a fishing level that reduces the equilibrium spawners-per-recruit to 40% of the unfished level. It is slightly different than simply dividing equilibrium spawning biomass when fishing by unfished equilibrium spawning biomass because it is on a per-recruit basis, thus eliminating the density-dependent effects of the spawner-recruit curve, and simply measuring equilibrium spawning potential. SPR-based harvest policies are commonly used in the management of many fisheries around the world, including U.S. fishery management councils.

The only new concept in Figure 2, other than the order of the procedure, is the introduction of Spawning Potential Ratio (SPR) and a fishing level associated with it. Everything else is the same as in the current harvest policy, with the exception of eliminating EBio and area-specific harvest rate values based on EBio. This new harvest policy, hereafter called an SPR-based approach, can be easily mapped to the current harvest policy, with the improvement of

separating the scale and distribution of fishing mortality, and accounting for all mortality of Pacific halibut.

DISCUSSION

This new harvest policy is an improvement, as described above, but also allows for the MSE to move forward and begin testing management procedures. The current harvest policy is severely limits evaluation via an MSE due to its complexity and lack of accounting for U26 mortality; however, separating the scale and distribution of fishing mortality in this SPR-based approach allows for specific management procedures to be tested. The first management procedure to test and evaluate is the level of F_{SPR} that best meets the Commission's strategic objectives, and results should be available in 2018. However, for the 2017 decision table (Table 1), the fishing intensity (F_{SPR}) is presented as a column, and a new row has been added called *status quo SPR*.

Table 1. The decision table for the 2016 stock assessment including a new row for status quo SPR.

				Stock Trend				Stock Status				Fishery Trend				Fishery Status
				Spawning biomass				Spawning biomass				Fishery CEY from the harvest policy				Harvest rate
				in 2018		in 2020		in 2018		in 2020		in 2018		in 2020		in 2017
2017 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	is less than 2017	is 5% less than 2017	is less than 2017	is 5% less than 2017	is less than 30%	is less than 20%	is less than 30%	is less than 20%	is less than 2017	is 10% less than 2017	is less than 2017	is 10% less than 2017	is above target
No removals	0.0	0.0	$F_{100\%}$	<1	<1	<1	<1	3	<1	1	<1	<1	<1	<1	<1	0
FCEY = 0	11.2	0.0	$F_{77\%}$ 61%-84%	1	<1	3	<1	3	<1	1	<1	<1	<1	<1	<1	<1
	20.0	8.6	$F_{66\%}$ 49%-75%	5	<1	20	4	4	<1	3	<1	<1	<1	<1	<1	<1
	30.0	18.4	$F_{55\%}$ 39%-67%	32	<1	53	31	5	<1	6	<1	6	3	8	4	8
Blue Line	37.9	26.1	$F_{48\%}$ 33%-62%	56	3	77	53	6	<1	12	<1	47	33	48	39	50
status quo SPR	41.6	29.7	$F_{46\%}$ 32%-60%	68	6	87	64	6	<1	15	<1	57	45	57	49	61
	50.0	37.9	$F_{40\%}$ 27%-55%	92	29	98	88	7	<1	25	1	94	83	95	86	95
	60.0	47.7	$F_{35\%}$ 23%-51%	>99	52	>99	99	9	<1	37	3	>99	>99	>99	>99	>99
				a	b	c	d	e	f	g	h	i	j	k	l	m

The *status quo SPR* defines a fishing intensity that is consistent with the average of the fishing intensities that were adopted by the Commission over the last three years. In the interim, before results from the MSE are available, this is a measure indicating a management option that is consistent with the decisions that have been made in recent years. The last three years are used because that is a period of time with a consistent assessment and consistent decision making. The spawning stock of Pacific halibut has been stable or slowly increasing over this period given these decisions, thus empirically, it is an option with good tactical

performance. The MSAB will use MSE to evaluate alternative levels of F_{SPR} to find one that best meets the long-term strategic objectives of the Commission and stakeholders.

The SPR-based approach allows the Commission to clearly separate the scale and distribution of fishing mortality when making a decision on area-specific catch levels. The rows in the decision table (Table 1) only show the change in risk given a change in scale, and it is assumed that the distribution of fishing intensity is the same for all rows (using apportionment and the current relative harvest rates). Therefore, if the decision is to increase the catch in a particular area, the catch can be increased similarly in all areas and the decision table can provide an insight into the risk associated with increasing the coastwide fishing intensity on all sizes of fish. To maintain the same level of risk (e.g. *status quo* SPR), but an increase in the catch in a particular area is desired, then the catch from one or more other areas would need to be reduced by the same amount. Conversely, if a specific distribution of catch is desired, the area-specific catches can be adjusted to find the total mortality (scale) associated with the desired level of risk. Specifically, the scale is coastwide and independent of the distribution of catch across areas, resulting in two clear dimensions to the decision-making process.

RECOMMENDATION/S

That the Commission:

1) **NOTE** paper IPHC-2016-IM092-08 Rev_1 which provided an update on the task assigned to IPHC staff and the MSAB at the 2016 Annual Meeting to review and provide recommendations for updating the IPHC harvest policy and harvest control rules.
2) **CONSIDER** this proposed harvest policy (IPHC-2016-IM092-08 Rev_1) which uses an SPR-based approach and is presented as "*status quo* SPR".
3) **NOTE** that the IPHC Secretariat will use MSE to evaluate a modified harvest policy that separates scale and distribution, and accounts for all mortality.

ADDITIONAL DOCUMENTATION / REFERENCES

[1] *http://iphc.int/news-releases/447-nr20160208.html*

[2] *IPHC-2016-MSAB08-11: http://www.iphc.info/MSAB%20Documents/meeting8/IPHC-2016-MSAB08-11-DraftWorkplanMSAB_Oct2016_v6.0.pdf*

APPENDICES

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