HIGHLY MIGRATORY SPECIES MANAGEMENT TEAM
REPORT ON DRIFT GILLNET FISHERY HARD CAPS – FINAL ACTION

The Highly Migratory Species Management Team (HMSMT) met October 12-14, 2022 at the Southwest Fisheries Science Center in La Jolla, CA to discuss the results of a bootstrap analysis of the range of alternatives (ROA) for hard caps in the large-mesh drift gill net (DGN) fishery adopted by the Council in November 2021. The bootstrap analysis was used to inform the draft Environmental Assessment (EA) for this ROA (Agenda Item G.3, Attachment 1).

The alternatives should be evaluated with respect to the purpose and need adopted by the Council in November 2021. In summary, the purpose of the proposed action is to incentivize practices by DGN fishery participants that minimize bycatch and bycatch mortality including protected species. This action is intended to prevent further limitations on the economic viability of the West Coast swordfish fishery.

This report provides HMSMT comments on the alternatives under consideration and the draft EA, describes methods to evaluate differences between alternatives, including analyses completed prior to the conclusion of the meeting and possible additional approaches to evaluate the alternatives, and provides discussion of the bootstrap analysis results.

Comments on the Alternatives Under Consideration

The options and sub-options under Alternative 3 offer an array of approaches to the implementation of hard caps. Since the Council's revised Purpose and Need aims to influence fishing behavior in order to reduce bycatch, Alternative 3's individual caps components may incentivize bycatch reduction through individual accountability with potentially more restrictive outcomes than a fleetwide cap, as individual vessels could be prohibited from fishing both due to individual caps and fleetwide caps being reached during a single season. Making unobservable vessels subject to individual vessel closures is additionally intended to encourage unobservable vessels to seek remediation of conditions preventing them from being observed. Thus, the individual vessel closures are effectively comparable to a fleetwide closure for unobservable vessels in terms of the incentive structure.

Some commentators have suggested that the use of deep-set buoy gear (DSBG) could mitigate negative economic impacts due to a hard cap closure. There are various reasons why this may not effectively compensate for lost DGN revenue. DSBG is currently not an authorized fishery, and the anticipated limited entry fishery is structured such that not all DGN participants will obtain a limited entry (LE) permit in the first few years of authorization. When fishers are eligible to receive an LE permit for DSBG, there is a significant financial burden in the cost of purchasing gear and a steep learning curve for successful use of the gear. Simultaneously, there is a cost to switching gear types mid-season due to lost days of fishing and operational changes necessary upon switching. Finally, it is unclear how successfully DSBG could be used late in the season following a late season cap closure of DGN due to weather considerations.

As shown in Table 1 below, while DSBG generates greater per-vessel revenue in the May to October period, during the November to January period when average per vessel DGN revenue is highest, DSBG revenue has averaged 21 percent of DGN revenue. Part of NMFS's negative determination for the Council's 2015 Final Preferred Alternative was that DGN fishery participants that are highly dependent on the fishery have few or no alternative fishing opportunities during that high revenue period (as discussed in the Final Regulatory Impact Review and Regulatory Flexibility Act Analysis). These data suggest it may only slightly offset lost revenue due to closures during the period when most DGN revenue is accumulated. It should be noted that a comparison of profits (or net revenue) might further reduce the mitigation benefit of DSBG, because of the higher unit cost associated with that gear type. But these data are from the period when the gear was being tested under Exempted Fishing Permits. It may be that over time and with increased expertise, per-vessel revenue could increase. However, the limited numbers of buoys and hooks per vessel currently proposed for authorization creates a practical limit on catch rates and revenues production that could be achieved with this method. In conclusion, it seems unlikely DSBG could increase to a level that would fully compensate for lost DGN revenue or profits during this crucial period when few other fishing opportunities are available.

Table 1. Average annual per-vessel inflation-adjusted ex-vessel revenue by two season time periods for DGN and DSBG, 2014-2021.

	Time period	
Fishery	May-Oct.	Nov.-Jan.
DGN	$5,526	$24,039
DSBG	$12,794	$5,140

Comments on the Draft Environmental Assessment

The HMSMT reviewed the draft EA, and noted the need for clarifications to some captions in the draft and some distributions which could be more clearly expressed. Editorial suggestions were conveyed directly to Council staff, which should be commended for quickly revising the draft to reflect them.

A sentence in italics on p. 35 (2.2.2.1) states, "Note, however, that to simplify modeling, this method of counting towards caps was applied to all of the cap levels in Sub Option II." The HMSMT notes that this was not a modeling decision, but rather a reinterpretation of the description of sub-option C.II that was provided in the June 2022 information paper (Agenda Item G.3, Attachment 1, June 2022).

Summary of Historically Observed High Priority Protected Species Interactions in Baseline Data

The HMSMT discussed the observed high priority protected species (HPPS) interactions in the baseline data for analysis. As shown in Table 2, there have been seven observed HPPS mortality/injury (M/I) events between the 2001/02 and 2020/21 fishing seasons, which represents

the baseline period adopted by the HMSMT for the input data (observer, logbooks, landings) for the bootstrap simulation model. Of these events, only two would have triggered closures under the Alternative 3 options: two sperm whale M/Is observed on the same set in the 2010/11 season would have exceeded an individual cap and reached the fleetwide cap, and one humpback whale M/I in the 2020/21 season would have reached an individual cap.

Table 2. Number of observed Mortality/Injury (M/I) events in the large-mesh drift gillnet (DGN) fishery by season, 2000/01 - 2020/21. Cells with M/I events are color-coded by resulting cap action, and events which would not trigger any hard caps action are shaded gray. Asterisks indicated an interaction with a single animal that was released alive and uninjured, and the event is therefore not applicable to caps. The black bar represents implementation of the Pacific Leatherback Conservation Area (PLCA).

Species	Individual Cap Reached	Individual Cap Exceeded & Fleetwide Cap Reached	Fleetwide Cap Exceeded	OBSERVED NUMBER OF MORTALITY/INJURY Season:																				
				00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21
Fin whale	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	1	2	3	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sperm whale	1	2	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	1	2	3	0	0	0	0	0	0	0	0	0	*	0	0	*	0	0	0	0	0	0	0	0
Loggerhead sea turtle	1	2	3	0	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olive-ridley sea turtle	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green sea turtle	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-fin pilot whale C/O/W	3	4	5	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Common bottlenose dolphin C/O/W	3	4	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
			Estimated number of sets:	*1,953*	*1,678*	*1,673*	*1,433*	*1,022*	*1,075*	*1,353*	*998*	*1,060*	*832*	*396*	*525*	*408*	*559*	*379*	*378*	*714*	*618*	*473*	*321*	*147*

** indicates interaction with one animal, released alive and uninjured (and therefore not applicable to caps)*

Methods to Evaluate Differences Between Alternatives

Qualitative Evaluation of Alternative 3 Options Using a Contingency Approach

To help highlight differences between Alternative 3 options and sub-options, Table 3 provides a comparison across all possible contingencies for caps being reached or exceeded. These are ranked from left-to-right in approximate order of decreasing restrictiveness, although some comparisons may be ambiguous. Yellow highlights indicate differences from options/sub-options moving from left to right. For example, Sub-option A.I would close the fishery for a shorter period of time than A.II in the case of a vessel cap being reached more than 14 days before the end of the fishing season. By contrast, whether a vessel or fleetwide cap exceedance under Sub-option C.I or C.II would result in a longer closure period would depend on the timing of the interaction, which would trigger the cap relative to the end of the fishing season (January 31) or October 31. Reaching a fleetwide cap would result in a closure for the remainder of the fishing year under Option A, a temporary closure under Option C, and no closure under Option B.

Table 3. Contingency Table to Compare Alternative 3 Options and Sub-options. Rows correspond to the eight possible conditions for caps, defined by columns 1-3. Columns 4-8 correspond to options and sub-options.

Cap Type	Condition	Timing	A.II	A.I	C.I	C.II	B
Vessel	Reached	5/1-10/31	Closed to 1/31	30 days	30 days	30 days	30 days
Vessel	Reached	11/1-1/31	Closed to 1/31	14 days	14 days	14 days	14 days
Vessel	Exceeded	5/1-10/31	Closed to 1/31	Closed to 1/31	Closed to 1/31	Closed to 10/31	Closed to 1/31
Vessel	Exceeded	11/1-1/31	Closed to 1/31	Closed to 1/31	Closed to 1/31	Closed to 10/31	Closed to 1/31
Fleetwide	Reached	5/1-10/31	Closed to 1/31	Closed to 1/31	30 days	30 days	Open
Fleetwide	Reached	11/1-1/31	Closed to 1/31	Closed to 1/31	14 days	14 days	Open
Fleetwide	Exceeded	5/1-10/31	Closed to 1/31	Closed to 1/31	Closed to 1/31	Closed to 10/31	Closed to 1/31
Fleetwide	Exceeded	11/1-1/31	Closed to 1/31	Closed to 1/31	Closed to 1/31	Closed to 10/31	Closed to 1/31

Alternative 3 Option C-II differs from the other options and sub-options in that the count towards caps begins on November 1 and extends through October 31 of the subsequent year. The HMSMT understood the intent of this option as offering greater conservation benefit given that fishing effort is generally highest in the November to January period.

Bootstrap analysis

The qualitative analysis to compare alternatives based on Table 3 does not address the question of the frequency or impacts of the various cap conditions being met or exceeded which would occur in actual practice. The bootstrap analysis uses landings and observer data to provide a quantitative comparison of the alternatives which is representative of recent DGN fishery operations.

The HMSMT provided an overview of the bootstrap methodology in a June 2022 supplemental report (Agenda Item G.4.a HMSMT Report 1). Bootstrap analysis results using the baseline period of 2001/02 through 2020/21 are presented in the draft EA. For purposes of the analysis in the EA, the bootstrap model resamples from the data to construct a season for each of 10,000 replicates.

Simulated seasons may include different cap levels being reached or exceeded besides the ones observed in the 2001/02 through 2020/21 period (Table 2).

There are eight distinct ways that a cap condition can be met in the ROA (Table 3), each of which applies to nine different HPPS subject to caps, for a total of up to 72 (8 x 9) cap conditions that could be met which would result in a closure[1]. By contrast, the seven observed interactions in the baseline data used to inform the bootstrap analysis results in the draft EA occurred at a rate far lower than one observed M/I interaction per season. Infrequent observed interactions that count towards hard caps create a challenge for distinguishing between highly nuanced and closely similar Alternative 3 options and sub-options in the analysis results. For example, no simulated season could distinguish between Alternative 3 Sub-options A.I and A.II, due to the absence of multiple observed interactions for the same species on a range of dates that would distinguish these cases.

Estimate of Indirect Finfish Bycatch Reduction Resulting from Application of Hard Caps

Part of the purpose and need for this action highlights a desire to "conserve other unmarketable non-target species." The HMSMT examined observer data to assess the benefits of the action alternatives on reduction in finfish bycatch mortality, consistent with the purpose of the proposed action. The rate of observed mortality (i.e., dead discards) of all finfish is estimated to be approximately 2.8 animals per set, using data from the 2001/02 through 2020/21 baseline period for analysis[2]. While finfish mortality was not directly estimated within the bootstrap simulations, the HMSMT developed an approach using the bootstrap simulation results to estimate finfish mortality, based on an assumption that the number of sets fished in a given season is a reasonable proxy for a proportional amount of finfish mortality. Subtracting the average number of sets per simulated season under each hard caps alternative from the average number of sets under No Action gives an estimate of the reduction in the number of sets which would be fished each season, on average, under each alternative. Multiplying this by an estimate of the average rate of finfish mortality allows for a rough estimate of how much finfish mortality would be avoided under each hard cap alternative. These calculations were produced for all three scenarios of fleet size (Table 4).

[1] Interaction counts in the alternatives for individual cap exceedance overlap with counts for a fleep cap being reached, somewhat reducing the number of distinct cap conditions below 72.

[2] Table 2-28 in the draft EA summarizes finfish species catch and bycatch by # per 100 sets and retention rate.

Table 4. Estimated annual finfish mortality reduction (average numbers of individuals, all species) compared to Alternative 1 under the three fishery participation scenarios.

Annual Average Finfish Mortality Reduction, Scenario 1 (2 Vessels)

	Reduction in Sets	Finfish Mortality Reduction
Alternative 2	0.91	2.55
Alternative 3-A.I	0.27	0.76
Alternative 3-A.II	0.27	0.76
Alternative 3-B	0.27	0.76
Alternative 3-C.I	0.27	0.76
Alternative 3-C.II	0.57	1.60

Annual Average Finfish Mortality Reduction, Scenario 2 (11 Vessels)

	Reduction in Sets	Finfish Mortality Reduction
Alternative 2	27.42	76.78
Alternative 3-A.I	7.11	19.91
Alternative 3-A.II	7.11	19.91
Alternative 3-B	3.54	9.91
Alternative 3-C.I	5.20	14.56
Alternative 3-C.II	9.97	27.92

Annual Average Finfish Mortality Reduction, Scenario 3 (30 Vessels)

	Reduction in Sets	Finfish Mortality Reduction
Alternative 2	201.12	563.14
Alternative 3-A.I	51.20	143.36
Alternative 3-A.II	51.20	143.36
Alternative 3-B	15.32	42.90
Alternative 3-C.I	27.78	77.78
Alternative 3-C.II	43.84	122.75

Additional Approaches Considered by the HMSMT to Evaluate the Alternatives

The HMSMT discussed additional approaches to evaluate the alternatives, including a possible sensitivity analysis based on data back to 1990/91, a hypothesis testing approach to determine whether differences across alternatives are statistically significant, and an opportunity cost metric to simplify comparison of alternatives.

Sensitivity Analysis

To increase the potential for the results to highlight differences among the Alternative 3 options, the HMSMT discussed using data over the 1990/91 through 2020/21 seasons for a sensitivity analysis to the bootstrap analysis results for the baseline period of 2001/02 through 2020/21. A similar approach was endorsed by the Scientific and Statistical Committee (SSC) for the 2015 ROA analysis. Given that other HPPS were observed in the earlier period, the proposed sensitivity

analysis might better highlight differences across alternatives than results using the baseline period.

Preliminary results from testing this approach showed more differences in results across options and sub-options, although they also raised questions about whether they appropriately represent current fishery operations. Concerns were raised that the adoptions of Marine Mammal Protection Act (MMPA) regulations in 1997 and Endangered Species Act (ESA) regulations in 2001 changed the operation of the fishery to reduce HPPS interaction rates, making results based on an earlier period of data unrepresentative of current DGN operations, and thus unrepresentative of the expected impacts of selecting an action alternative at this time. For example, some HPPS with M/I interactions in the eleven seasons from 1990/91 through 2000/01 had no observed HPPS interactions in the 20 subsequent seasons from 2001/02 through 2020/21 used as a baseline for analysis. Excluding data before the 2001/02 season representative of the PLCA closure may make the sensitivity analysis more relevant for comparison to current DGN fishery operations.

Hypothesis Test for Differences between the Effects of Alternatives

The HMSMT discussed an approach to determine if differences in average bootstrap simulation results between alternatives are statistically significant. Under standard hypothesis testing methodology, the answer is dependent on the number of bootstrap replicates used in the analysis, as described in the methods documentation. For example, using 10,000 replicates, as for the analysis presented in the EA, results in much smaller standard errors and a larger number of significant results than if the analysis used 1,000 bootstrap replicates. It seems problematic if the significance of differences between alternatives depends on an arbitrary choice of bootstrap sample size. Discussion with the SSC may be helpful to determine an appropriate approach to determine which differences are significant.

Opportunity Cost Metric to Compare Alternatives

The HMSMT developed an approach to estimating tradeoffs between conservation benefits and socioeconomic impacts that compares the change between the action alternatives and the No Action alternative (Alternative 1) in average annual fleetwide inflation adjusted ex-vessel revenue to the corresponding change in average annual M/I events for all HPPS. The ratio of these quantities gives rise to a metric for the opportunity cost of ex-vessel revenue production per unit reduction in HPPS interactions which may simplify comparison of options and sub-options under Alternative 3. This work is a candidate for further discussion and reporting during the HMSMT's November meeting.

PFMC
10/26/22