HIGHLY MIGRATORY SPECIES MANAGEMENT TEAM REPORT ON SWORDFISH MANAGEMENT AND MONITORING PLAN HARDCAPS

The Highly Migratory Species Management Team (HMSMT) further discussed the Council's Swordfish Fishery Management and Monitoring Plan Hardcaps at their June 2015 meeting. This report covers a number of elements from that discussion.

1 May 2015 Swordfish Meeting

The HMSMT participated in a May 2015 Swordfish Meeting at the Southwest Fisheries Science Center – La Jolla Laboratory (Agenda Item E.3.a, Supplemental NMFS Report 2). A broad consensus emerged among meeting participants representing industry, academia, government, and conservation organizations that deep-set buoy gear is a method with high potential for targeting swordfish and should be authorized under the HMS fishery management plan in the near future.

The meeting included a presentation by Dr. Rebecca Lewison of San Diego State University, which set forth the objective to develop new methods for bycatch reduction in U.S. swordfish fisheries that continue to support managed target catches and economic viability. One such effort is the dynamic, real-time management tool (EcoCast) under development in collaboration with Dr. Sara Maxwell and other researchers. The HMSMT received an update on recent work to develop the methodology by Dr. Maxwell and her students at Old Dominion University which is summarized in the appendix.

2 Range of Hard Caps Alternatives

The HMSMT discussed a slight modification to the California Department of Fish and Wildlife (CDFW) Preliminary Preferred Alternative (PPA) for hard caps, which would apply a two-year average of observed bycatch over the biennial management cycle against the CDFW PPA caps. Based on historical performance, this adjustment may limit bycatch to a greater degree, while allowing the fishery to close less frequently, thus reducing conservation impacts while improving economic viability. A threat of potential closure of a year or more would provide incentive to reduce bycatch in order to avoid the risk of lost fishing opportunity. However, there is a possibility that at the end of each two-year period, the incentive to avoid risky fishing behavior would be reduced as a closure would only be in effect until the beginning of the next season.

Table 1. is a truncated version of Table 13 from the HMSMT report (Agenda Item E.3.a) showing historical performance of the DGN fishery under Hard Cap Alternative 5 (CDFW PPA) proposed entanglement caps. From the 2001-02 (enactment of the PLCA) season through 2013-14, the fishery would have reached cap levels resulting in fishery-wide closures in 7 out of 13 seasons (54%).

In comparison, Table 2. shows the historical performance of the DGN fishery under the CDFW PPA caps applied over a two-year window. With this cap window, the fishery would have closed once for a period of less than two consecutive full seasons; the remainder of the 2010-11 season and the entirety of the 2011-12 season.

Table 1. Historical performance (2000-2013) of the drift gillnet fishery under hardcap Alternative 5 (CDFW PPA) proposed entanglement caps. Shaded cells denote season closures resulting from meeting or exceeding a hard cap for one or more species (full table in Agenda Item E.3.a).

Species	Observed Entanglement Cap*	Estimated Annual Take**	OBSERVED NUMBER OF TAKES													
			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
Fin whale	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	0.6 (1)	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Sperm whale	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Leatherback sea turtle	0.9 (1)	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Loggerhead sea turtle	0.9 (1)	3	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Olive ridley sea turtle	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green sea turtle	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-fin pilot whale C/O/W	1.5 (2)	5	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Common bottlenose dolphin C/O/W	1.8 (2)	6	0	0	0	0	0	0	0	0	0	0	1	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*

Table 2. Historical performance (2000-2013) of the DGN fishery under Hard Cap Alternative 5 (CDFW PPA) proposed entanglement caps applied over a two year window. Solid shaded cells denote seasons where caps would have been reached under the original CDFW PPA, shaded cells with a dot pattern denote season closure due to average annual interaction meeting or exceeding a cap.

Species	Observed Entanglement Cap*	Estimated Annual Take**	OBSERVED NUMBER OF TAKES													
			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
Fin whale	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	0.6 (1)	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Sperm whale	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Leatherback sea turtle	0.9 (1)	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Loggerhead sea turtle	0.9 (1)	3	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Olive ridley sea turtle	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green sea turtle	0.6 (1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-fin pilot whale C/O/W	1.5 (2)	5	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Common bottlenose dolphin C/O/W	1.8 (2)	6	0	0	0	0	0	0	0	0	0	0	1	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*
	Highest average annual take		***0.5***		***0.5***		***0.5***		***0.5***		***0.5***		***1***		***1***	
	Would the fishery close?		***NO***		***NO***		***NO***		***NO***		***NO***		***YES***		***NO***	

The HMSMT also discussed the possibility of applying a two year cap with a rolling window. In each season, a closure would occur if the average number of takes over the current and previous seasons reached a cap. This approach potentially reduces the incentive to avoid bycatch species at the end of a biennial window with no previous interactions, since the previous year's observed bycatch would count towards the cap in any year.

Table 3. is intended to illustrate differences between using a fixed versus a rolling biennial cap window, assuming a cap of 2 in each case (equivalently, a cap of 1 on the two-period average). The top row identifies biennial periods while the second row shows seasons. The third row shows hypothetical numbers of takes in each season, with 1 take in each of the first three seasons followed by 0 takes in the fourth and 2 in the fifth. Shading indicates seasons when the fishery would close under either scenario due to reaching a cap; no takes could occur in the sixth period because the fishery would remained closed as a carryover from hitting the cap with two interactions in season 5. (Hypothetical takes are shown as blank in season 6 to reflect no fishing effort would occur.)

Table 3. Hypothetical Illustration of the Difference between Fixed and Rolling 2-year Caps.

Biennial Period	1		2		3	
Season	1	2	3	4	5	6
Hypothetical Takes	1	1	1	0	2	
Fixed 2-year Period	1	2	1	1	2	2
Rolling 2-year Window	1	2	2	1	2	2

The fourth row of the table shows the cumulative take counts that would apply against the cap in each season, based on a fixed 2-year cap period. The cap is reached in year 2, shutting down the fishery. However in year 3 the fishery would reopen in a new biennial period with a clean slate. Since only 1 take occurs in the second biennial period, the cap is never again reached until year 5.

The fifth row provides cumulative take counts under a rolling 2-year window; in each season after the first, the cumulative sum of previous and current season interactions are shown. During the first biennial cycle, the operation of the fishery is identical to under the fixed 2-year period caps. Since the fishery does not start over each biennial cycle with a clean slate, a cap condition is again reached in year 3 under rolling caps. With no takes in year 4, only the take in period 3 counts towards the cap under either the fixed or rolling 2-year window case; thus the fishery does not shut down in year 4. Since the fishery would close in year 5 and remain closed in year 6 due to the two interactions in year 5, the fixed and rolling caps have the same effect over the third biennial period.

3 Historically Observed Finfish Bycatch

At the March 2015 meeting, the Council expressed a desire to examine finfish bycatch in the DGN fishery for the last five seasons, inside and outside the geographical boundaries of the PLCA. Tables 4. and 5. represent catch numbers extrapolated from the observer data based on percentage of observer coverage. Differences in the sum of retained and discarded dead/unknown equates to the number of individuals released alive.

Highlighted rows represent management unit species. The "Other 35 species" grouping includes the remaining finfish species with observed catch counts over the five seasons, but are not HMS FMP management species and have a minimal amount of take.

Market species included in Table 4. and Table 5. that are discarded dead may reflect damage from depredation, making them unsaleable.

Table 4. Expanded finfish bycatch (no. individuals) in the DGN fishery for expanded sets fished within the geographic boundaries of the PLCA. In 2010-2012, no observed sets were fished in this area.

Species	2009/2010 (31 sets)			2010-2011	2011-2012	2012/2013 (44 sets)			2013/2014 (117 sets)		
	Estimated caught	Estimated retained	Estimated discarded dead/unkn			Estimated caught	Estimated retained	Estimated discarded dead/unkn	Estimated caught	Estimated retained	Estimated discarded dead/unkn
Albacore	254	246	8			123	123	0	1,018	957	38
Blue Marlin	0	0	0			0	0	0	0	0	0
Blue Shark	23	0	15			78	0	54	53	0	41
Bluefin Tuna	0	0	0			5	5	0	56	56	0
Bullet Mackerel	0	0	0			0	0	0	0	0	0
Common Mola	69	0	0			191	0	20	691	0	18
Common Thresher Shark	0	0	0			25	25	0	211	211	0
Opah	23	23	0			0	0	0	41	41	0
Pacific Bonito	0	0	0			0	0	0	0	0	0
Pacific Mackerel	0	0	0			0	0	0	0	0	0
Shortfin Mako Shark	39	39	0			20	20	0	29	29	0
Skipjack Tuna	0	0	0			44	34	10	41	3	38
Striped Marlin	0	0	0			0	0	0	0	0	0
Swordfish	116	116	0			108	103	5	659	659	0
Yellowfin Tuna	0	0	0			0	0	0	0	0	0
Other Finfish (35 species)*	31	31	0			44	44	0	100	82	18
Total Billfish (including swordfish)	116	116	0			108	103	5	659	659	0
Total Billfish (excluding swordfish)	0	0	0			0	0	0	0	0	0
Total Sharks (including blue)	62	39	15			128	50	54	293	240	41
Total Sharks (excluding blue)	39	39	0			50	50	0	240	240	0
Total Finfish Catch	555	455	23			638	354	89	2,899	2,038	153

Table 5. Expanded finfish bycatch (no. individuals) in the DGN fishery for expanded sets fished outside the geographic boundaries of the PLCA.

Species	2009/2010 (801 sets)			2010/2011 (396 sets)			2011/2012 (525 sets)			2012/2013 (364 sets)			2013/2014 (442 sets)		
	Estimated caught	Estimated retained	Estimated discarded dead/unkn	Estimated caught	Estimated retained	Estimated discarded dead/unkn	Estimated caught	Estimated retained	Estimated discarded dead/unkn	Estimated caught	Estimated retained	Estimated discarded dead/unkn	Estimated caught	Estimated retained	Estimated discarded dead/unkn
Albacore	277	278	0	38	38	0	308	281	27	999	989	10	112	108	26
Blue Marlin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue Shark	478	0	316	205	0	122	265	0	151	368	0	265	354	0	275
Bluefin Tuna	385	377	8	106	106	0	842	745	97	358	348	10	483	465	18
Bullet Mackerel	254	216	31	0	0	0	22	0	22	0	0	0	550	196	354
Common Mola	11,188	0	54	5,168	0	84	2,257	0	135	2,034	0	24	3,295	0	17
Common Thresher Shark	169	169	0	608	600	0	1,129	929	151	284	284	0	146	146	0
Opah	2,333	2,310	23	874	874	0	1,021	1,010	0	475	475	0	433	430	3
Pacific Bonito	116	62	23	23	23	0	32	32	0	0	0	0	50	47	3
Pacific Mackerel	0	0	0	312	91	213	108	0	65	0	0	0	73	0	73
Shortfin Mako Shark	731	708	15	228	228	0	540	502	22	612	597	0	1,159	1,124	6
Skipjack Tuna	31	23	8	0	0	0	16	11	5	118	74	44	176	73	102
Striped Marlin	8	0	8	8	0	8	0	0	0	5	0	5	3	0	3
Swordfish	1,632	1,578	54	190	190	0	685	680	0	358	358	0	790	790	0
Yellowfin Tuna	23	23	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Finfish (35 species)*	408	285	100	669	600	23	216	76	113	139	89	25	213	70	117
Total Billfish (including swordfish)	1,648	1,578	70	198	190	8	685	680	0	358	358	5	793	790	3
Total Billfish (excluding swordfish)	16	0	16	8	0	8	0	0	0	5	0	5	3	0	3
Total Sharks (including blue)	1,209	708	331	1,087	844	144	2,047	1,436	421	1,298	886	285	1,659	1,270	281
Total Sharks (excluding blue)	731	708	15	882	844	23	1,782	1,436	270	930	886	20	1,305	1,270	6
Total Finfish Catch	18,033	6,029	640	8,429	2,750	450	7,441	4,266	788	5,750	3,214	383	7,836	3,450	997

4 Discussion of Current Version of Bootstrap Analysis

The HMSMT discussed the bootstrap analysis of drift gillnet alternatives under development. One question of interest regarded differences in bootstrap results between Alternative 4 (Council PPA) versus Alternative 5 (California PPA). The NMFS West Coast Region Observer Data that was used in the analysis documents a history of live releases of some species proposed for hard caps under alternatives, including leatherback sea turtles and sperm whales. For example, the biological opinion for the DGN fishery prepared in 2013 includes an estimated 65% mortality rate for leatherback sea turtles (cf. pp. 94-95), reflecting that a number of entangled leatherback turtles are released alive. A higher risk of reaching a cap due to including entanglements with live releases results under Alternative 5 compared to Alternative 4, which only counts M&SI against the same caps.

The bootstrap analysis reflects a greater risk of closure due to reaching a cap under Alternative 5 compared to Alternative 4. The average amount of simulated effort under Alternative 5 is lower than under Alternative 4 for each observer coverage level and period of observer data combination used in the analysis in Tables 15 through 18 in the Agenda Item E.3.a HMSMT report. Lower average annual effort results in reduced cumulative bycatch risk under Alternative 5 than Alternative 4 for all species of concern but also reduces the economic viability of the fishery, since less allowable effort results in less target species catch and variable profit.

The lower average level of effort under Alternative 4 helps explain why there are values for species at the Q75 level for Alternative 4 but none at the Q75 level for Alternative 5. For example under Alternative 4 in Table 16, up to one short-fin pilot whale would be taken during at least 75% of the seasons, but under Alternative 5, none would be taken during at least 75% of the seasons. An average of fewer sets per season under Alternative 5 due to more frequent closures results in less risk of short-fin pilot whale interactions, consistent with no M&SI for the (lowest) 75% of outcomes under Alternative 5 but "1 or fewer" for the lowest 75% of outcomes under Alternative 4.

5 Future HMS Planning Considerations

The HMSMT notes that scoping for a SSLL fishery outside the EEZ (FMP Amendment 3) is slated for Council consideration in September 2015; specifying a range of alternatives for transferring the DGN fishery to a federal permit system is slated for consideration in November 2015. As currently scheduled, these actions would be considered separately. When the Council previously considered establishing a limited entry shallow-set longline fishery in 2009, qualifying criteria for potential alternatives were based on a history of swordfish landings on the west coast, including by DGN gear. In case the Council wishes to consider permitting for a SSLL fishery outside the EEZ in tandem with transitioning to a federal permit for DGN, the HMSMT has identified a potential schedule to do so (Table 6). This timeline takes into consideration the following HMS activities:

- Under COP 20, preliminary results of EFPs are reported to the Council in March and final reports are submitted in September each year.
- HMS biennial management specifications will be considered in June, September and November, 2016.
- EFP applications could be considered in 2016, under the normal annual cycle.

Further, if the Council wishes to establish the deep-set buoy gear as an authorized FMP fishery at the time the EFPs are completed, the HMSMT has included a potential schedule to do so in the same table.

Table 6. Potential Schedule to Coordinate Permitting a SSLL Fishery Outside the EEZ in Tandem with Transitioning to a Federal Permit for DGN.

Action	2015		2016						Earliest Potential Implementation
	Sep	Nov	Mar	Apr	Jun	Sep	Nov	Mar	
Authorizing SSLL Outside EEZ / DGN Federal Permit		Scoping	ROA/PPA			FPA			Fall 2017
Authorizing Deep Set Buoy Gear					Scoping		ROA/PPA	FPA	Fall 2017
DGN Hard Caps	FPA								2016 Fishing Season
EFPs			Preliminary EFP Reports			Final EFP Reports			n/a
Biennial Specs					Scoping	ROA	FPA		Mar 2017

6 Clarification of 100% observer coverage effect on CA PPA

The HMSMT discussed the possible implications of maintaining the same hard cap levels after transitioning from 30% to 100% observer coverage. Because a closure under Alternative 5 would be based on comparing the actual (unexpanded) observed entanglement count to the caps, a failure to adjust caps to reflect the increased chance of observing entanglements with an increase in observer coverage to 100% would result in an increased risk of reaching a cap earlier in the season. This result is reflected in mean simulated sets for Alternative 5 bootstrap results with a mean of 415 sets per season under 30% observer coverage (Table 15) versus a mean of 266 sets under 100% observer coverage (Table 16). The HMSMT recommends that the Council clarify whether caps would adjust under Alternative 5 to compensate for the increased chance of observing bycatch incidents when moving from 30% to 100% observer coverage.

7 Clarification of Electronic Monitoring and timeline for closing the fishery

Electronic monitoring (EM) may be used to monitor hard caps on protected species. EM could be more appropriate for an alternative which counts entanglements rather than mortalities/serious injuries. It is not yet known whether EM is able to collect data necessary for making a serious injury determination. A requirement for vessel operators to self-report entanglements of all protected species upon arrival to port would aid in the timely closure of the fishery once a hard cap is met or exceeded. Rather than reviewing EM data near real-time for entanglements, NMFS could audit the EM data for compliance with the self-reporting requirement. Strict penalties for non-reporting would increase compliance towards 100 percent.

Under the CDFW PPA for hard caps, it may take between six and sixteen business days to close the DGN fishery once a vessel returns to port with a report of an entanglement which meets or exceeds a hard cap. This timeline includes:

- Self-reporting, 1 day

- EM data retrieval and review, 2 – 5 days
- Species identification, 1 – 5 days
- Publication of FR notice closing the fishery, 2 – 5 days

Under the Council's hard cap PPA (Alternative 4), an additional ten to fifteen business days would be required to make a serious injury determination for an injured marine mammal, if EM is proven able to collect data necessary to make this determination.

Appendix: Key Oceanographic Variables for Common Pelagic Bycatch Species in the California Current

A meeting was hosted by the SWFSC Fisheries Resources Division in late January 2015 on 'Habitat modeling of pelagic species in the California Current' to support the Council's ongoing efforts to determine potential spatial or temporal triggers for key bycatch species in the drift gillnet fishery. The HMSMT recently received an update from meeting participant Sara Maxwell, professor at Old Dominion University and former SWFSC affiliate on a project to compile and codify key environmental variables that define the habitat of common bycatch species in the California drift gillnet fishery.

The project uses published literature (peer-reviewed and grey) from around the world to develop the compilation. Codified information includes: study area, data type (e.g., boat-based survey, satellite tracking), study period, sex and age class of study animals, environmental variables included in models, model response variable (e.g., presence vs. absence, foraging vs. transiting, number of individuals), relationship to environmental variables (e.g., greater probability of presence in higher SST regions), environmental variable source, and spatial and temporal resolution of variables.

Thus far, Dr. Maxwell and her students (Tiffany Dawson and Jeri Wisman) have compiled and codified data from peer-reviewed literature sources for two species: sperm whales and leatherback sea turtles. Data types included survey, acoustic, visual and satellite tracking data, and only studies that applied statistical methods to determine habitat characteristics were included. Table 7 provides a brief summary of the preliminary findings.

Next steps will include:

- Further integrating grey literature into the compilation (e.g., NOAA Technical Memorandums)

- Including other species such as loggerhead sea turtles, California sea lions, and short-beaked common dolphins

This work will support efforts by Dr. Maxwell and collaborators to develop a dynamic, real-time management tool (EcoCast) that uses near real-time oceanographic modeling to reduce bycatch in the drift gillnet or other future swordfish fisheries. Dr. Maxwell is interested in comments on how to improve the data collected and make it useful to the Council's efforts to manage the fishery. She can be contacted at smaxwell@odu.edu.

Table 7. Preliminary results from literature review of key oceanographic variables for common pelagic bycatch species in the California Current.

Species	Variable	General trend	Study regions
Leatherback sea turtles (*Dermochelys coriacea*)	Bathymetry	Foraging occurs in shallower depths, on continental shelf	N Pac, S Pac, N Atl, S Atl

	Chlorophyll-a	Greater foraging and presence in high chl areas, though some mixed results	N Pac, S Pac, N Atl
	Eddy kinetic energy	Foraging occurs in areas with lower EKE	N Pac, S Pac
	Sea surface temperature	Significant correlations but mixed results though foraging or presence more common in cooler temperatures	N Pac, S Pac, N Atl, S Atl
	Sea surface height	Significant correlations but mixed results; foraging occurs in both high and low SSH	N Pac, S Pac
	Upwelling	Significant correlations but mixed results; foraging occurs in both upwelling and downwelling areas	N Pac, S Pac
Sperm whales (*Physeter macrocephalus*)	Bathymetry	Found primarily in waters deeper than 1000 m	S Pac, N Atl, G of Mexico
	Bathymetric slope	Found primarily found in steep slope areas	S Pac, N Atl
	Sea surface temperature	Found in temperatures between 28 and 30 degrees	N Atl
	Thermocline	Less common near deep isotherms	Indian, S Atl
	Upwelling	Found near upwelling centers	S Pacific

References:
Baumgartner, 2001, Fishery Bulletin
Benson, 2011, Ecosphere
Dodge, 2014, PLoS ONE
Hamazaki, 2002, Marine Mammal Science
Houghton, 2006, Ecology
Howell, 2015, Fisheries Oceanography
James, 2006, Biological Conservation
Jonsen, 2007, MEPS
Lambert, 2014, PLoS ONE
Lopez-Mendilaharsu, 2009, Journal of Experimental Marine Biology and Ecology
Rendell, 2004, MEPS
Sale, 2006, Journal of Experimental Marine Biology and Ecology
Sangol, 2014, New Zealand Journal of Zoology
Shillinger, 2011, MEPS
Waring, 2001, Marine Mammal Science
Willis-Norton, 2015, Deep Sea Research II
Wong 2014 Deep-Sea Research I

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