HIGHLY MIGRATORY SPECIES MANAGEMENT TEAM REPORT ON ESSENTIAL FISH HABITAT REVIEW

During a joint meeting between the Highly Migratory Species Management Team (HMSMT) and Highly Migratory Species Advisory Subpanel (HMSAS) Southwest Fisheries Science Center (SWFSC) Fisheries Resource Division Life History Program staff scientist, Nicole Nasby-Lucas presented a report (E.4.a, Supplemental HMSMT PPT 1) on the literature review she completed as part of the Phase I Essential Fish Habitat (EFH) review process. The report highlighted research updates on distribution, movement, habitat utilization, and feeding habits of each HMS Management Unit Species (MUS). The literature review did not provide updated information on HMS MUS life histories or fisheries.

Discussion following the presentation considered whether the HMS EFH description has changed sufficiently to warrant moving on to Phase II of the review. Council Operating Procedure (COP) 22 states that a Phase II review process may be unnecessary unless sufficient information is provided to document changes in distribution, prey species, or habitat of MUS. While a substantial amount of new research was brought to light (primarily updates to HMS MUS' diets, movements, and distributions), it was not entirely clear how much the actual EFH for HMS MUS has changed since the original version was set forth in 2003.

There has also been substantial advancement in mapping technology since the original HMS EFH maps were created, and the current maps are outdated both in terms of information on species' distributions, as well as visual clarity.

The HMSMT discussed the range of possible next steps the Council could take regarding the EFH Review. These include taking no further action, revising the maps in the HMS Fishery Management Plan (FMP) describing EFH, updating the bibliography, or revising the body of the EFH description. Other than "no action," the other choices would constitute a decision to move on to Phase II of the review.

Following the Habitat Committee's (HC) recommendation, the HMSMT prepared a spreadsheet documenting potential changes to the current EFH descriptions in the HMS FMP. If the Council decides to move forward and consider revisions to the EFH descriptions in the HMS FMP, the HMSMT could develop a scope of work (per COP 22) for consideration at a future Council meeting. The HMSMT recommends the Council consider the workload involved in deciding whether, how, and when to implement Phase II of the review.

PFMC
09/14/20

Appendix: Potential Changes to EFH Descriptions in the HMS FMP

Management Unit Species	Potential Changes	Location in Current FMP	Source
	Remove EFH descriptions for 2 species: pelagic thresher shark & bigeye thresher shark (Those two species were re-designated EC species and thus no longer need EFH described for them.)	HMS FMP & Appendix F*	HMSMT
	New and/or better maps of EFH within the EEZ	Appendix A*	HMSMT
Common Thresher Shark	Along the west coast of North America, common thresher sharks are seasonally distributed in coastal waters from British Columbia, Canada to central Baja California, Mexico, with the highest concentration in the Southern California Bight (from Point Conception, California to Cabo Colonet, Mexico) (Hanan et al. 1993; Smith et al. 2008a).	Appendix F 1.1.1, 1.1.6	SWFSC literature review
Common Thresher Shark	Replace Smith et al. in prep with Smith et al. 2008a	Appendix F 1.1.2	SWFSC literature review
Common Thresher Shark	Replace Preti et al. 2001 in press with Preti et al. 2020	Appendix F 1.1.3, 1.1.8	SWFSC literature review
Common Thresher Shark	Use of the caudal fin to stun prey during feeding activity was documented for the common thresher shark (Aalbers et al., 2010)	Appendix F 1.1.3	PIER
Common Thresher Shark	During a cool water period, the diet of common thresher sharks contained only 8 prey taxa as compared with 20 during the warm water period. Those included in order of importance northern anchovy (*Engraulis mordax*) market squid (*Loligo opalescens*) “unidentified teleosts”; Pacific sardine (*Sardinops sagax*);Pacific hake (*Merluccius productus*); and Pacific or chub mackerel (*Scomber japonicus)* (Preti et al 2004).	Appendix F 1.1.3	SWFSC literature review
Common Thresher Shark	Stomach contents from 225 thresher sharks (large juveniles - adults) were sampled between 2002 and 2008 and overall northern anchovy and pacific sardine were identified as the most important prey (Preti et al. 2012, Preti 2020).	Appendix F 1.1.3, 1.1.8	SWFSC literature review
Common Thresher Shark	Various electronic tagging studies have better identified the inshore distribution and habitat utilization of common thresher sharks off Southern California (Cartamil, 2009; Cartamil et al., 2010; Cartamil et al., 2011; Sepulveda et al.,2014).	Appendix F 1.1.4	PIER
Common Thresher Shark	Juvenile common thresher sharks have a larger overall range than previously thought, extending from Morro Bay, CA to Bahia Sebastian Vizcaino, BC (Cartamil et al. 2016). Although they are found most frequently in shallow, nearshore areas over the continental shelf, especially within the SCB, which is an important nursery area (Holts and Bedford 1989; Cartamil et al. 2010).	Appendix F 1.1.4	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Common Thresher Shark	Single stock along west coast of North America reaffirmed by Trejo (2005)	Appendix F 1.1.4	SWFSC literature review
Common Thresher Shark	Replace Goldman and Amorim in press with Goldman 2005	Appendix F 1.1.5	SWFSC literature review
Common Thresher Shark	Replace Smith et al. b in prep with Smith et al. 2008b	Appendix F 1.1.6	SWFSC literature review
Common Thresher Shark	Delete Au et al. in prep (not published)	Appendix F 1.1.6	SWFSC literature review
Common Thresher Shark	In neighboring Mexican waters, a gear shift from drift gillnet (DGN) to longline has ensued over the past decade. Because the common thresher is less susceptible to longline than the DGN gear type, fishery utilization of this species has likely changed along the Mexican coast.	Appendix F 1.1.7	PIER
Common Thresher Shark	For thresher sharks, diets of the two different size classes were similar. The most important prey items, northern anchovy, Pacific sardine and other coastal pelagic species, ranked similarly in the two size groups and did not present significant differences (Preti 2020).	Appendix F 1.1.8	SWFSC literature review
Shortfin Mako Shark	Since the past EFH assessment, several studies have been performed on mako shark movement trends off Southern California, including significant efforts by the NOAA SWFSC. A tagging study of 105 shortfin mako sharks from 2002-2014 showed increased coastal range (47°N to 3°N) from Washington State to just south of Puerto Vallarta, Mexico (Nasby-Lucas et al 2019). Seasonal movements up and down the California Current coincided with periods of higher primary productivity and chlorophyll a, and sea surface temperatures (SSTs) between 15 and 25 °C. Overall SST ranged from 11 to 31 °C throughout the range, indicating a broad thermal tolerance. The SCB was found to be important habitat for all size classes from late spring to early fall and in late summer and fall sharks disbursed either north or south with the largest sharks moving offshore. Habitats utilized included the entire California Current, the Sea of Cortez and offshore in the areas of the North Pacific Subtropical Gyre, North Pacific Transition Zone and North Equatorial Current (Nasby-Lucas et al 2019).	Appendix F 1.4.1	SWFSC literature review
Shortfin Mako Shark	Although variability was apparent in diel patterns, in general, tagged mako sharks exhibited diel vertical migration patterns, remaining in the mixed layer at night and diving to deeper depths during the day (Nasby-Lucas et al. 2019).	Appendix F 1.4.1	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Shortfin Mako Shark	Tagged mako sharks were found to spend around 99% of their time in the top 150m of the water column in the coastal region from California to Washington remaining shallower than 50 m >90% of time. Maximum dive depth logged in the coastal region was 350m north of Point Conception and 528m in the Southern California Bight (Nasby-Lucas et al. 2019.)	Appendix F 1.4.1 1.4.4	SWFSC literature review
Shortfin Mako Shark	The SCB ecoregion has long been considered a pupping and nursery area for mako sharks (Hanan et al. 1993, O'Brien & Sunada 1994, Taylor & Bedford 2001), based primarily on the prevalence of juveniles in this region. Nosel et al. (2019) data, in combination with previous studies, show that mako shark nursery extends along the continental margins of the SCB ecoregion, south to the tip of the Baja California peninsula (approximately 23.4−34.5° N)	Appendix F 1.4.1, 1.4.8	SWFSC literature review
Shortfin Mako Shark	Mature females are caught in the SCB by recreational fishermen as documented by Lyons et al. (2015) with the catch of a 373 cm female. In addition, a tagging study of mature females shows that they are present in the SCB May-August (Domeier unpublished data).	Appendix F 1.4.1, 1.4.8	SWFSC literature review
Shortfin Mako Shark	Preti et al. (2012) sampled 330 mako sharks and found that 238 stomachs collected from 2002 to 2008 contained 42 prey taxa with jumbo squid (*Dosidicus gigas*), Pacific saury (*Cololabis saira*), Pacific sardine (*Sardinops sagax*), and Pacific chub mackerel (*Scomber japonicus*), representing the most important prey. For larger mako sharks, marine mammals are also important. Lyons et al. (2015) found that the stomach of a 373 cm female contained a 4 year-old female California sea lion (*Zalophus califforniasnus*). There were differences in diet by subregion, striped mullet and Pacific sardine were important within the SCB, whereas Pacific saury, and Pacific pomfret ranked higher beyond the SCB, however, jumbo squid and jack mackerel were important prey items in both areas (Preti et al. 2012, Preti 2020).	Appendix F 1.4.3	SWFSC literature review
Shortfin Mako Shark	Preti et al. (2012) found that for mako sharks <109 cm FL Pacific sardine was the most important prey item followed by Pacific mackerel, Pacific saury, and jumbo squid. Pacific saury ranked first in importance for mako shark between 110-149 cm FL, followed by jumbo squid and striped mullet. One specimen (137 cm FL) in this size category fed on a short-beaked common dolphin, demonstrating that medium sized makos are capable of consuming marine mammals. Jumbo squid ranked first in importance for makos > 150cm FL, followed by Pacific mackerel and Pacific saury. Two mako specimens in this group fed on blue sharks. The number of taxa consumed increased with body size, demonstrating an ontogenetic expansion of diet rather than a shift in prey types	Appendix F 1.4.3, 1.4.8	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Shortfin Mako Shark	Observer data examined from the California drift gillnet fishery from 1990-2017 show that YOY and age-1 mako sharks were captured almost exclusively south of Point Conception in the SCB. However, makos appear to expand their northward range as they grow, with catch rates north of Point Conception increasing with size (Nosal et al. 2019).	Appendix F 1.4.4	SWFSC literature review
Shortfin Mako Shark	The shift in commercial gear used to target mako sharks in neighboring Mexican fleet operations (i.e., from DGN to Longline) has likely altered catch and landings statistics for this species since the last EFH assessment. In particular, the expansion of the industrial longline fishery and increased targeting of both blue and mako sharks has likely impacted fishery utilization within the region.	Appendix F 1.4.7	PIER
Shortfin Mako Shark	Mako sharks presented size-related differences in diets. Results show how makos of all sizes can feed opportunistically on a high diversity of prey, but large specimens can also feed on larger and faster prey that can dive deeper. Jumbo squid was significantly more important for large makos than for small and medium-sized sharks. Coastal pelagic fish prey like Pacific sardine and Pacific mackerel were significantly more important for small makos than for medium and large specimen indicating how juveniles are feeding more inshore and exploiting the SCB that is considered to be an important pupping and nursery area (Preti 2020).	Appendix F 1.4.8	SWFSC literature review
Blue Shark	The SCB ecoregion has long been considered a pupping and nursery area for blue sharks (Hanan et al. 1993, Holts et al. 2001) based primarily on the prevalence of juveniles in this region. However, Nosal et al (2019), in combination with previous studies, suggest that the nursery areas extends along the continental margins of the SCB ecoregion, north through Oregon (approximately 27.7−46.2° N),	Appendix F 1.5.1, 1.5.8	SWFSC literature review
Blue Shark	Since the past EFH assessment, electronic tagging research has been performed on blue sharks tagged off Southern California, including significant efforts by the NOAA SWFSC. A tagging study of 90 blue sharks from 2002-2015 showed that late juveniles/subadults utilized the entire US west coast EEZ from the Mexican border to the Canadian border, while adults utilized the region from the Mexican border to approximately 37°N seasonally and then moved offshore to the south and west. Late juveniles/subadults which were found as far north as the Canadian border were found in SST and 9 to 29 °C (average 18 °C) while adult blue sharks were found in SST from about 14 to 29 °C (average 20 °C) (Nasby-Lucas et al. in prep).	Appendix F 1.5.1, 1.5.4, 1.5.8	SWFSC literature review
Blue Shark	Replace Nakano and Seki in press with Nakano and Seki 2003	Appendix F 1.5.1, 1.5.4	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Blue Shark	Preti et al. (2012) sampled 158 mako sharks from 2002 to 2008 (76 to 248 cm FL) and found that 114 stomachs contained 38 prey taxa with jumbo and *Gonatus spp*. squids representing the most important prey. Differences in diet by subregion, *Gonatus spp*. squids were the most important prey item within and beyond the SCB revealing the wide distribution of these cephalopods. *Argonauta sp*. was significantly more important within the SCB. Argonauts are free swimming octopuses of the open oceans, Their presence in coastal waters is likely due to weather or current conditions carrying these pelagic cephalopods closer to shore. (Preti 2020).	Appendix F 1.5.3	SWFSC literature review
Blue Shark	Preti et al. (2012) found that for blue sharks <109 cm FL Pacific euphausiids were the most important prey item (although this result is biased due to a large number of this prey found in a single stomach) followed by *Argonauta sp*. and *Gonatus spp*. *Gonatus spp*. ranked first in importance for blue shark between 110-149 cm FL, followed by jumbo squid and *Argonauta sp*. Jumbo squid ranked first in importance for blue sharks > 150cm FL, followed by *Gonatus spp*. and pelagic red crab (*Pleuroncodes planipes*). One large specimen fed on an unidentified cetacean. The number of taxa consumed increased with body size, demonstrating an ontogenetic expansion of diet rather than a shift in prey types	Appendix F 1.5.3, 1.5.8	SWFSC literature review
Blue Shark	Observer data examined from the California drift gillnet fishery from 1990-2017 show that YOY- juvenile blue sharks are commonly encountered north of Point Conception, well into waters off Oregon and Washington (Nosal et al. 2019).	Appendix F 1.5.4	SWFSC literature review
Blue Shark	Replace Stevens 2000 in press with Nakano and stevens 2008	Appendix F 1.5.5	SWFSC literature review
Blue Shark	Updated Bertalanffy growth parameters from Yokoi et al. 2017. Updated estimates of 50% maturity for males at 175.1 cm FL and 170.5 cm FL for females (Fujinami et al 2017).	Appendix F 1.5.6. 1.5.8	SWFSC literature review
Blue Shark	The shift in gear used to target blue sharks by neighboring Mexican fleet operations (i.e., from DGN to industrial Longline), and increased targeting has likely altered catch and landings statistics for this species since the last EFH assessment.	Appendix F 1.5.7	PIER
Blue Shark	Regional longline effort outside of the U.S. West Coast has also changed since the last EFH assessment, a factor that will also impact fishery utilization for this species.	Appendix F 1.5.7	PIER

Management Unit Species	Potential Changes	Location in Current FMP	Source
Blue Shark	Blue sharks showed only minor differences in diet by size. There was a difference in the unusual prey items the different size classes consumed. Small and medium blue sharks fed on birds while larger animals preyed on marine mammals, including one elephant seal and an unidentified cetacean. It is not clear if these rare prey types could have been scavenged. The most important prey item for small blue shark was euphausiids but this was mainly due to high numbers (300) in one stomach. Jumbo squid was significantly more important for large blue sharks than small and medium sized blue sharks. *Argonauta sp*. was significantly more important for small and medium blue sharks than large blue sharks (Preti 2020).	Appendix F 1.5.8	SWFSC literature review
Albacore Tuna	Replace Au et al in press with Au et al. 2008	Appendix F 2.1.6, 2.2.6, 2.3.6, 2.4.6, 2.5.6, 3.0.2, 4.0.2	SWFSC literature review
Albacore Tuna	Juvenile albacore are found along the North America coast in summer and fall months and in the NPTZ during winter and spring months. Childers et al (2011) showed 5 patterns for juvenile albacore movement. 1) albacore tagged in the northern fishery area (off Northern California, Oregon and Washington) migrated offshore between 150 and 180 °W during the winter and returned to the northern fishery area the following summer 2) migrated west and south form the norther fishery area (off northern Baja California, Mexico, and Southern California) during the winter then into the southern fishery area the following summer 3) migrated from the northern fishery area into the central North Pacific during the winter then into the western Pacific the following spring 4) migrating west from the southern fishery area to offshore areas between 130 and 140°W during the winter and returning to the southern fishery area the following summer 5) overwintering along the Baja peninsula, Mexico, and returning to the southern fishery area during the following summer. Tagged juvenile albacore were found to exploit deeper waters off Baja California, Mexico, making frequent dives to depths exceeding 200 m during the day and remaining in the surface mixed layer at night, whereas off Oregon and Washington, where MLDs are shallow and Chl-a concentrations are high, they remained near the surface both day and night,. Water temperatures encountered ranged from 3.3 to 22.7°C (Childers et al. 2011).	Appendix F 2.1.1, 2.1.4, 2.1.8	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Albacore Tuna	Muhling et al. (2019) used catch logbook data and trawl survey records to investigate how juvenile albacore in the California Current use their oceanographic environment, and how their distributions overlap with the habitats of four key forage species. they show that northern anchovy (*Engraulis mordax*) and hake (*Merluccius productus*) habitat is associated with productive coastal waters found more inshore of core juvenile albacore habitat, whereas Pacific sardine (*Sardinops sagax*) and boreal clubhook squid (*Onychoteuthis borealijaponica*) habitat overlaps more consistently with that of albacore.	Appendix F 2.1.3	SWFSC literature review
Albacore Tuna	Madigan et al (2015) found that in stomach samples taken in the SCB, the most important prey items for albacore tuna were Euphausiids, Pacific jack mackerel (*Trachurus symmetricus*), *Gonatus spp*, and *Sardinops sagax*.	Appendix F 2.1.3	SWFSC literature review
Bigeye Tuna	Woodworth-jefcoats (in press Fisheries Oceanography (DOI: 10.1111/fog.12487) found that median phytoplankton size (MD50) is an informative environmental predictor of bigeye tuna recruitment in the Hawaii longline fishery	Appendix F 2.2.1	SWFSC literature review
Bigeye Tuna	Bigeye tuna stomachs contained 324 fish, identified to at least 18 species in 12 families. Sternoptychids were the most numerous, at 33.6% (101 out of 109 fish were S. obscura), followed by gempylids at 18.5% (51 out of 60 fish were *Diplospinus multi-striatus*), paralepidids (11.4%), and myctophids(8.3%). Gempylids and paralepidids occurred the most frequently, 38.1 and 33.3%, respectively. Sternoptychids ranked third in frequency (23.8%).Although bramids and omosudids only represented 3.4 and 3.1% in numbers, they occurred frequently, 23.0 and 21.1%, respectively. (Moteki et al. 2001).	Appendix F 2.2.3	SWFSC literature review
Northern Bluefin Tuna	Runcie et al. (2018) examined the effects of local oceanic conditions(sea surface temperature, surface chlorophyll, sea surface height, eddy kinetic energy), as well as large-scale oceanographic phenomena, such as El Niño, on Pacific bluefin tuna (PBF) availability to commercial and recreational fishing fleets. Results from generalized additive models showed that warmer temperatures of around 17–21°C with low surface chlorophyll concentrations (<0.5 mg/m3) increased probability of occurrence of PBF in the Commercial Passenger Fishing Vessel and purse seine fisheries	Appendix F 2.3.1	SWFSC literature review
Northern Bluefin Tuna	Madigan et al (2015) found that in stomach samples taken in the SCB, the most important prey items for PBF were *Sardinops sagax*, Pacific jack (*Trachurus symmetricus*), *Dosidicus gigas*, and *Melanostigma pammelas*.	Appendix F 2.3.3	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Northern Bluefin Tuna	Several electronic tagging studies have been performed off the coast of California since the last EFH assessment. Electronic tagged bluefin tuna showed repeatable seasonal movements along the west coast of North America. Bluefin tuna were found farthest south in the spring when they were located off southern Baja California, Mexico and farthest north in the fall when fish were found predominately off central and northern California. Fish showed latitudinal movement patterns that were correlated with peaks in coastal upwelling-induced primary productivity. Interannual variation in the locality of these productivity peaks was linked with a corresponding move-ment in the distribution of tagged fish. Overall geographical area occupied by tagged bluefin varied with primary productivity, with fish being more tightly clustered in areas of high productivity and more dis-persed in regions of low productivity. In the spring through fall, bluefin tuna were located in areas with the highest levels of primary productivity available in the California Current ecosystem. However, in the winter months, tagged bluefin tuna were found in areas with lower productivity compared to other regions along the coast at that time of year suggesting that during the winter, bluefin tuna are feeding on aggregations of pelagic red crabs, sardines and anchovies that preferentially spawn in areas of reduced coastal upwelling (Boustany et al., 2010; Domeier et al., 2003)	Appendix F 2.3.1, 2.3.4	SWFSC literature review
Northern Bluefin Tuna	Changes in recreational fishery dynamics as well as captive tuna ranching operations in nearby Mexican waters have altered utilization trends for this species in the Eastern North Pacific. 1) Commercial tuna pen operations have expanded off Northern Baja California since the last EFH document was generated. 2) Recreational vessels have altered gear configurations and fishing styles to successfully target and land larger size classes of PBF. 3) Many of the recreational changes have largely taken place among the private access fleet and therefore remain poorly documented.	Appendix F 2.3.7	PIER
Yellowfin Tuna	Yellowfin tuna preyed on a large variety of species. A total of 204 prey fish found were identified to at least 22 species in 18 families. Based on numbers of individuals consumed, sternoptychids *Sternoptyx obscuradominated* (61.3%), followed by exocoetids and bramids (4.4 and 3.9%, respectively). Infrequency of occurrence, however, exocoetids and bramids dominated with 23.3 and 20.0%, respectively, whereas sternoptychids only occurred 3.3% (Moteki et al. 2001).	Appendix F 2.5.3	SWFSC literature review
Yellowfin Tuna	Madigan et al (2015) found that in stomach samples taken in the SCB, the most important prey items for Yellowfin tuna were *Sardinops sagax*, Pacific jack (*Trachurus symmetricus*), *Doryteuthis opalescens*, and *Dosidicus gigas*.	Appendix F 2.5.3	SWFSC literature review

Management Unit Species	Potential Changes	Location in Current FMP	Source
Striped Marlin	Replace Holts 2001a in press with Holts 2001a	Appendix F 3.0.1, 3.0.2, 3.0.3, 3.0.4, 3.0.7	SWFSC literature review
Striped Marlin	Despite advancements to date from genomic and electronic tagging studies (Domeier 2006; Domeier et al., 2018), annual migration patterns remain poorly understood.	Appendix F 3.0.1	PIER
Striped Marlin	Moteki et al. (2001) found a total of 347 fish of 17 species in 12 families in the stomachs of striped marlin. Based on numbers of individuals found, bramids (*Brama spp.*) were dominant in the stomach contents (60.5%), and scombrids had the second highest value (11.0%).	Appendix F 3.0.3	SWFSC literature review
Striped Marlin	Spawning occurs in coastal waters of the mouth of the Gulf of California (Armas et al. 1999)	Appendix F 3.0.5	SWFSC literature review
Broadbill Swordfish	Optimal sea surface temperatures for swordfish are regionally and seasonally dependent (Dewar et al., 2011; Sepulveda et al., 2020) and vary between warm tropical spawning grounds and foraging areas. Overall SST encountered ranged from 14 to 30°C, and experienced rapid temperature change over 20°C during daily vertical movements (Sepulveda et al., 2020).	Appendix F 4.0.1	PIER, SWFSC literature review
Broadbill Swordfish	Recent electronic tagging research has shown that despite large-scale seasonal migrations, individuals may return to the same location year after year (Sepulveda et al., 2020; Sepulveda et al., in preparation). The seasonal site fidelity proposed by Sepulveda et al., (2020) has been shown to occur across different seasons and locations and includes the foraging grounds along the eastern margins of the Pacific basin as well as offshore spawning areas.	Appendix F 4.0.1	PIER
Broadbill Swordfish	Both juvenile and adult swordfish occur off southern California to forage during the summer and fall, with some individuals (mainly juveniles) possibly remaining in the SCB throughout the entire year. During warm water periods (i.e., El Nino) the average size and length frequency distribution of swordfish landed off Southern California may change, with juveniles making up a large component of the commercial catch (Sepulveda and Aallbers 2018, Sepulveda et al., 2020; Sepulveda et al., unpublished data).	Appendix F 4.0.1	PIER
Broadbill Swordfish	Reproductive habitat for swordfish has been visualized in Lu (2014) based on several previous studies documenting where early life history stages have been observed and the occurrence of females with high gonadal indices	Appendix F 4.0.1	TNC
Broadbill Swordfish	Otolith analysis of young-of-the-year swordfish reveal the Central North Pacific Ocean nursery is the dominant contributor to the California swordfish fishing region (Quesnell 2017).	Appendix F 4.0.1	TNC

Management Unit Species	Potential Changes	Location in Current FMP	Source
Broadbill Swordfish	Moteki et al. (2001) identified 18 species of prey in 13 families for swordfish in the EPO collected by longline. Preti (2020) reported that Jumbo squid (Dosidicus gigas) was the most important prey item and the boreopacific gonate squid (*Gonatopsis borealis*) was the second most important prey.	Appendix F 4.0.3	SWFSC literature review
Broadbill Swordfish	Broaden prey species consumed off western Baja to include mesopelagic fishes as teleosts made up nearly 25% of stomach contents (Markaida and Hochberg, 2005).	Appendix F 4.0.3	TNC
Broadbill Swordfish	Since the last EFH update there has been significant progress made towards understanding migration patterns and regional movements of swordfish in the Eastern North Pacific (Sepulveda et al., 2010; Dewar et al., 2011; Abecassis et al., 2012; Sepulveda et al., 2018; Sepulveda et al., 2020; Griffiths et al., 2020). Griffiths et al. (2020), collate the existing horizontal movement information published to date for swordfish tagged in the eastern north Pacific. Griffiths et al., (2020) present and discuss the horizontal movements in relation to existing stock structure hypotheses used to manage the swordfish resource in the North Pacific (ISC, 2014; 2018). From the data presented, it is PIER's conclusion that existing boundary hypotheses do not align directly with the movement data currently used to manage the resource in the Eastern North Pacific.	Appendix F 4.0.4	PIER
Broadbill Swordfish	Recent tagging research has identified both east-west movements as described by previous fishery dependent observations as well as movements to the south and southwest into the neighboring Eastern Pacific Ocean management unit (Dewar et al., 2011; Sepulveda et al., 2020; Griffiths et al., 2020).	Appendix F 4.0.4	PIER
Broadbill Swordfish	The use of dorsal-fin mounted smart position transmitters (SPOT tags) have also shown that swordfish off California may display some level of seasonal site fidelity, with individuals departing the foraging grounds during the winter months, travelling to warm tropical spawning grounds and subsequently returning to the SCB the following season (Sepulveda et al., 2020; Griffiths et al., 2020, Sepulveda in preparation).	Appendix F 4.0.4	PIER
Broadbill Swordfish	It is identified in the most recent stock assessment that the stock structure in the eastern north Pacific is a source of uncertainty (ISC, 2018; ISC, 2014).	Appendix F 4.0.4	PIER
Broadbill Swordfish	Electronic tag data showing diurnal depth distribution of swordfish off Southern and Central California reveal that daytime depths typically range from the surface down to depths in excess of 400m. As swordfish move offshore towards tropical spawning grounds the average daytime depth distribution increases to depths closer to 600m (Dewar et al., 2011).	Appendix F 4.0.4	PIER

Management Unit Species	Potential Changes	Location in Current FMP	Source
Broadbill Swordfish	Replace Reeb et al. in press with Reeb et al 2000	Appendix F 4.0.4	SWFSC literature review
Broadbill Swordfish	Replace Holts 2001b in press with Holts 2001	Appendix F 4.0.6	SWFSC literature review
Broadbill Swordfish	In 2019 the PFMC authorized the use of deep-set buoy gear and Linked buoy gear as two gear types permissible for use in targeting swordfish off the California and Oregon coast (Sepulveda et al., 2018). Since 2016, landings have increased as the experimental fishery operated under exempted status. It is expected that landings from this new gear type will increase as the fishery expands and develops.	Appendix F 4.0.6	PIER
Broadbill Swordfish	In the Eastern North Pacific fishing effort on the EPO swordfish stock has changed since the last EFH update and concerns have been raised over stock status and potential for overfishing (ISC, 2014).	Appendix F 4.0.6	PIER
Dorado (Mahimahi)	Olson and Galván-Magaña (2002) analyzed the stomach contents of 545 common dolphinfish sampled from 74 sets of tuna purse-seine vessels fishing in the eastern Pacific Ocean (EPO) over a 22-month period. Common dolphinfish in the EPO appear to feed at night, as well as during the daytime. Prey importance varied by area. Flying fishes, epipelagic cephalopods, tetraodontiform fishes, several mesopelagic fishes, *Auxis spp*., and gempylid fishes predominated in the diet. In contrast, Tripp_ Valdez et al. (2015) found that the most important prey were invertebrate species followed by fish. Varela et al. (2017) reported wide variations among size classes and periods of capture indicating that the dorado is an opportunistic feeder, which is capable of consuming a wide variety of schooling epipelagic organisms. Torres-Rojas et al. (2014) reported that Dolphinfish consumed mainly epipelagic prey, with the red crab *Pleuroncodes planipes* as the most abundant prey species.	Appendix F 5.0.3	SWFSC literature review
Dorado (Mahimahi)	The stock structure of dorado in the EPO is still unclear. Aires-da-Silva et al. (2016) reviewed available information on potential stock structure and found no clear evidence that there is more than one population of dorado in the EPO. However, a conceptual model developed during the 2nd dorado workshop (IATTC 2016) postulated two sub-stocks, a resident coastal sub-stock and an oceanic sub-stock that migrates seasonally towards the coast. The degree of connectivity between dorado from the dorado stocks in the South and North EPO is also poorly known (Aires-da-Silva et al., 2016).	Appendix F 5.0.4	SWFSC literature review
	Catch data from the California deep-set fishery for swordfish show that swordfish can seasonally be found as close to shore as the 150 fm isobaths.	Appendix A Maps Fig 27 and 29	PIER

*Appendices A and F are identical text, but App F does not have the maps that App A does.