Agenda Item E.4.a
Supplemental HMSMT PPT1
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SWFSC Literature Review to Suggest Potential Changes to the Highly Migratory Species Essential Fish Habitat Descriptions

Nicole Nasby-Lucas (SWFSC)




APPENDIX F

U.S. WEST COAST HIGHLY MIGRATORY SPECIES: LIFE HISTORY ACCOUNTS AND ESSENTIAL FISH HABITAT DESCRIPTIONS

(Originally Appendix A to the FMP)

U.S. West Coast Highly Migratory Species Plan Development Team
Pacific Fishery Management Council

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Potential changes: Species list

- Removal of EFH descriptions for 2 species: pelagic thresher shark & bigeye thresher shark
  - These species were removed from the HMS FMP and thus no longer need EFH described for them.

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- Species reviewed were Common Thresher Shark, Shortfin Mako shark, Blue Shark, Albacore Tuna, Northern Bluefin Tuna, Skipjack Tuna, Yellowfin Tuna, Striped Marlin, Broadbill Swordfish and Dorado.

Potential changes: Updated Maps

- New and/or better maps of EFH within the EEZ

Potential changes: Common Thresher Shark (*Alopias vulpinus*)

- Updated references on general distribution in the California current (Smith et al. 2008)
- New electronic tagging data that better identify the inshore distribution and habitat utilization in southern California (Cartamil, 2009; Cartamil et al., 2010; Cartamil et al., 2011; Sepulveda et al., 2014).
- New data on feeding habits including comparing prey species in warm water and cool water periods, showing a higher number of prey items in warm water periods than cold water, another study that looked at stomach contents of 225 common thresher sharks between 2002 and 2008, and also a comparison of diet between size classes. (Preti et al 2004, Aalbers et al., 2010, Preti et al. 2012, Preti 2020)

- Aalbers, S.A., Bernal, D. and Sepulveda, C.A., 2010. The functional role of the caudal fin in the feeding ecology of the common thresher shark *Alopias vulpinus*. Journal of Fish Biology, 76(7), pp.1863-1868.
- Cartamil, D.P., 2009. Movement patterns, habitat preferences, and fisheries biology of the common thresher shark (Alopias vulpinus) in the Southern California Bight. Doctoral Dissertation, UCSD: California Sea Grant College Program. Available from: http://www.escholarship.org/uc/item/3908d6cv.
- Cartamil, D., Wegner, N.C., Aalbers, S., Sepulveda, C.A., Baquero, A. and Graham, J.B., 2010. Diel movement patterns and habitat preferences of the common thresher shark (Alopias vulpinus) in the Southern California Bight. Marine and Freshwater Research, 61(5), pp.596-604.
- Cartamil, D.P., Sepulveda, C.A., Wegner, N.C., Aalbers, S.A., Baquero, A. and Graham, J.B., 2011. Archival tagging of subadult and adult common thresher sharks (Alopias vulpinus) off the coast of southern California. Marine Biology, 158(4), pp.935-944.
- Cartamil, D., Wraith, J., Wegner, N.C., Kacev, D., Lam, C.H., Santana-Morales, O., Sosa-Nishizaki, O., Escobedo-Olvera, M., Kohin, S., Graham, J.B. and Hastings, P., 2016. Movements and distribution of juvenile common thresher sharks Alopias vulpinus in Pacific coast waters of the USA and Mexico. Marine Ecology Progress Series, 548, pp.153-163.
- Preti, A., Smith, S.E. and Ramon, D.A., 2004. Diet differences in the thresher shark (Alopias vulpinus) during transition from a warm-water regime to a cool-water regime off California-Oregon, 1998-2000. California Cooperative Oceanic Fisheries Investigations Report, 45, p.118.
- Preti, A., Soykan, C.U., Dewar, H., Wells, R.D., Spear, N. and Kohin, S., 2012. Comparative feeding ecology of shortfin mako, blue and thresher sharks in the California Current. Environmental Biology of Fishes, 95(1), pp.127-146.
- Preti A (2020) Trophic ecology of nine top predators in the California Current. PhD dissertation, University of Aberdeen, Scotland, UK
- Sepulveda, C.A, C. Heberer, S.A. Aalbers**,** N. Spear, M. Kinney, D. Bernal and S. Kohin (2014). Post-release survivorship studies on common thresher sharks (*Alopias vulpinus*) captured in the southern California recreational fishery. *Fisheries Research*. 161:102–108
- Smith, S.E., Rasmussen, R.C., Ramon, D.A. and Cailliet, G.M., 2008a. The biology and ecology of thresher sharks (Alopiidae). In (M.D. Camhi, E.K. Pikitch and E.A. Babcock, eds) Sharks of the open ocean: biology, fisheries and conservation, pp.60-68.

Potential changes: Shortfin Mako Shark (*Isurus oxyrhinchus*)

- Much of the currently listed information comes from fisheries data, but new electronic tagging data are available for juvenile through adult mako sharks that better identify the coastal range within the California Current providing details on preferred depth, temperature and variations in movement patterns by season, sex and size (Nasby-Lucas et al. 2019, Nosel et al. 2019).
- A recent analysis of observer data from the California drift gillnet fishery from 1990-2017 showing that YOY and age-1 mako sharks were captured almost exclusively south of Point Conception in the SCB. It also shows that makos appear to expand their northward range as they grow, with catch rates north of Point Conception increasing with size (Nosal et al. 2019).
- New data on feeding habits from a study that sampled 330 mako sharks between 2002 and 2008, and also did a comparison of diet between subregion and size classes. (Preti et al. 2012, Preti 2020)

- Nasby-Lucas, N., Dewar, H., Sosa-Nishizaki, O., Wilson, C., Hyde, J.R., Vetter, R.D., Wraith, J., Block, B.A., Kinney, M.J., Sippel, T. and Holts, D.B., 2019. Movements of electronically tagged shortfin mako sharks (Isurus oxyrinchus) in the eastern North Pacific Ocean. Animal Biotelemetry, 7(1), p.12.
- Nosal, A.P., Cartamil, D.P., Wegner, N.C., Lam, C.H. and Hastings, P.A., 2019. Movement ecology of young-of-the-year blue sharks Prionace glauca and shortfin makos Isurus oxyrinchus within a putative binational nursery area. Marine Ecology Progress Series, 623, pp.99-115.
- Preti, A., Soykan, C.U., Dewar, H., Wells, R.D., Spear, N. and Kohin, S., 2012. Comparative feeding ecology of shortfin mako, blue and thresher sharks in the California Current. Environmental Biology of Fishes, 95(1), pp.127-146.
- Preti A (2020) Trophic ecology of nine top predators in the California Current. PhD dissertation, University of Aberdeen, Scotland, UK

Potential changes: Blue Shark (*Prionace glauca*)

- Much of the currently listed information comes from fisheries data, but new electronic tagging data are available for juvenile through adult blue sharks that better identify the coastal range within the California Current providing details on preferred depth, temperature and variations in movement patterns by season, sex and size (Nosel et al. 2019, Nasby-Lucas et al. in prep).
- A recent analysis of observer data 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).
- New data on feeding habits from a study that sampled 158 blue sharks between 2002 and 2008, and also did a comparison of diet between subregion and size classes. (Preti et al. 2012, Preti 2020)

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- Nosal, A.P., Cartamil, D.P., Wegner, N.C., Lam, C.H. and Hastings, P.A., 2019. Movement ecology of young-of-the-year blue sharks Prionace glauca and shortfin makos Isurus oxyrinchus within a putative binational nursery area. Marine Ecology Progress Series, 623, pp.99-115.
- Preti, A., Soykan, C.U., Dewar, H., Wells, R.D., Spear, N. and Kohin, S., 2012. Comparative feeding ecology of shortfin mako, blue and thresher sharks in the California Current. Environmental Biology of Fishes, 95(1), pp.127-146.
- Preti A (2020) Trophic ecology of nine top predators in the California Current. PhD dissertation, University of Aberdeen, Scotland, UK

Potential changes: Albacore Tuna (*Thunnus alalunga*)

- A recent study examined how juvenile albacore in the California Current use their oceanographic environment, and how their distributions overlap with the habitats of four key forage species (Muhling et al. 2019)
- New electronic tagging data shows seasonal movements, migration patterns and vertical distribution of juvenile albacore tuna off Southern California and Washington and Oregon (Childers et al 2011).
- Recent analysis of stomach samples taken in the SCB indicates important prey species (Madigan et al 2015).

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- Childers, J., Snyder, S. and Kohin, S., 2011. Migration and behavior of juvenile North Pacific albacore (*Thunnus alalunga*). Fisheries Oceanography, 20(3), pp.157-173.
- Muhling, B., Brodie, S., Snodgrass, O., Tommasi, D., Dewar, H., Childers, J., Jacox, M., Edwards, C.A., Xu, Y. And Snyder, S., 2019. Dynamic Habitat Use of Albacore and Their Primary Prey Species In The California Current System. California Cooperative Oceanic Fisheries Investigations Reports, 60, Pp.79-93.
- Madigan, D.J., Carlisle, A.B., Gardner, L.D., Jayasundara, N., Micheli, F., Schaefer, K.M., Fuller, D.W. and Block, B.A., 2015. Assessing niche width of endothermic fish from genes to ecosystem. Proceedings of the National Academy of Sciences, 112(27), pp.8350-8355.

Potential changes: Bigeye Tuna (*Thunnus obesus*)

- A recent study found that median phytoplankton size (MD50) is an informative environmental predictor of bigeye tuna recruitment in the Hawaii longline fishery (Woodworth-Jefcoats and Wren 2020)
- Additional information on prey species is available (Moteki et al 2001).

- Moteki, M., Arai, M., Tsuchiya, K. and Okamoto, H., 2001. Composition of piscine prey in the diet of large pelagic fish in the eastern tropical Pacific Ocean. Fisheries Science, 67(6), pp.1063-1074.
- Woodworth-Jefcoats, P.A. and Wren, J.L., 2020. Toward an environmental predictor of tuna recruitment. Fisheries Oceanography, 29, pp 436-441

Potential changes: Northern Bluefin Tuna (*Thunnus orientalis*)

- A recent study examined 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 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 in the Commercial Passenger Fishing Vessel and purse seine fisheries (Runcie et al. 2018).
- New electronic tagging data show repeatable seasonal movements along the west coast of North America. Fish showed latitudinal movement patterns that were correlated with peaks in coastal upwelling-induced primary productivity.(Boustany et al., 2010; Domeier et al., 2003).
- Recent analysis of stomach samples taken in the SCB updates information on important prey species (Madigan et al 2015).

- Boustany, A.M., Matteson, R., Castleton, M., Farwell, C. and Block, B.A., 2010. Movements of Pacific bluefin tuna (Thunnus orientalis) in the Eastern North Pacific revealed with archival tags. Progress in Oceanography, 86(1-2), pp.94-104.
- Domeier, M.L., Kiefer, D., Nasby-Lucas, N., Wagschal, A. and O'Brien, F., 2005. Tracking Pacific bluefin tuna (Thunnus thynnus orientalis) in the northeastern Pacific with an automated algorithm that estimates latitude by matching sea-surface-temperature data from satellites with temperature data from tags on fish. Fishery Bulletin, 103(2), pp.292-306.
- Madigan, D.J., Carlisle, A.B., Gardner, L.D., Jayasundara, N., Micheli, F., Schaefer, K.M., Fuller, D.W. and Block, B.A., 2015. Assessing niche width of endothermic fish from genes to ecosystem. Proceedings of the National Academy of Sciences, 112(27), pp.8350-8355.
- Runcie, R.M., Muhling, B., Hazen, E.L., Bograd, S.J., Garfield, T. and DiNardo, G., 2019. Environmental associations of Pacific bluefin tuna (Thunnus orientalis) catch in the California Current system. Fisheries Oceanography, 28(4), pp.372-388.

Potential changes: Yellowfin Tuna (*Thunnus albacares*)

- Updated information on diet (Moteki et al 2001, Madigan et al 2015).

- Madigan, D.J., Carlisle, A.B., Gardner, L.D., Jayasundara, N., Micheli, F., Schaefer, K.M., Fuller, D.W. and Block, B.A., 2015. Assessing niche width of endothermic fish from genes to ecosystem. Proceedings of the National Academy of Sciences, 112(27), pp.8350-8355.
- Moteki, M., Arai, M., Tsuchiya, K. and Okamoto, H., 2001. Composition of piscine prey in the diet of large pelagic fish in the eastern tropical Pacific Ocean. Fisheries Science, 67(6), pp.1063-1074.

Potential changes: Striped Marlin (*Tetrapturus audax*)

- Despite advancements to date from genomic and electronic tagging studies (Domeier 2006; Domeier et al., 2018), annual migration patterns remain poorly understood.
- Additional information on diet (Moteki et al 2001).
- Spawning occurs in coastal waters of the mouth of the Gulf of California (Armas et al. 1999)

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- Armas, R.G., Sosa-Nishizaki, O., Rodríguez, R.F. and Pérez, V.A.L., 1999. Confirmation of the spawning area of the striped marlin, Tetrapturus audax, in the so-called core area of the eastern tropical Pacific off Mexico. Fisheries Oceanography, 8(3), pp.238-242.
- Domeier, M.L., 2006. An analysis of Pacific striped marlin (Tetrapturus audax) horizontal movement patterns using pop-up satellite archival tags. Bulletin of Marine Science, 79(3), pp.811-825.
- Domeier, M.L., Ortega-Garcia, S., Nasby-Lucas, N. and Offield, P., 2019. First marlin archival tagging study suggests new direction for research. Marine and Freshwater Research, 70(4), pp.603-608
- Moteki, M., Arai, M., Tsuchiya, K. and Okamoto, H., 2001. Composition of piscine prey in the diet of large pelagic fish in the eastern tropical Pacific Ocean. Fisheries Science, 67(6), pp.1063-1074.

Potential changes: Broadbill Swordfish (*Xiphias gladius*)

- New data available on optimal sea surface temperature for swordfish (Dewar et al., 2011; Sepulveda et al., 2020)
- 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; Griffiths et al., 2020; Sepulveda et al., in preparation). 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.
- 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).
- Additional information on diet (Moteki et al 2001, Markaida and Hochberg, 2005).

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- Dewar, H., Prince, E.D., Musyl, M.K., Brill, R.W., Sepulveda, C., Luo, J., Foley, D., Orbesen, E.S., Domeier, M.L., Nasby-Lucas, N. and Snodgrass, D., 2011. Movements and behaviors of swordfish in the Atlantic and Pacific Oceans examined using pop-up satellite archival tags. Fisheries Oceanography, 20(3), pp.219-241..
- Griffiths, S., Sepulveda, C. and Aalbers, S., 2020. Movements of swordfish (Xiphias gladius) in the northeastern Pacific Ocean as determined by electronic tags (2002-2019). ISC Billfish Working Group. ISC/20/BILLWG-01/10
- Moteki, M., Arai, M., Tsuchiya, K. and Okamoto, H., 2001. Composition of piscine prey in the diet of large pelagic fish in the eastern tropical Pacific Ocean. Fisheries Science, 67(6), pp.1063-1074
- Sepulveda, C.A., Wang, M., Aalbers, S.A. and Alvarado-Bremer, J.R., 2020. Insights into the horizontal movements, migration patterns, and stock affiliation of California swordfish. Fisheries Oceanography, 29(2), pp.152-168.

Potential changes: Dorado (Mahimahi, *Coryphaena hippurus*)

- New data on feeding habits for dorado (Olson and Galván-Magaña 2002, Torres-Rojas et al. 2014, Tripp-Valdez et al. 2015)

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- Olson, R.J. and Galván-Magaña, F., 2002. Food habits and consumption rates of common dolphinfish (Coryphaena hippurus) in the eastern Pacific Ocean. Fishery Bulletin, 100(2), pp.279-298.
- Torres-Rojas, Y.E., Hernandez-Herrera, A., Ortega-Garcia, S. and Soto-Jiménez, M.F., 2014. Feeding habits variability and trophic position of dolphinfish in waters south of the Baja California Peninsula, Mexico. Transactions of the American Fisheries Society, 143(2), pp.528-542.
- Varela, J.L., Lucas-Pilozo, C.R. and González-Duarte, M.M., 2017. Diet of common dolphinfish (Coryphaena hippurus) in the Pacific coast of Ecuador. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, 97(1), p.207.

Summary

- New information is available for HMS EFH descriptions due to advancements in electronic tagging data over the last 17 years, providing important data on migration patterns, preferred depth and temperature data, and additional environmental preferences through remote sensing data. Also show variations in movement patterns by season, sex and size
- New studies also available on feeding ecology
- New mapping technology available to update EFH maps by species

Conclusions

- New information generally supports the original descriptions of general distribution and trophic interactions
- There is some updated information on prey items
- New information from electronic tagging studies indicate that several HMS species are present farther inshore than currently indicated in the HMS EFH descriptions
- Tagging data also provide new details of habitat utilization linked with environmental data (i.e. SST and Chlorophyll a)