4 DATA INTEGRATION

This chapter intends to advance ecosystem-based fishery management of Western Pacific pelagic fisheries by examining the fisheries in the context of marine ecosystems. The Council convened a two-day workshop on November 30th-December 1st, 2016, to identify content for this chapter. The pelagic fisheries group suggested this chapter focus on three topical issues: 1) bycatch (with a focus on protected species factors that may influence interaction rates; 2) a socioeconomics section examining fishery performance in two areas: attrition in American Samoa longline fleet and the decline of shallow-se longline swordfish fishery; and 3) the projected decrease in oceanic productivity with implications for management issues, including a discussion of factors influencing significant changes in the CPUE of target species.
Initially, this chapter will include abstracts of recent publications and a qualitative discussion of these research results with respect to data streams included in Chapters 2 and 3. In later years the subject of the publications may be updated through the SAFE report process as more data become available and an update may have significance for management. The 2019 Pelagic Fishery Ecosystem Plan Team recommended action items including directing Council staff and PIRO Sustainable Fisheries Division (SFD) to update the SAFE report data integration section with regularity and to include notable changes or issues pertinent to the FEP as a guide for adaptive management; this may also include compiling abstracts on recent relevant studies. The Plan Team also noted that Council staff should work with PIRO SFD to review thematic priorities that were previously identified in the Data Integration Workshop going forward.

4.1 FACTORS INFLUENCING SEABIRD INTERACTION RATES IN THE HAWAII LONGLINE FISHERY

Seabird mitigation measures implemented in the Hawaii longline fishery in the early 2000s significantly reduced Laysan and black-footed albatross interaction rates (Gilman et al. 2008). The fishery has since seen a gradual increasing trend in albatross interaction rates, especially for black-footed albatrosses. Recent analysis conducted by Gilman et al. 2016 using data from October 2004 to May 2014 indicated that seabird interaction rates in the deep-set longline fishery significantly increased as annual mean multivariate ENSO index (MEI) values increased, suggesting that decreasing ocean productivity may have contributed to the increasing trend in seabird catch rates. The analysis also showed a significant increasing trend in the number of albatrosses following vessels, which may also be contributing to the increasing seabird catch rates. An earlier analysis of seabird interactions in the shallow-set longline fishery also indicated that catch rates significantly increased with increased albatross density (Gilman et al. 2014). The deep-set longline fishery analysis showed that both side setting and blue-dyed bait significantly reduced the seabird catch rate compared to stern setting and untreated bait, respectively (Gilman et al. 2016). Of two options for meeting regulatory requirements, side setting had a marginally significantly lower seabird catch rate than blue-dyed bait (Gilman et al. 2016).

From 2015 to 2016, black-footed albatross interaction rates in the deep-set and shallow-set longline fishery exhibited continued increasing trends, with substantially higher number of interactions and interaction rates in the deep-set fishery, although the estimated total interactions and interaction rates are still substantially lower than pre-seabird measure years. Laysan albatross interaction rates were similar or lower in 2015 and 2016 compared to previous years in both the deep-set and shallow-set longline fishery. The higher number of overall seabird interactions in 2015 and 2016 coincided with the strong El Niño (see Section 3.3.3) and the high MEI values, suggesting that the recent interaction trend is consistent with the findings of Gilman et al. 2016.

At its 166th Meeting in June 2016, the Council directed the Plan Team and the Protected Species Advisory Committee to continue monitoring interactions through the SAFE report to detect any future changes in albatross interactions that may be attributed to fishing operations. The Council noted that current seabird measures implemented in the Hawaii longline fishery are effective and recent increase in seabird captures are driven by non-fishery factors at this time. The Council additionally recommended research to be conducted, as appropriate, on at-sea foraging behavior of albatross species to improve understanding of interaction rates in the Hawaii longline fisheries.

The Council and NMFS Pacific Island Regional Office will continued undertaking efforts in 2018 and 2019 to improve the understanding of the factors underlying the higher seabird interaction rates in 2015 through 2017 through data analyses and an expert workshop. Results of these efforts can be found in the Protected Species section of this report (Section **Error! Reference source not found.**).

4.2 ATTRITION IN LONGLINE FLEETS

4.2.1 AMERICAN SAMOA LONGLINE

A downward trend of economic returns to the American Samoa longline fishery for the period of 2007 to 2013 has been observed in a recent economic study (Pan et al. 2017). This decline continues based on results from ongoing Pacific Islands Fisheries Science Center (PIFSC) Socioeconomics Program economic data collection and performance indicator monitoring programs. Based on data from a 2009 cost-earnings study on the fishery researchers found that the economic performance of the American Samoa longline fleet is highly sensitive to changes in albacore price, fuel prices, and the CPUE of albacore (Pan et al. 2017). The fishery was hit hard in 2013, when all three of these elements trended in the wrong direction, resulting in negative impacts to profit (Pan 2015). In early 2014, the majority of vessels in the American Samoa longline fleet were tied up at the docks in Pago Pago, and according to the *Samoa News*, "For Sale" signs had been posted on close to 20 (of the 22) active vessels[1].
Based on the analyses, the situation in 2013 was clearly associated with poor economic performance resulting from: (a) a continuous decline in albacore CPUE, (b) increasing fuel price, (c) a sharp drop in market prices for albacore, and (d) a baseline of limited profit margins resulting from a long term downward trend of net return since 2007 (Pan 2015). The previous cost-earnings study indicated that the fleet in 2009 operations was barely profitable where the albacore CPUE was at 14.8 fish per 1,000 hooks, the fuel price was at $2.53 (adjusted to 2013 value), and the market price for the albacore species was $1.00/lb. ($2,200 per mt). However, in 2013, the CPUE for albacore fell to 11.9 fish per 1,000 hooks (versus 14.8 in 2009) and the fuel price increased to $3.20 per gallon (versus $2.53 in 2009, adjusted to 2013 value). The albacore price in 2013 was similar to the 2009 level but it was a sharp drop compared to the price of

[1] http://www.samoanews.com/tri-marine-says-local-longline-fleet-vital-economy

$1.47/lb. in the previous year (2012). Thus, these changes yielded extensive losses across the fleet in 2013.

It is worth noting that the continuing decline of the American Samoa longline fishery during this period was not an isolated event, but was a part of a region-wide economic collapse of the South Pacific albacore fishery. According to a report of the SPC Fisheries Newsletter #142 (September to December 2013), domestic fishing fleets targeting primarily albacore in Pacific Island Countries and Territories (PICTs) had reported difficulties in maintaining profitability in recent years, probably facing the challenges in fuel price rise, and albacore CPUE and price decline[2]. Ongoing PIFSC Socioeconomics Program economic monitoring programs will allow researchers to provide timely updates on future changes in economic performance for the American Samoa longline fishery.

4.2.2 HAWAII LONGLINE: SHALLOW-SET FISHERY

Gear configuration for Hawaii longline vessels is rather flexible as operations can easily be adjusted to change target species between swordfish or tuna fishing trips. Tuna fishing (deep-set fishery) has shown steady increases in both effort (hooks) and catch over the past two decades, while swordfish fishing (shallow-set fishery) has experienced a steady downward trend during the same period (Pan 2014). Since its closure and reopening in the early 2000s, the shallow set fishery has yet to recover even halfway to levels during its historical peak in the early 1990s. Diminishing economic performance of shallow-set fishing may have contributed to the overall decline of the shallow set fishery, in addition to regulatory measures in controlling sea turtle interactions within the fishery. The Pacific Islands Fisheries Science Center (PIFSC) Socioeconomics Program economic data collection has documented declining net returns to the fishery during the period of 2005-2014, while the average net revenue for tuna trips has generally increased over the same period of time (Pan, 2016).

Trends in swordfish and tuna trip costs have been similar over the years; however, swordfish trip revenues have fluctuated widely over the years unlike the relatively steady increase in tuna trip revenue over time (see Chapter 2). As a result, the average net revenue of swordfish trips moved up and down during 2005 to 2014. Prior to 2008, the average net revenue of a tuna trip was less than 50% of the average net revenue of a swordfish trip. In 2014, the level of the average tuna trip net revenue, $32,100, was much closer to the level of the average swordfish trip net revenue, $33,446. Yet, a swordfish trip usually lasts longer than a tuna trip, so the average net returns per day at sea for a swordfish trip are lower than for a tuna trip. Thus, tuna fishing seems to have an increasing comparative advantage over swordfish fishing in terms of trip-level economic returns. Without improved economic performance for swordfish fishing, there may not be much economic incentive to increase fishing effort for swordfish in the future.

Economic performance of longline fishing is the combined effect of many factors, but the key factors that determine the net revenue of Hawaii longline fishing may include: a) prices of target species, b) CPUE of the target species, c) fuel prices, and d) regulatory effects.

4.2.2.1 WEAKENED SWORDFISH MARKET

The weakened swordfish market has been a disincentive for Hawaii fishermen to re-engage in the swordfish fishery in recent years. Unlike bigeye tuna, which is mainly consumed in Hawaii's

[2] http://www.spc.int/coastfish/publications/bulletins/419-spc-fisheries-newsletter-142.html

local market, the majority of the swordfish landed in Hawaii and used to be exported to the U.S. mainland where it competed with imports from other nations and the Atlantic. Concern over mercury contamination could have possibly contributed to decreased demand as well. In early 1990, bigeye and swordfish ex-vessel prices in the Hawaii market were similar at around $4.50 per pound. From 1994 to 2009, swordfish prices declined while bigeye prices have held relatively stable. In recent years, the price differential between these two species has increased. For example, in 2008 the ex-vessel price of bigeye tuna was $4.12 per pound while the ex-vessel price of swordfish was only $2.08 per pound.

4.2.2.2 CPUE DECLINES FOR SWORDFISH TRIPS

Swordfish CPUE was high at the beginning of the time series, being above 15 fish per 1,000 hooks in the years of 2005, 2006, and 2007. It has decreased since 2007, dropping to its lowest in 2010 with only 10 fish per 1,000 hooks. The swordfish CPUE has slightly increased and then remained unchanged in recent years. Bigeye CPUE, on the other hand, shows a different trend; it was quite steady from 2005 to 2012, and has increased continuously in the last four years from 3.8 fish per 1,000 hooks in 2012 to approximately 4.5 fish per 1,000 hooks in 2015.

4.2.2.3 FUEL PRICES

While the two types of fisheries face the same fuel market, trip costs, revenues, and subsequent net revenues can vary across the deep-set and shallow-set fisheries. As previously stated, PIFSC Socioeconomics Program economic data collection programs have documented declining net returns to the swordfish fishery during the period from 2005 to 2014, while the average net revenue for tuna trips has generally increased over the same period of time (Pan, 2016).

4.2.2.4 SUDDEN CLOSURES DURING FISHING SEASON

Due to hitting the sea turtle caps, the fishery experienced closures in 2006 and 2011 respectively. The sudden closures had interrupted the normal fishing trip cycle and might have resulted in economic loss to the fishermen as a fishing trip had to be ended no matter if the catch was fully loaded as planned. In the case of 2006, the closure brought back all the swordfish fishing vessels to port, flooding the swordfish market, which in turn constrained air shipping capacity and limited local consumption.

4.2.3 FACTORS AFFECTING CPUE OF TARGET SPECIES

The work of PIFSC researchers in spatial and temporal changes in Hawai‘i longline fishery catch and their potential for forecasting future fishery performance are excerpted below from the briefing document provided for the 124th meeting of the Council's Scientific and Statistical Committee (SSC). Authors include Phoebe Woodworth-Jefcoats, Johanna Wren, Jeff Drazen and Jeff Polovina[3]. Additional explanatory text was provided by Phoebe Woodworth-Jefcoats (pers. comm.)

A comprehensive examination of the spatial and temporal trends in the Hawai‘i-based longline fishery over the past 20 years was conducted using three fisheries-dependent data sets: logbook

[3] Factors behind the recent rise in bigeye CPUE in the Hawaii longline fishery. Documented submitted for Western Pacific Fishery Regional Management Council 124th Scientific and Statistical Committee Meeting, October 4 to October 6, 2016, Honolulu, Hawaii, 4 p.

(1995-2016), observer (2006-2016), and dealer (2000-2016) data. Logbook data completed by fishermen provides catch, effort, and catch location data of landed species for all vessels in the fleet, while observer data provides lengths of every third fish caught, including discards, but only ~20% of vessels have an observer on board. Dealer data provides weight of all fish sold at the Honolulu Fish Auction and can be matched with logbook data for each vessel trip.

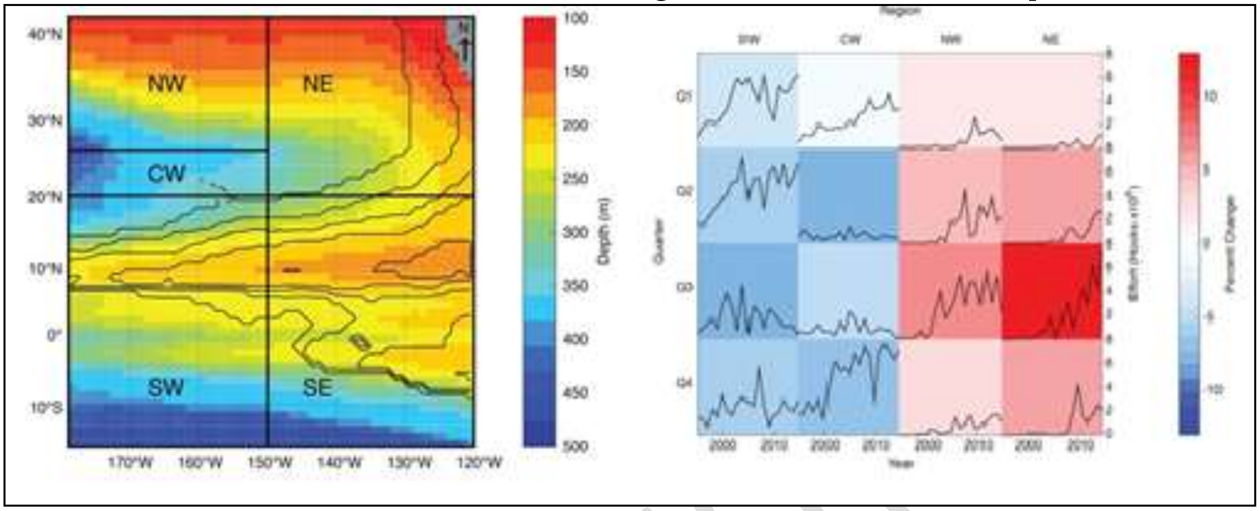

Figure 1. Left: Map depicting the five regions by which the fishery is examined overlaid on the climatological (1995-2015) median depth of preferred thermal habitat

Note: (8 – 14 °C, shaded) and the depth of the 1 mL/L oxygen threshold (contoured every 100 m from 100 to 500 m, with stippling where the depth is less than 100 m). Right: The difference between the proportion of total annual effort set in each region and quarter from the beginning (1995 – 1997 mean) to the end (2013 – 2015 mean) of the time series is shaded. Total annual effort in each region and quarter is plotted in black. Note: nearly no effort is deployed in the SE region.

The deep-set longline fishery, which targets bigeye tuna, has expanded considerably over the past two decades. Not only has total effort increased from nearly 8.4 million hooks set in 1995 to over 47 million hooks set in 2015, but the spatial footprint of the fishery has expanded as well. At the beginning of the time series, nearly all (97%) of Hawai‘i’s deep-set effort was set in the fishery’s core operating area south of 26°N and west of 150°W, whereas in 2015 over 40% of the deep-set effort was set either north or east of these bounds. This expansion is most prominent in the third quarter of the year (Figure 1).

The marked northeastward expansion of the fishery appears to have several drivers. First, it is possible that waters closer to Hawai‘i were unable to support an increase in effort due to both Hawai‘i-based and international effort. Waters northeast of Hawai‘i had little to no international competition. Second, bigeye catch rates within the fishery’s core operating area are lowest in the third quarter of the year. However, during this quarter catch rates are still high in waters to the northeast of Hawai‘i. Finally, preferred bigeye thermal habitat and oxygen levels overlap most completely with deep-set gear in waters to the northeast of Hawai‘i (Figure 1). This overlap could act to increase bigeye’s catchability, and in turn catch rates, in northeastern waters. The fishery expanded spatially in the third quarter in response to low target catch rates. In waters to the northeast of Hawai‘i the fleet faced little competition and found a particularly efficient fishing ground due to its local oceanography.

One consequence of the fishery's spatiotemporal expansion has been an increase in the amount of lancetfish caught. Lancetfish have no commercial value and all catches are discarded. Lancetfish catch rates are highest north of 26°N and in the third quarter. Thus, the fishery is deploying more effort both in the region where lancetfish are most commonly caught and at the time when catch rates are highest. This has resulted in lancetfish catches exceeding bigeye catches for the past decade (Figure 184).

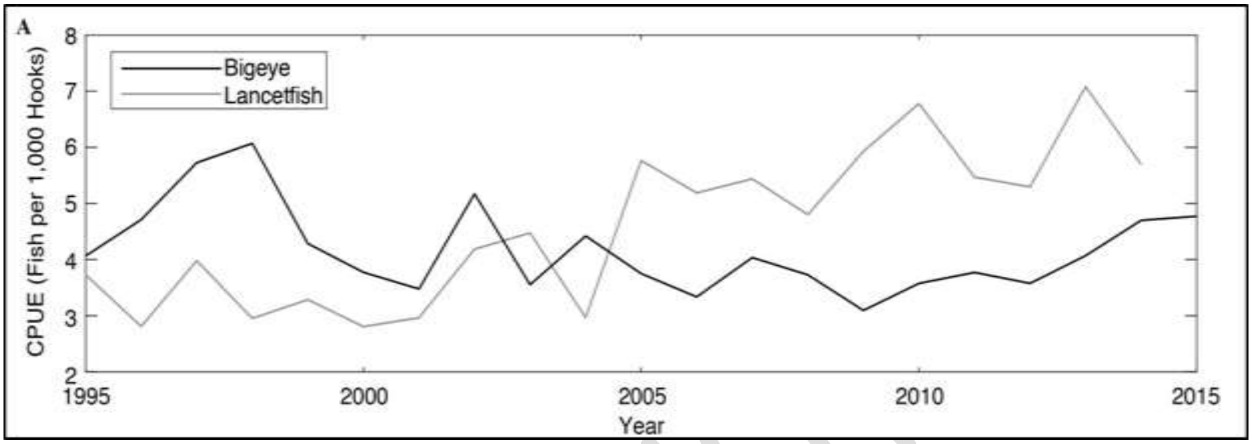

Figure 2. Annueal deep-set bigeye tuna (black) and lancetfish (gray) CPUE

Trends in productivity and catch rates in the fishery over the past decades may be caused by spatiotemporal changes in the fishery itself, changes in the stock, or both. In order to better understand these trends A General Additive Models (GAM) was built to analyze time series of mean weight, catch per unit effort (CPUE, in number of fish caught per 1000 hooks) and weight per unit effort (WPUE, in kg caught per 1000 hooks). The GAM a llowed researchers to tease apart trends caused by changes in the stock from those caused by changes in seasonality and geographic location of the fishery. Over the past 16 years, mean weights of commercially important fish in the Hawai‘i- based longline fishery have declined 10%.

This is in part due to a decline in mean weight by five out of the eleven most commonly caught species, and partly due to a change in species composition of the catch. Smaller fishes, such as pomfrets and walu, are becoming more common while larger fishes, such as opah and striped marlin, make up a lesser proportion of the total catch (Figure 3A). Because more small fish, and more small fish species are caught, the productivity of the fishery (WPUE) declined by 53% since 2000, but the shift in area and seasonality of fishing effort helped maintain productivity in the fishery (Figure 3C).

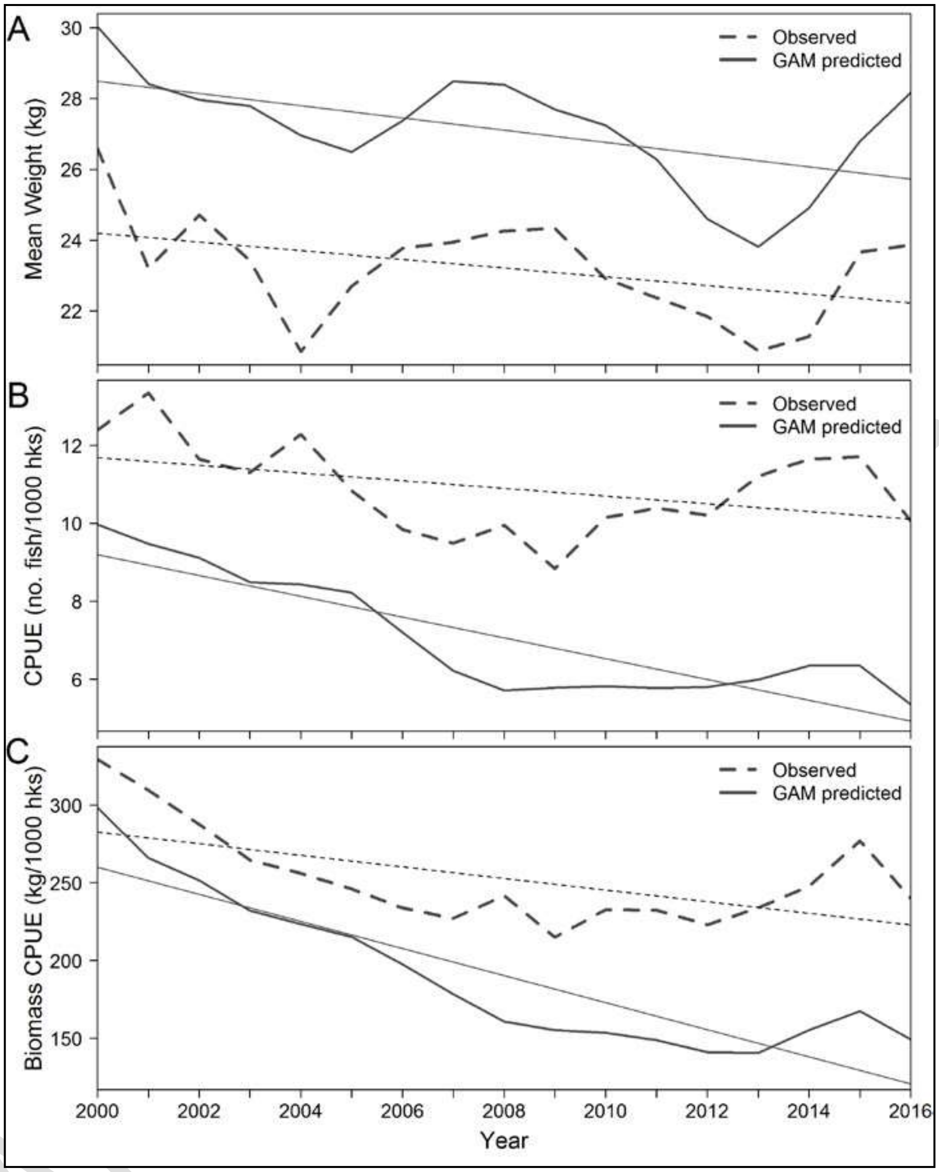

Figure 3. Mean weight (A), catch per unit effort (B), and weight per unit effort (WPUE) for all fish in the Hawai‘i-based longline fishery from dealer provided data.

Note: The dashed lines show the annual values from the dealer data with a linear trend line, and the solid line shows the GAM predicted annual values with linear trend lines.

CPUE has increased slowly since 2008, but when accounting for the increase in effort and geographic shift of the fishery, CPUE has remained stable. The recent peaks in both CPUE and WPUE are largely due to a strong recruitment pulse of bigeye tuna entering the fishery in the third quarter of 2013. This recruitment pulse in the fishery can be followed through 2016, where it provides an increase in first CPUE then WPUE. A recruitment index could be generated for bigeye tuna that provides a forecast of fishery performance. A peak in small bigeye tuna (<=15kg) is an indication that there will be an increase in CPUE and WPUE in the following two years (Figure 4).

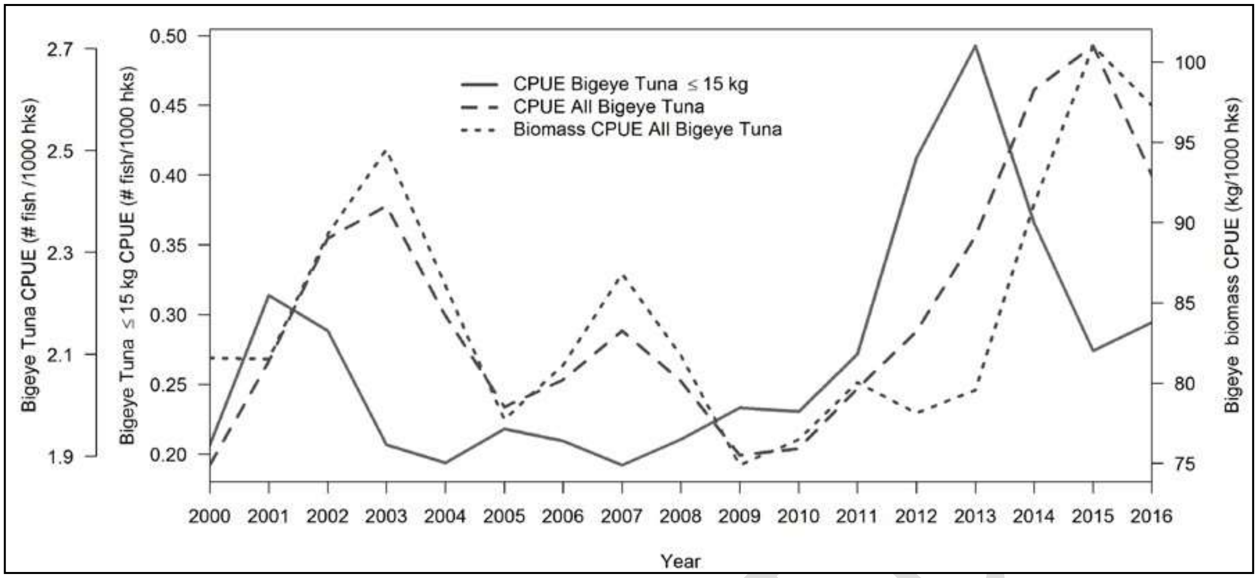

Figure 4. Temporally- and spatially-adjusted annual catch per 1000 hooks
Note: (CPUE; dashed line), and biomass per 1000 hooks (WPUE) for all bigeye tuna and bigeye tuna 15 kg or less (solid line) from the GAM from 2000-2016.

Additional reading on the influence of environmental impacts on tuna populations can be found in Lehodey et al. (2010) and Lehodey et al. (2013).

4.3 ABSTRACTS FROM RECENT RELEVANT STUDIES

In this section, abstracts from primary journal articles published in 2019 and relevant to data integration are compiled. Collecting the abstracts of these articles is intended to further the goal of this section being used to guide adaptive management.

Chang, Y.J., Winker, H., Sculley, M., and J. Hsu, 2019. Evaluation of the status and risk of overexploitations of the Pacific billfish stocks considering non-stationary population processes. *Deep Sea Research Part II: Topical Studies in Oceanography*, 104707.

Fish population processes could exhibit non-stationary behaviour as a stochastic biological process with temporal autocorrelation that may be influenced by environmental changes. Here we developed a Bayesian autoregressive state-space surplus production modelling framework to explore potential non-stationarity in population processes. We then evaluated the consequence of non-stationary population processes on the future risk of overexploitation for three Pacific billfish stocks (striped marlin, *Kajikia audax*; blue marlin, *Makaira nigricans*; and swordfish *Xiphias gladius*) that are formally assessed on a regular basis by a Regional Fisheries Management Organization in the Pacific Ocean. The results showed evidence of non-stationary population processes for Western and Central North Pacific Ocean (WCNPO) striped marlin, and to a lesser extent, Pacific blue marlin and WCNPO swordfish. Trends in the theoretical maximum sustainable yield and intrinsic growth rate were observed as oscillating regimes for swordfish, and as long-term directional changes for striped marlin. The non-stationary population processes did not strongly influence the forecasted biomass trend at the current catch level for any of the three stocks. However, the future risk of overexploitation (Prob[$B < B_{MSY}$]) was sensitive to changes in the population processes for striped marlin (increased the risk by 20%). This work illustrates that the inclusion of non-stationary population processes could impose challenges for developing a stock rebuilding plan and provides a framework to account for non-stationary population processes for the billfish stocks in the Pacific Ocean.

Gove, J.M., Whitney, J.L., McManus, M.A. et al., 2019. Prey-size plastics are invading larval fish nurseries. *Proceedings of the National Academy of Sciences of the United States of America, 116*(48). Pp. 24143-24149.

Life for many of the world's marine fish begins at the ocean surface. Ocean conditions dictate food availability and govern survivorship, yet little is known about the habitat preferences of larval fish during this highly vulnerable life-history stage. Here we show that surface slicks, a ubiquitous coastal ocean convergence feature, are important nurseries for larval fish from many ocean habitats at ecosystem scales. Slicks had higher densities of marine phytoplankton (1.7-fold), zooplankton (larval fish prey; 3.7-fold), and larval fish (8.1-fold) than nearby ambient waters across our study region in Hawaiʻi. Slicks contained larger, more well-developed individuals with competent swimming abilities compared to ambient waters, suggesting a physiological benefit to increased prey resources. Slicks also disproportionately accumulated prey-size plastics, resulting in a 60-fold higher ratio of plastics to larval fish prey than nearby waters. Dissections of hundreds of larval fish found that 8.6% of individuals in slicks had ingested plastics, a 2.3-fold higher occurrence than larval fish from ambient waters. Plastics were found in 7 of 8 families dissected, including swordfish (Xiphiidae), a commercially targeted species, and flying fish (Exocoetidae), a principal prey item for tuna and seabirds. Scaling up across an ∼1,000 km^2 coastal ecosystem in Hawai'i revealed slicks occupied only 8.3% of ocean surface habitat but contained 42.3% of all neustonic larval fish and 91.8% of all floating plastics. The ingestion of plastics by larval fish could reduce survivorship, compounding threats to fisheries productivity posed by overfishing, climate change, and habitat loss.

Merkens, K.P., Simonis, A.E., and E.M. Oleson, 2019. Geographic and temporal patterns in the acoustic detection of sperm whales *Physeter macrocephalus* in the central and western North Pacific Ocean. *Endangered Species Research*, *39*, pp. 115-133.

The easily identifiable, high-amplitude echolocation signals produced by sperm whales Physeter macrocephalus make the species ideal for long-term passive acoustic monitoring. Sperm whale signals were manually identified in the recordings from high-frequency acoustic recording packages monitoring 13 deep-water locations across the central and western North Pacific Ocean from 2005 to 2013, constituting the longest passive acoustic study of sperm whales to date. The species was detected at all of the sites, with the highest detection rate at Ladd Seamount (>18% of analyzed periods) and the lowest rates at equatorial sites (<1% of analyzed periods). Generalized additive models and generalized estimating equations were used to produce explanatory models to assess temporal and geographic patterns. The model variables included diel phase, lunar day, day of the year, year, and site. The site-specific variability in detection rates was high across the North Pacific, but there were also common patterns, including a seasonal trend, with decreased detections during the summer or fall, and a diel trend, with increased detections at night. There appeared to be a seasonal movement pattern, with minimum detection rates occurring later in the year at more northerly sites. The nocturnal pattern was seen across all data sets but was not strong at equatorial locations. Although lunar cycles were important at many sites, there was no consistent trend at any spatial scale. Overall, this analysis confirms the broad distribution of sperm whales across the North Pacific and highlights the subtle temporal patterns in their acoustic activity, which may be related to shifts in animal behavior or movement.

Runcie, R.M., Muhling, B., Hazen, E.L., Bograd, S.J., Garfield, T., and G. DiNardo, 2019. Environmental associations of Pacific bluefin tuna (*Thunnus orientalis*) catch in the California Current system. *Fisheries Oceanography*, *28*, pp. 372-388.

We investigate the impact of oceanographic variability on Pacific bluefin tuna (*Thunnus orientalis*: PBF) distributions in the California Current system using remotely sensed environmental data, and fishery-dependent data from multiple fisheries in a habitat-modeling framework. We 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 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/m^3) increased probability of occurrence of PBF in the Commercial Passenger Fishing Vessel and purse seine fisheries. These associations were particularly evident during a recent marine heatwave (the "Blob"). In contrast, PBF were most likely to be encountered on drift gillnet gear in somewhat cooler waters (13–18°C), with moderate chlorophyll concentrations (0.5–1.0 mg/m^3). This discrepancy was likely a result of differing spatiotemporal distribution of fishing effort among fleets, as well as the different vertical depths fished by each gear, demonstrating the importance of understanding selectivity when building correlative habitat models. In the future, monitoring and understanding environmentally driven changes in the availability of PBF to commercial and recreational fisheries can contribute to the implementation of ecosystem approaches to fishery management.

Woodworth-Jefcoats P.A., Blanchard J.L., and J.C. Drazen, 2019. Relative Impacts of Simultaneous Stressors on a Pelagic Marine Ecosystem. *Frontiers in Marine Science*, *6*, p. 383.

Climate change and fishing are two of the greatest anthropogenic stressors on marine ecosystems. We investigate the effects of these stressors on Hawaii’s deep-set longline fishery for bigeye tuna (*Thunnus obesus*) and the ecosystem which supports it using a size-based food web model that incorporates individual species and captures the metabolic effects of rising ocean temperatures. We find that when fishing and climate change are examined individually, fishing is the greater stressor. This suggests that proactive fisheries management could be a particularly effective tool for mitigating anthropogenic stressors either by balancing or outweighing climate effects. However, modeling these stressors jointly shows that even large management changes cannot completely offset climate effects. Our results suggest that a decline in Hawaii’s longline fishery yield may be inevitable. The effect of climate change on the ecosystem depends primarily upon the intensity of fishing mortality. Management measures which take this into account can both minimize fishery decline and support at least some level of ecosystem resilience.

Wren, J.L.K, Shaffer, S.A., and J.J. Polovina, 2019. Variations in black-footed albatross sightings in a North Pacific transitional area due to changes in fleet dynamics and oceanography 2006–2017. *Deep Sea Research Part II: Topical Studies in Oceanography*, *169*, 104605.

A serious threat to pelagic seabird populations today is interactions with longline fisheries. While current seabird mitigation efforts have proven successful in substantially reducing seabird interactions in the Hawai‘i-based longline fishery, black-footed albatross (*Phoebastria nigripes*) interactions have increased. In an effort to better understand when and where these interactions take place, we explore the relationship between black-footed albatross sightings in the Hawai‘i-based deep-set longline fishery and fleet dynamics and environmental variables. Environmental drivers include both large scale climate variability due to the Pacific Decadal Oscillation (PDO) and El Niño – Southern Oscillation, as well as local oceanographic and atmospheric drivers, such as wind patterns, sea surface temperature, and surface chlorophyll. Using generalized linear models, we found that while season, latitude, and longitude of fishing explained much of the variation throughout the time series, both large scale and local climate variables – positive PDO, strong westerly winds, and sea surface temperature fronts – explained the increase in black-footed albatross sightings in recent years. Black-footed albatross nest in the Northwestern Hawaiian Islands, and their main foraging habitat while nesting are the productive fronts to the north and east of the Hawaiian Islands. During a positive PDO, a more intense and expanded Aleutian Low shifts westerly winds southward, replacing trade winds in the northern region of the longline fishing grounds. The expanded westerly winds may have two impacts. Firstly, they drive productive surface waters to the south, increasing the overlap of the albatross foraging grounds and the deep-set fishing grounds. Secondly, when westerlies move south, more birds transit through the fishing grounds to the east rather than traveling north to reach the westerlies before traveling eastward north of the fishing grounds. Because PDO operates on decadal timescales, the high levels of sightings and interactions may persist for many years.