Population-level impacts of proposed incidental take of olive ridley, loggerhead, and green turtles in the Hawaii deep-set longline fishery

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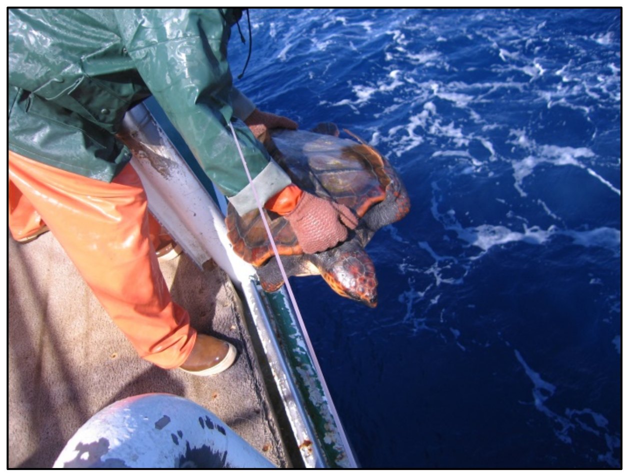

Left: Central South Pacific green turtle returning to see after nesting with satellite tag attachment (Rose Atoll National Wildlife Refuge, photo PIFSC MTBAP). Right: North Pacific loggerhead turtle release after interaction with Hawaii longline vessel (photo PIRO Observer Program).

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1. INTRODUCTION

In July 2016, NMFS Pacific Islands Regional Office (PIRO) requested that NMFS Pacific Islands Fisheries Science Center (PIFSC) analyze the population-level effects of incidental take of olive ridley, loggerhead, and green turtles in the Hawaii deep-set longline fishery. Specifically, PIRO needed to determine the impact of a proposed fishery action on adult female turtles and the significance of the proposed level of take on the breeding populations of impacted turtles. At the time of the request, the Protected Resources Division (PRD) of PIRO was conducting a formal consultation under the Endangered Species Act (ESA) due to the exceedance of take for the 2014 Biological Opinion's incidental take statement for these turtle species in the Hawaii deep-set longline fishery. For the consultation, PRD estimated the fishery could take up to 61 olive ridley and 6 loggerhead turtles annually, along with 12 green turtles from six Distinct Population Segments (DPSs): 4 from the East Pacific DPS, 2 from the Central North Pacific, 2 from the East Indian-West Pacific, 2 from the Southwest Pacific, 1 from the Central West Pacific, and 1 from the Central South Pacific. This report summarizes the analysis PIFSC provided to PIRO to assist with their analysis of population-level impacts from the fishery action.

2. OVERVIEW OF FISHERIES IMPACT ASSESSMENT METHODS

Nesting female population abundance

Marine turtles are tied to land for ovipositioning (i.e., egg laying), with female turtles returning to the vicinity of their natal beach to nest every 2-5 years once reaching sexual maturity. It is relatively easy to monitor nesting activity and collect census data on nesting beaches, especially compared to the challenges of studying marine turtle populations at sea. Therefore, the number of nesting female turtles (total nester abundance) is commonly used as an index of abundance for marine turtle populations. PIFSC assessments of fishery impacts on turtle populations translate bycatch levels into nester equivalents to facilitate comparison of the bycatch with a known index of abundance. The use of nester equivalents assumes that the number, status, and trends of nesting females are representative proxies for the entire population.

Estimates of total nester abundance for a species or population are based on best science available at the time of an assessment. The quality of available data varies by species and population; thus, our estimation approach varies depending on the type of data available. For some populations, every nester is counted annually through saturation monitoring, and estimates of total nester abundance are available. For other populations, only nests are counted, and sometimes sporadically, across years. For those populations, we may need to combine nest counts with other biological parameters (e.g., clutch frequency, remigration interval) to estimate total nester abundance. Additionally, for some species or populations, available data may only represent a portion of the nesting beaches for that population, and we conservatively use the available data as a minimum index.

For each species, we consider which populations the fishery may potentially impact based on historical fishery observer data and genetic analysis. For some species, DPSs have already been defined, and we analyze possible impacts to each DPS separately. For other species, DPSs have not yet been delineated, but we may have enough information (e.g., genetic differentiation) to warrant treating populations separately when analyzing fishery impacts.

Adult nester equivalents (ANEs)

For each species or DPS, PIRO provides PIFSC with a total number of proposed takes (interactions), and PIFSC estimates the corresponding number of adult female deaths – the adult nester equivalent (ANE) –

using the best available data. The ANE is a useful metric because it can be compared to the total number of nesting females in a population, typically the only available index of abundance. To calculate ANE for a population, three adjustment factors are required: 1) adult equivalence of juveniles (probability of juveniles naturally surviving to become adults), 2) ratio of females in the population (female to male sex ratio), and 3) probability that a turtle will die if it interacts with the fishery (not all interactions lead to death). The first factor, adult equivalence, accounts for the fact that juvenile turtles interacting with the fishery have some probability of natural (non-fishery) mortality prior to becoming adults, and therefore have a lower reproductive value than adults (also known as Relative Reproductive Value; Bolten et al. (2011)). Calculating the adult equivalence of a turtle requires fishery observer data on its length and estimates of length at maturity, growth rates, and stage-specific survival rates for the population. The second factor, ratio of females in the population, comes from published studies, either on the specific population or from similar populations elsewhere if data are limited. The third factor, the probability of mortality given an interaction occurs, comes from fishery observer data, where turtles are either confirmed dead by the observer or assigned a post-release mortality probability using the criteria in Ryder et al. (2006). For a given species, we apply the three adjustment factors to all previously observed interactions in the DSLL fishery, producing individual ANEs. Summing the individual ANEs and dividing the total by the number of observed interactions yields an empirical ANE rate. For each potentially impacted population, we apply the empirical ANE rate for the species to the proposed number of interactions to yield an estimated ANE for the proposed fishery action. In cases where we do not have sufficient observer data on the mortality of individual turtles interacting with the fishery, we use an average mortality rate provided by PIRO.

Metrics of population-level impacts

To determine possible population-level impacts of proposed takes, we calculate metrics to compare each ANE estimate to the total nester abundance for the corresponding population. The proportion of the nesting population represented by the ANE provides a snapshot of the population impact, as it can be interpreted as the fraction of the population being removed by the fishery over a specified period of time. A proportion of 0.001 would mean that 1 out of 1000 nesting females would be killed by the fishery, which would decrease the nesting population by 0.1%. We also calculate the number of years it would take for the fishery to kill one nester to provide context for interpreting the frequency of adult nester mortality expected. We base our determination of whether the ANE would have a significant impact on the breeding population on the proportion of nesting females expected to be killed. At present, we consider a change in the population of 0.1% to be a significant impact with cause for concern, as this represents a change in the population growth rate (r) equivalent to 0.001; for context, r = 0.03 would be a typical growth rate for an increasing population. An estimated population impact of 0.1% or greater therefore elicits us to conduct a population viability analysis (PVA) to evaluate the impact of the proposed fishery action on the population trend for three generations into the future.

3. IMPACT ASSESSMENTS BY SPECIES

Olive ridley turtles

The global olive ridley turtle population is listed as Threatened under the Endangered Species Act, except for breeding populations on the Pacific coast of Mexico that are listed as Endangered. The DSLL fishery interacts with turtles from western and eastern Pacific breeding populations. Because these populations show genetic differentiation, we treat them separately in this analysis. We assign the proposed 61 interactions to populations based on genetic analysis of turtles previously caught by the fishery (NMFS 2014), with 77% of the takes apportioned to the eastern Pacific population (47 takes) and 23% to the western Pacific population (14 takes). While the Mexican breeding population is listed separately from the global population, it has not been genetically differentiated from other eastern Pacific populations; therefore, we treat all eastern Pacific olive ridleys as one population. We estimate the impacts to the two populations using the take levels specified above.

The ANE calculations (Tables A, B) for both populations incorporate several biological parameter estimates. We used an annual survival rate for juveniles of 0.85 (Van Houtan 2015), a growth rate of 2 cm per year (derived from Zug et al. (2006)), and length at maturity of 63.3 cm and age at maturity of 19.5 years (derived from Shanker et al. (2004), Zug et al. (2006), Whiting et al. (2007), and SWOT Report (2010)). For the proportion of females in the population, we used 0.5 in the absence of a more informed estimate. We used the individual mortality estimates from 118 observed fishery interactions.

We took a conservative approach to estimating total nester abundance for the eastern and western populations, acknowledging that there are more nesting subpopulations than we account for here. The best available data on nesting numbers in the western Pacific or Indo-Pacific for olive ridley turtles come from Shanker et al. (2004), Whiting et al. (2007), and SWOT Report (2010). As of 1999, over 200,000 turtles were known to nest per year in the greater Orissa area of India, and as of 2005, the northern Australian nesters ranged from 1,000 to 4,000 nesters per year. Throughout the rest of India and Southeast Asia there are several thousand additional nesters (data 1999 – 2007). Therefore, we used 205,000 as the best available nesting population estimate (females nesting per year). The eastern Pacific population of olive ridley turtles is estimated at over a million nesters annually (SWOT Report 2010, NMFS 2014).

To estimate the population-level impacts of fishing at the proposed level of annual effort over one and five year periods, we compared single-year and five-year ANEs to the total nester abundance for each population (Tables A, B). At the proposed interaction level, it would take 0.08 years and 0.26 years to kill the equivalent of one adult female from the eastern and western populations, respectively. We found the proposed take level to have an insubstantial impact on either the eastern or western Pacific olive ridley populations. Because the proposed action would change the population by less than 0.1% (0.00133% for the eastern population and 0.00193% for the western population), we did not proceed with a population viability analysis.

Table A – Olive ridleys – total estimated impact for 1 year

Species	Total Estimated Annual Takes	Total takes over 1 year period	ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All olive ridley	61	61	17.23			
Eastern		46.97	13.27	0.0000133	0.08	NO
Western		14.03	3.96	0.0000193	0.26	NO

Table B – Olive ridleys – total estimated impact for 5 years

Species	Total Estimated Annual Takes	Total takes over 5 year period	Cumulative ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All olive ridley	61	305	86.16			
Eastern		234.85	66.35	0.0000663	0.08	NO
Western		70.15	19.82	0.0000967	0.26	NO

Loggerhead turtles

On September 9, 2011, a final rule under the Endangered Species Act split the global loggerhead turtle population into 9 DPSs and designated each DPS as Threatened or Endangered. The DSLL fishery only interacts with turtles from the Endangered North Pacific DPS; therefore, our analysis estimates the impact of all 6 proposed takes from this one DPS.

The ANE calculations (Tables C, D) incorporate estimates of several biological parameters. Stage-specific annual survival rates for pelagic juveniles (0.81), benthic juveniles (0.79), and sub-adults (0.88) were taken from Snover (2002). Ages at which turtles reach the benthic juvenile stage (16 years), sub-adult stage (22 years), and adult stage (25 years) followed Vaughn (2009), Van Houtan (2011), and Van Houtan and Halley (2011). We used 0.5 for the proportion of females in the population, from Van Houtan (2011). For mortality, we used the derived average mortality rate of 0.73 provided by PIRO due to limitations in the observer data available at the time of this analysis (10 interactions with only 5 mortality estimates).

All nesting for this DPS occurs in Japan. Total nester abundance was estimated at 8,897 turtles by adding the total nest counts from 2009, 2010, and 2011 (Matsuzawa 2010, 2011, 2012), which reflects a 2.7 year remigration interval (Conant et al. 2009), and dividing the totals by an average clutch frequency of 3 nests per female per year (Conant et al. 2009).

To estimate the population-level impacts of fishing at the proposed level of annual effort over one and five year periods, we compared a single-year ANE of 0.31 and five-year ANE of 1.53 to the 8,897 total nesters for this DPS (Tables C, D). At the proposed interaction level, it would take 3.26 years to kill the equivalent of one adult female. We found the proposed take level to have an insubstantial impact on the North Pacific population of loggerhead turtles. Because the proposed action would change the population by less than 0.1% (0.00345%), we did not proceed with a population viability analysis.

Table C – Loggerhead turtles – total estimated impact for 1 year

Species	Total Estimated Annual Takes	Total takes over 1 year period	ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All loggerheads (Japan)	6	6	0.31	0.0000345	3.26	NO

Table D – Loggerhead turtles – total estimated impact for 5 years

Species	Total Estimated Annual Takes	Total takes over 5 year period	Cumulative ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All loggerheads (Japan)	6	30	1.53	0.000172	3.26	NO

<u>Green turtles</u>

On April 6, 2016, a final rule under the Endangered Species Act split the green turtle into 11 DPSs and designated each DPS as Threatened or Endangered. The DSLL fishery may interact with turtles from 6 DPSs according to a recent mixed-stock genetic analysis (Dutton 2016 pers. comm.); therefore, our analysis estimates the impact of the proposed takes on each of 6 DPSs separately. Proposed takes included 4 green turtles from the East Pacific DPS (Threatened), 2 from the Central North Pacific (Threatened), 2 from the East Indian-West Pacific (Threatened), 2 from the Southwest Pacific (Threatened), 1 from the Central West Pacific (Endangered), and 1 from the Central South Pacific (Endangered).

The ANE calculations (Tables E, F) for the 6 DPSs incorporate several biological parameter estimates. We used an annual survival rate for juveniles of 0.81 (derived from Seminoff et al. (2015)), age at maturity of 22.5 years (Van Houtan et al. 2014), and growth curve based on parameter estimates from Van Houtan et al. (2014) and Balazs et al. (2015). We set the proportion of females in the population to 0.514 per Balazs et al. (2015). For mortality estimates, we used all previous individual estimates from DSLL fishery observer data (16 interactions).

We used the total number of nesting females for each DPS provided by the 2015 Status Review of Green Turtles (Seminoff et al. 2015). Total nester abundance was 77,000 for the East Indian-West Pacific DPS, 6,500 for the Central West Pacific, 83,000 for the Southwest Pacific, 2,600 for the Central South Pacific, 3,800 for the Central North Pacific, and 20,000 for the East Pacific.

To estimate the population-level impacts of fishing at the proposed level of annual effort over one and five year periods, we compared single-year and five-year cumulative ANEs to the total nester abundance for each DPS (Tables E, F). At the proposed interaction levels, it would take at least 18.62 years to kill the equivalent of one adult female from any DPS. We found the take level to have an insubstantial impact on the 6 listed green turtle DPSs. Because the proposed action would change the population by less than 0.1% (between 0.00003% and 0.00071%, depending on the DPS; Table E), we did not proceed with a population viability analysis.

Table E – Green turtles – total estimated impact for 1 year

Species	Total Estimated Annual Takes	Total takes over 1 year period	ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All greens	12	12	0.16			
DPS 6 (East Indian-West Pacific)		2	0.03	0.0000003	37.25	NO
DPS 7 (Central West Pacific)		1	0.01	0.0000021	74.49	NO
DPS 8 (Southwest Pacific)		2	0.03	0.0000003	37.25	NO
DPS 9 (Central South Pacific)		1	0.01	0.0000052	74.49	NO
DPS 10 Central North Pacific)		2	0.03	0.0000071	37.25	NO
DPS 11 (East Pacific)		4	0.05	0.0000027	18.62	NO

Table F – Green turtles – total estimated impact for 5 years

Species	Total Estimated Annual Takes	Total takes over 5 year period	Cumulative ANE	Proportion of nesting population	Years to female mortality	Significant Impact
All greens	12	60	0.81			
DPS 6 (East Indian-West Pacific)		10	0.13	0.0000017	37.25	NO

DPS 7 (Central West Pacific)		5	0.07	0.0000103	74.49	NO
DPS 8 (Southwest Pacific)		10	0.13	0.0000016	37.25	NO
DPS 9 (Central South Pacific)		5	0.07	0.0000258	74.49	NO
DPS 10 Central North Pacific)		10	0.13	0.0000353	37.25	NO
DPS 11 (East Pacific)		20	0.27	0.0000134	18.62	NO

4. SUMMARY OF ASSESSMENTS

PIFSC estimated the population-level effects of incidental takes of olive ridley, loggerhead, and green turtles in the Hawaii deep-set longline fishery using the best available science and the estimated number of takes provided by PIRO. PIRO estimated the fishery could take up to 61 olive ridley and 6 loggerhead turtles annually, along with 12 green turtles from six Distinct Population Segments (DPSs): 4 from the East Pacific DPS, 2 from the Central North Pacific, 2 from the East Indian-West Pacific, 2 from the Southwest Pacific, 1 from the Central West Pacific, and 1 from the Central South Pacific. For each species and DPS, PIFSC calculated the adult nester equivalent (ANE) of the proposed takes and compared it to the total nester abundance to determine whether the fishery would have a significant population-level impact (a population change greater than 0.1%) that would elicit the need to conduct a population viability analysis. For all species and DPSs evaluated, PIFSC found no significant population-level impact, and therefore did not conduct any population viability analyses.

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