Data Report

Hawaii Longline Fishery 2020 Seabird and Sea Turtle Bycatch for the Entire Fishing Grounds, Within the IATTC Convention Area, and Seabird Bycatch to the north of 23°N and 23°N–30°S

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The tables in this report include information on sea turtle and seabird bycatch requested by the (1) Pacific Islands Regional Office (PIRO) for their annual review of seabird interactions, (2) West Coast Regional Office (WCRO) for use in preparing their submission to the Inter-American Tropical Tuna Commission (IATTC), and the Pacific Islands Fisheries Science Center (PIFSC) for use in preparing their submission to the Western and Central Pacific Fisheries Commission (WCPFC).

Tables 1 through 4 provide the bycatch estimates for seabirds and sea turtles requested by PIRO and WCRO. Table 5 provides the bycatch estimates for seabirds to the north of 23°N and 23°N–30°S requested by the PIFSC. Tables 6 and 7 provide the requested information about fishing effort. The estimates and measures of effort are for all longline trips landing in 2020. When computing effort within the IATTC Convention Area for Tables 6 and 7, a fishing operation (set) was considered within the region if at least one of the recorded locations (begin set, end set, begin haul, or end haul) was within the region. The total number of trips within the IATTC Convention Area is the number of trips that had at least one fishing operation (set) in the region. The number of hooks hauled on a fishing operation assigned to the IATTC Convention Area was the number of hooks multiplied by the proportion of recorded locations within the area. For example, if the end set and begin haul were located within the area and the begin set and end haul were located outside the area, the number of hooks hauled was multiplied by 2/4 to estimate the number of hooks assigned to the area. The total number of hooks within the IATTC Convention Area is the sum of hooks assigned to the area.

The sampling design used to sample the deep-set fleet is the systematic-plus (SYSPLUS) design described in McCracken (2019). A component of the SYSPLUS design is a systematic sample drawn at a coverage level slightly less than the targeted observer coverage for the year. The additional samples needed to achieve the targeted coverage are sampled in an adaptive manner and described in McCracken (2019). Prior to departing, a vessel owner or operator must notify the observer program at least 72 hours prior to the intended departure date and declare the intended trip type (shallow-set or deep-set). The sample is drawn from the list of notifications for deep-set trips. In 2020, the targeted observer coverage for the year was 20% and a systematic sample at 15% coverage was drawn.

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In 2020, there were two occasions when the observer coverage fell below the 15% coverage of the systematic sample. The first occasion occurred near the end of December, 2019 (approximately between the 27th and 31st) and involved all notifications received during this period, approximately 45 notifications. During this period, 6 notifications were selected by the systematic sample and only 2 of these were sampled. Herein, this gap in 15% observer coverage is referred to as the 2019 gap. The second occasion occurred from March 10 through May 12 and was due to concerns with the spread of COVID-19. During this period, 258 notifications were received and none of the trips selected by the systematic sample were sampled; although, 3 trips selected by the Pacific Islands Regional Observer Program (PIROP) were sampled. These observed trips provided their notification between March 13 and March 19. The NOAA Fisheries issued a national emergency rule to waive observer coverage on March 24, 2020. This emergency action was taken to protect public health and to ensure the safety of fishermen, observers, and others. Herein, this gap in observer coverage is referred to as the COVID gap. Outside these gaps of coverage, the SYSPLUS sampling protocol was followed and bycatch was estimated using the methods described in McCracken (2019). The bycatch in the two gaps were estimated separately. The bycatch for 2020 is the sum of the 3 bycatch estimates. Although the 3 bycatch estimates are not independent, time did not permit establishing an estimator of their covariance; therefore, independence was assumed when estimating the standard error of the estimated 2020 bycatch. Hence, the reported standard errors likely underestimate the uncertainty in the 2020 estimates.

Let us now consider the estimation of bycatch for the 2019 gap. The estimation of bycatch centered on the ratio of bycatch/effort where the bycatch is the total number of bycatch events in the specified domain and effort is the total number of trips in the domain. To estimate the bycatch within the 2019 gap, a synthetic estimator (Lohr 2010) was used where the bycatch/effort ratio was estimated over a span that included trips prior to and after the 2019 gap. The estimated bycatch was the product of this estimated ratio and the number of trips in the gap. Specifically, the ratio was estimated based on the sample drawn from December 10, 2019, through January 8, 2020. As coverage varies over time, the sampling frame for this period (notifications received) was split into 3 strata that represented periods where the level of observer coverage was similar. The second strata includes the 2019 gap and 24 notifications prior to this gap. These 24 notifications were included in the second strata as they overlapped with the fishing dates of trips in the gap. All trips in the second stratum landed in 2020. To facilitate bycatch estimation within a stratum a simple random sample is assumed. First, the bycatch/effort ratio over the 3 strata was estimated using the combined ratio estimator (Lohr 2010, Cochran 1977). This estimated ratio was then multiplied by the number of trips in the second stratum to derive the estimated bycatch in the second strata. The estimates of bycatch within the IATTC, to the north of 23°N, and 23°N–30°S used the same estimator but were based on the bycatch/effort ratio in the specified area.

The synthetic estimator assumes that the bycatch/effort is similar between strata and each of these ratios is similar to the bycatch/effort ratio over the 3 strata. If the ratio of bycatch/effort varies greatly over the 3 strata, this estimator may have large bias. For this

reason, we tried to balance the benefits of increasing the sample size with the potential bias introduced by extending the timeframe of the synthetic estimator too far before or after the gap. Additionally, as the sampling probabilities are approximated when assuming the stratified design, some estimation bias was likely introduced. As the 69 trips in the second strata represent only a small fraction of effort in 2020, the biases in this stratum's point estimate and occupying standard error likely have little impact on the 2020 estimates.

Let us now consider the COVID gap. This gap involved a long period with no observer coverage and appears to be associated with changes in fishing behavior. Foremost, it appears that the effort became more concentrated closer to the main Hawaiian Islands, especially to the south of the islands. To estimate bycatch for this gap a synthetic estimator similar to the estimator for the 2019 gap was used. Specifically, the bycatch/effort ratio was estimated for notifications received between February 19 and June 14, 2020. The sampling frame for this period (notifications received) was split into 5 strata that represented periods where observer coverage was similar. The third stratum is composed of notifications received during the period where the systematic samples were missed but PIROP selected 3 trips for observer deployment. The fourth stratum is composed of notifications received during the period with no observer coverage. As we do not expect species to be uniformly distributed over the fishing grounds, we expect the bycatch/effort ratio within the 5 stratum to differ since the spatial distribution of effort was not similar. However, it appears that most trips concentrated the majority of their effort in 1 of 4 areas. These 4 areas are defined as (1) latitude south of 20°N and longitude west of 154.5°W (2) latitude south of 19.5°N and longitude at or east of 154.5°W and west of 142°W, (3) latitude at or north of 20°N and longitude west of 154.5°W or latitude at or north of 19.5°N and longitude at or east of 154.5°W and west of 142°W, (4) longitude at or east of 142°W.

To estimate bycatch, all observed trips in the 5 strata and all trips in strata 3 and 4 were assigned to one of the 4 areas based on where the majority of its begin set locations recorded in the vessel logbook database (Pacific Islands Fisheries Science Center, 2021) were located. As there were few trips in the fourth area, the estimation for bycatch in this area was computed differently. Let us first consider the estimation of bycatch within the first three areas. The bycatch/effort ratio for each area (defined by its boundary and trip assignment protocol) is assumed to be similar between strata and over all strata. The bycatch/effort ratio within an area is estimated using the combined ratio estimator and then multiplied by the number of trips in strata 3 and 4 assigned to the area. The product is the area's estimated bycatch. For the fourth area, observed trips that occurred in the same area during the same months as the gap but in a different year were located. The bycatch/effort ratio over all observed trips was then multiplied by the number of trips in strata 3 and 4 within this area. To estimate the bycatch within the IATTC, to the north of 23°N, and 23°N–30°S, the bycatch/effort ratio refers to the total number of bycatch events within the specified management area (IATTC, to the north of 23°N, or 23°N–30°S) by trips within the specified COVID gap area (areas 1–4 above). This bycatch/effort ratio was estimated using the combined ratio estimator for areas 1–3 and the observed ratio for area 4. The estimated ratio was then multiplied by the number of trips in strata 3 and 4 within the area. The bycatch estimates for the four areas were

summed to derive the total estimated bycatch for the COVID gap, strata 3 and 4. The variance was estimated assuming that the estimated bycatch/effort ratio for the fourth area was independent of the other three.

The estimators used to estimate bycatch in the 2019 gap and COVID gap were selected because they could be used across species and easily adapted to fulfill all the annual bycatch reporting requirements. The 2019-gap was brief and included a few randomly selected observed trips and any potential bias in the estimates is unlikely to have much influence in the 2020 bycatch estimates. The COVID gap was longer and was due to a major world event that affected many things. As there were no randomly selected observed trips during this period and only limited information in the vessel logbooks, it is not possible to evaluate the assumptions made to estimate bycatch during this gap. Therefore, the potential bias in the bycatch estimates for this gap could bias the 2020 estimates to a greater degree than the estimates for the 2019 gap. With time, these estimators could likely be improved upon, especially if handled on a per species bases. If the 2020 bycatch estimates for seabirds or sea turtles will significantly influence the management of the deep-set fishery, it is recommended that further time be spent on estimating seabird and sea turtle bycatch.

Table 1. Estimates of the number of incidental interactions of sea turtles for the Hawaii deep-set longline fishery in 2020. Estimates are provided for all species with an observed interaction in 2020 and species of concern because of their endangered species status and history of past interactions. Estimates are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Species of Sea Turtle	Observed Takes	Point Estimates	Standard Error
Total fishing grounds			
Loggerhead	3	19	9.2
Leatherback	4	31	12.9
Olive Ridley	11	79	19.3
Green	2	13	7.5
Within IATTC Convention Area			
Loggerhead	1	6	5.5
Leatherback	0	0	5.9
Olive Ridley	0	0	5.9
Green	0	0	5.9

Table 2. Estimates of the number of incidental interactions of seabirds for the Hawaii deep-set longline fishery in 2020. Estimates are provided for all species with an observed interaction in 2020. Estimates are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Species of Seabird	Observed Takes	Point Estimates	Standard Error
Total fishing grounds			
Laysan Albatross	59	315	79.2
Black-footed Albatross	96	590	98.6
Brown Booby	1	5	4.9
Sooty Shearwater	1	7	5.4
Within IATTC Convention Area			
Laysan Albatross	0	0	5.9
Black-footed Albatross	5	30	13.5
Brown Booby	0	0	5.9
Sooty Shearwater	0	0	5.9

Table 3. Number of observed incidental interactions of sea turtles for the Hawaii shallow-set longline fishery in 2020, where the Hawaii shallow-set longline fishery had 100% observer coverage. Counts are provided for all species with an observed interaction in in 2020 and species of concern because of their endangered species status and history of past interactions. Counts are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Species of Sea Turtle	Observed Takes
Total fishing grounds	
Loggerhead	15
Leatherback	2
Olive Ridley	0
Green	0
Within IATTC Convention Area	
Loggerhead	0
Leatherback	1
Olive Ridley	0
Green	0

Table 4. Number of observed incidental interactions of seabirds for the Hawaii shallow-set longline fishery in 2020, where the Hawaii shallow-set longline fishery had 100% observer coverage. Counts are provided for all species with an observed interaction in 2020. Counts are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Species of Seabirds	Observed Takes
Total fishing grounds	
Laysan Albatross	26
Black-footed Albatross	5
Northern Fulmar	1
Within IATTC Convention Area	
Laysan Albatross	23
Black-footed Albatross	5
Northern Fulmar	1

Table 5. Observed and estimated number of bycatch events of seabirds for the Hawaii longline fisheries, deep-set and shallow-set combined. Estimates are provided for all species with an observed bycatch event from 2020. Estimates are given for the entire fishing grounds (total), to the north of 23°N, and 23°N–30°S. The total estimated bycatch not equaling the sum of the parts is a consequence of the non-additive nature of the methods used for the 2019 gap.

	Observed Bycatch			Estimated Bycatch		
Species of Seabird	**>23°°N**	**23°N–30°S**	**Total**	**>23°N**	**23°N–30°S**	**Total**
Laysan Albatross	77	8	85	285	58	341
Black-footed Albatross	70	31	101	395	204	595
Brown Booby	0	1	1	0	5	5
Northern Fulmar	1	0	1	1	0	1
Sooty Shearwater	0	1	1	0	7	7

Table 6. Number of trips, sets, and hooks recorded in the vessel logbook database (Pacific Islands Fisheries Science Center, 2021) and Longline Observer Data System (Pacific Islands Regional Observer Program, 2021) for the Hawaii deep-set longline fishery in 2020. Total counts are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Source of Counts	Trips	Sets	Hooks
Total fishing grounds			
Number recorded in logbooks	1,564	20,286	58,174,848
Number recorded in LODS	238	3,131	8,738,011
Within IATTC Convention Area			
Number recorded in logbooks	371	3,580	10,124,240
Number recorded in LODS	53	466	1,296,601

Table 7. Number of trips, sets, and hooks recorded in the Longline Observer Data System (Pacific Islands Regional Observer Program, 2021) for the Hawaii shallow-set longline fishery in 2020, fishery had 100% observer coverage. Total counts are given for the entire fishing grounds and for waters within the IATTC Convention Area.

Source of Counts	Trips	Sets	Hooks
Total fishing grounds			
Number recorded in LODS	32	455	588,481
Within IATTC Convention Area			
Number recorded in LODS	18	288	395,669

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