Estimation of Incidental Interactions with Sea Turtles and Seabirds in the 2012 Hawaii Longline Deep-set Fishery[1]

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This report provides estimates of the number of incidental interactions with protected species of marine turtles and seabirds by the Hawaii longline deep-set fishery in the year 2012. For each species, point estimates of the number of interactions rounded to the nearest whole number, along with estimated 95% confidence intervals, are given in Table 1. Supplemental information is provided in the attached Excel workbook (IR-13-014_wkbk.xlsx). The supplemental file includes the numbers of observed takes of protected sea turtles and seabirds, unrounded point estimates of interactions with each species, and aggregated 2012 effort statistics for the deep-set fishery.

Within this report, an incidental interaction is an event during a longline fishing operation in which a protected animal is hooked or entangled by the fishing gear. An incidental interactions estimate refers to the estimated total number of incidental interactions for all longline deep-set fishing trips landing in 2012.

There are a couple practical constraints on the definition of incidental interactions. First, observers are instructed to record all observed hooked or entangled animals during the haul back of the longline gear. Animals observed hooked or entangled that are freed before being landed on deck are included in this definition. However, hooked or entangled animals that are freed or removed from the longline by predators prior to the longline becoming visible on the haul back would not be observable and therefore could not be recorded unless warranted by convincing circumstantial evidence of their capture. These "missed" animals are not included in the incidental interactions estimates as there is no practical way to quantify them. Nor do the estimates include animals that are not hooked or entangled but are in some other way caught, killed, or harmed by the activity of deep-set fishing. Such events are not included because it is not currently economically feasible to have observers monitoring for these events throughout the longline trip. If an observer does witness such an event they are instructed to record it. There have been very few of these events recorded.

Second, the estimates of incidental interactions refer to the total number of interaction events, which may exceed the number of individual animals that were caught. It is possible that an animal is observed caught, then is released or frees itself, and then is caught again during the year. For example, a loggerhead sea turtle was observed to be caught twice during a shallow set trip in 2012. These two events are considered two incidental interactions.

On 27 August 2012 there was a change in the regulations of the Hawaii longline deep set fishery that prevents the collection of a random probability sample of trips in the fishery. The regulation imposed new limits on swordfish landed. The new limits are as follows: (1) With a

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NMFS observer onboard, there is no limit on the number of swordfish landed or possessed on a trip, regardless of the type of hook used. (2) With no NMFS observer onboard, the limit is 25 swordfish landed or possessed on a trip, if the vessel uses only circle hooks. (3)With no NMFS observer onboard, and if the vessel uses any hooks other than circle hooks, the limit is 10 swordfish landed or possessed on a trip. In essence, this regulation created three components of the deep-set fleet defined by the number of swordfish a trip can keep. The first component has no limit on swordfish kept and has 100% coverage. The second and third component has a limit on the number of swordfish kept that is determined by the type of hooks being used. These two components have no observer coverage.

Prior to the new regulations all deep-set trips had a trip limit of 10 swordfish landed. The regulation limiting number of swordfish landed was put into place to discourage trips from targeting swordfish, which typically implies setting the gear shallow. The shallow setting of gear has historically resulted in different observed catch rates for the protected species.

To understand the consequence of the new regulations on our ability to produce accurate estimates of bycatch, compare the properties of a probability sample and a nonprobability sample. A probability sample is a sample where every unit in the population has a chance, greater than zero, of being included in the sample, and this inclusion probability can be accurately determined. With a probability sample it is possible to produce unbiased design-based estimates of population totals and estimate the sampling error. A nonprobability sample is a sample where some elements of the population have no chance of selection, or where the probability of selection can't be accurately determined. With such a sample, it is not possible to produce a design-based estimate of the population total or estimate the sampling error. Statistical inference requires making assumptions about the characteristics of the population. The exclusion of part of the population from the sample gives rise to exclusion bias and places limits on how much information a sample can provide about the population. Extrapolating from the nonprobability sample to the population requires making assumptions about the population that cannot be confirmed from the sample.

Since mid-year 2002, deep-set notifications (notifications of intended departures of a deep-set trip are required at least 72 hours prior to departure) have been sampled using a probability sample design. The sampling of these notifications under the same sampling design continued after issuance of the new regulations. What changed with the new regulations is what the sample represented. Prior to the new regulations, the sample was a random sample of all deep-set trips fishing under a uniform set of rules and requirements. Under the new regulations, what was being randomly drawn was a selection of trips that would have an observer onboard and not have a trip limit on swordfish landings. Any trip not selected would not have an observer onboard and would have a trip limit on swordfish landings. Consequently, a trip without a swordfish landings limit had a probability of 1 of being observed and a trip with a swordfish landings limit had a probability of 0 of being observed.

During review of the proposed new regulations, concern was expressed about the disruption of the probability sample caused by applying a different regulation for observed trips. A counter-argument was made that there would be no reason for the behavior of the unobserved trips to differ from observed trips. The regulations were approved, and PIFSC was asked to evaluate subsequent fishery data to determine whether or not fishing behavior remained the same for observed and unobserved trips. Two approaches to this issue are conceivable but have not been undertaken: 1) analyzing whether observer data on fishing operations changed with trip limit removal on observed trips (before-and-after analysis); or 2) looking for differences between observed and unobserved trips using other sources of data that do cover all trips, such as logbook data. There are serious problems with these approaches. Both observed and unobserved portions of the fleet can change behavior over time in ways that might not be similar across the whole fleet. That fraction of the unobserved portion that uses circle hooks also experienced a regulatory change that cannot be examined in a before-and-after analysis of observer data. The logbook data do not reliably record discards or protected species interactions, so that actual catch and discard comparisons are not possible. Landings, which can be compared, would be expected to change even if catch does not (the main purpose of changing the trip limits was to reduce discards). And neither the observer data nor other data sources record many important fishing operation variables that affect discards and protected species interactions.

One important operational factor is the shortening rate of the longline, which alters the tension and sag in the mainline, changing fishing depth. Longline tension and sag are difficult to quantify, even for experts, and are not regulated. Yet fishermen can alter the shortening rate in attempts to target species by depth. And this is just one means of altering operations that is not recorded. So even if all variables in a before-and-after observer data comparison, and in a comparison of the logbook data between the all deep-set sectors of the fishery were found to be similar, we still could not legitimately conclude that we have a representative sample for estimating the bycatch in the deep-set fishery, when our sample comes from only one component of the fishery rather than all three components of the fishery.

PIFSC has proceeded with estimating bycatch (interactions), using the probabilities that a deep-set trip notification is sampled. These bycatch estimates are subject to bias as a consequence of the new regulations and the lack of a true probability sample of the deep-set fleet in 2012. Nevertheless, the interaction estimates are based on this sample of longline trips on which scientific observers are deployed. Observed trips were selected using two sampling schemes to accommodate fluctuating coverage levels and utilize observers efficiently. Coverage levels vary throughout the year because of fluctuation in the fleet’s activity level, demands of 100% coverage in the Hawaii longline shallow set fishery for swordfish, and an influx of observers after completion of NMFS observer training. Because observers are not paid while waiting to be deployed, they must be assigned with minimal delay when available. The alternative of paying them while they are waiting to be deployed would increase the cost of the observer program. The two sampling schemes attempt to reach a balance between obtaining a probability sample and being cost effective.

The primary scheme was a systematic sample. Before departing on a fishing trip, longline vessels were required to notify the NOAA Fisheries Pacific Islands Regional Office (PIRO) observer program contractor at least 72 hours prior to their intended departure date. To enable sample selection, the PIRO contractor numbered notifications sequentially in the order in which they were received. Herein, this assigned number is referred to as the notification number. Prior to the beginning of a quarter, a systematic sample of notification numbers was drawn by PIFSC and supplied to the contractor. The trips associated with these selected notification numbers were designated to be sampled. If a trip was selected but the vessel did not leave within a reasonable amount of time, usually the observer was reassigned to a different vessel trip. When the selected vessel was ready to depart, a different observer was assigned to it.

The systematic sample requires having an observer available to be deployed whenever a selected trip is ready to depart. Achieving this requirement under full targeted coverage, typically 20% coverage, throughout the year requires having enough observers on contract to accommodate higher levels of fleet activity and paying them when they are not deployed on a vessel. These requirements frequently cannot be met under the current level of funding; therefore, the quarterly sample selected under the systematic design was usually slightly smaller than the targeted coverage, typically 5% less. When this occurred, the additional trips needed to reach the full targeted level were selected using a secondary sampling scheme. This secondary scheme was used when all trips selected by the systematic sample were already covered and an observer was ready to be deployed. In this instance, a trip was randomly selected with equal probability from the notifications received that day that had not already been selected. If more than one observer needed to be assigned, the appropriate number of trips was sampled with equal probability from this pool of notifications. The coverage obtained by this secondary sampling scheme was flexible and dependent on the need to deploy observers. The additional samples drawn under the secondary sampling scheme depart from traditional probability samples because the days when additional samples were drawn were not randomly selected but determined by the need to deploy observers. Trips sampled by the systematic and secondary protocols are used to estimate incidental take.

The contractor's sampling records were used to approximate sampling probabilities. Examination of these records revealed periods of time within a quarter when coverage appeared to have been greater or less than the full targeted coverage. Specifically, periods of time for which the number of secondary samples were greater than expected represent higher coverage and those for which the number of secondary samples were fewer than expected represent lower coverage. Before computing the sampling probabilities, periods of comparable coverage were identified. The sampling probabilities were computed by enumerating the number of notifications during consecutive time periods of comparable coverage and assuming that the secondary samples were selected with equal probability from those trips that had not been selected as part of the systematic sample.

Because the coverage level changed with fluctuations in observer availability and fishing activity, the observed trips were not selected with equal probability. Therefore, either the Horvitz-Thompson estimator or generalized ratio estimator was used to estimate total interactions, as these methods take into account unequal sampling probabilities. In applying the generalized ratio estimator, the number of hooks, number of sets, and number of fishing trips (denominator of the ratio estimator is 1) were considered as auxiliary variables. The generalized ratio estimator was selected over the Horvitz-Thompson estimator when the ratio estimator appeared to be more efficient. The point estimates were rounded to the nearest integer as the estimates represent the number of times an interaction event occurs; unrounded point estimates and corresponding effort information for 2012 are given in the included spreadsheet.

For species that very seldom interacted with the fishery, confidence intervals for the incidental interactions were estimated using the approximated sampling probabilities and assuming that the number of incidental interactions per trip for a given species was an independent Poisson variate with a constant mean value. In the case of Laysan and black-footed albatrosses, where interactions, although still rare, are more common than for other seabirds and sea turtles, confidence intervals were approximated using a nonparametric bootstrapping algorithm for the sampling design. Confidence intervals incorporate information only for a given year, not data accumulated over all years. Therefore, for some species the upper bound of the confidence interval may seem high given historical records. For example, there has not been an observed incidental interaction with a short-tailed albatross during the history of the observer program. Based on this information, it seems highly improbable that the incidental interaction level would be as high as 13 birds, the upper bound of the confidence interval estimated for this species in 2012 (Table 1).

Table 1. Point estimates of the number of incidental interactions by species, and corresponding 95% confidence intervals, for the Hawaii deep-set longline fishery in 2012. Estimates are provided for all protected species of sea turtles and seabirds with an observed interaction as well as species that most commonly interact with the fishery or are of special concern because of their endangered species status. The estimate for shearwaters represents an estimate for the number of incidental interactions by the group of species considered shearwaters.

Species	Point Estimate	95% Confidence Interval
Sea Turtles		
Loggerhead	0	[0,13]
Leatherback	6	[1,22]
Olive Ridley	34	[20,65]
Green	0	[0,13]
Seabirds		
Black-footed albatross	167	[110,234]
Laysan albatross	136	[60,217]
Short-tailed albatross	0	[0,13]
Red-footed booby	0	[0,13]
Brown booby	0	[0,13]
Shearwater	36	[23,71]