# Estimation of Incidental Interactions with Sea Turtles and Seabirds in the 2011 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 2011 (Table 1). Within this report, an incidental interaction means an event during a longline fishing operation in which a protected animal is hooked or entangled by the fishing gear. An incidental interaction estimate refers to the estimated total number of incidental interactions for all longline deep set fishing trips landing in 2011. A longline deep set fishing trip is defined as any commercial fishing trip by a vessel with a Hawaii longline permit that departs or returns at a Hawaii port, except a trip for which the vessel informed the observer program contractor that it would be swordfish fishing.

The interaction estimates are based on a random sample of longline trips on which scientific observers are deployed. In 2011, 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. A probability sample implies that all trips have a probability of being sampled and the sampling probabilities are known. These sampling probabilities form the basis of design-based estimators. An unbiased design-based estimator has the merit that it is unbiased regardless of the characteristics of the population being surveyed.

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.

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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. When coverage was below that of the anticipated systematic sample, the sampling probabilities were computed by enumerating all notifications during this period and assuming that the trips sampled were selected with equal probability.

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.

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 15 birds, the upper bound of the confidence interval estimated for this species in 2011 (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 2011. 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.

| Species | Point Estimate | 95% Confidence Interval |
|---|---|---|
| **Sea Turtles** | | |
| Loggerhead | 0 | [0,15] |
| Leatherback | 14 | [3,36] |
| Olive Ridley | 36 | [12,67] |
| Green | 5 | [1,22] |
| **Seabirds** | | |
| Black-footed albatross | 73 | [43,116] |
| Laysan albatross | 187 | [117,287] |
| Short-tailed albatross | 0 | [0,15] |
| Red-footed booby | 0 | [0,15] |
| Brown booby | 0 | [0,15] |
| Unidentified shearwater | 19 | [4,44] |