NOAA Technical Memorandum NMFS

JULY 2019

ESTIMATES OF MARINE MAMMAL, SEA TURTLE, AND SEABIRD BYCATCH FROM THE CALIFORNIA LARGE-MESH DRIFT GILLNET FISHERY: 1990-2017

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NOAA-TM-NMFS-SWFSC-619

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

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Recommended citation

James V. Carretta, Jeffrey E. Moore, and Karin. A. Forney. 2019. Estimates of marine mammal, sea turtle, and seabird bycatch from the California large-mesh drift gillnet fishery: 1990-2017. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-619.

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Abstract
Bycatch of marine mammals, sea turtles, and seabirds in the California swordfish drift gillnet fishery during a 28-year period (1990-2017), is estimated using random forest regression trees. Tree estimates were compared with annual ratio estimates generated from the same observer data. Biases associated with ratio estimators (systematic under- and overestimation of bycatch) are notable when observed bycatch is rare, bycatch rates are inferred from within-year data, and observer coverage is low. Estimates from regression trees result in more stable annual bycatch estimates with better precision, because estimates are informed by all available data. Even in years without observed bycatch, expected values from regression trees are typically positive (sometimes fractions of animals) and include estimates of error, whereas corresponding ratio estimates are zero and lack error estimates. Regression tree bycatch models include oceanographic, location, and gear variables used as predictors to estimate bycatch at the fishing-set level. Variables used in these models were identified with 'balanced random forest' classification trees that deliberately oversample sets with observed bycatch to overcome zero-inflated data signal-to-noise challenges. This method was previously validated with a simulated rare bycatch dataset where significant predictor variables were correctly identified in most cases, even when simulated bycatch events represented <1% of all data (Carretta et al. 2017).

Introduction

The California large-mesh drift gillnet fishery for swordfish and thresher shark ('the fishery') originated in the 1970s as an experimental fishery targeting pelagic sharks. By the mid-1980s, the fishery included approximately 200 vessels and annual effort was approximately 10,000 fishing sets (Hanan et al. 1993, Holts et al. 1998). Effort has steadily declined since then, with current annual effort of about 500-700 sets (Carretta *et al*. 2017). From 1990-2017, technicians in the NMFS West Coast Regional Office fishery observer program observed 8,956 sets from an estimated 56,358 sets fished, corresponding to 16% observer coverage (Carretta and Barlow 2011, Carretta et al. 2017, Figures 1-2). Prior estimates of marine mammal, sea turtle, and seabird bycatch, based on ratio estimates, are published in Julian and Beeson (1998), Carretta *et al*. (2004), and in a comparison of ratio and regression tree estimates from 1990-2016 (Carretta et al. 2017, 2018). Here, we present updated estimates of bycatch using both methods, using one additional year of observer data from 2017. Previous bycatch estimates in this fishery were generated with ratio estimators (Julian and Beeson 1998, Carretta *et al.* 2004, Carretta *et al*. 2014). For species with large sample sizes (e.g., short-beaked common dolphin, *Delphinus delphis* and California sea lion, *Zalophus californianus*), ratio estimates of bycatch are generally unbiased; however, the fishery entangles many species only rarely, including some (e.g., sperm whales, *Physeter macrocephalus* and short-finned pilot whales, *Globicephala macrorhynchus*) that are subject to a mandatory drift gillnet Take Reduction Plan (Federal Register 1997).

Amandè et al. (2012) and Carretta and Moore (2014) showed via simulations that annual estimates of bycatch derived from ratio estimates for rare events were biased, volatile, and imprecise, particularly when observer coverage was low. McCracken (2004) also addressed the issue of rare event bycatch and discussed challenges in identifying predictor variables for a U.S. longline fishery. Carretta and Moore (2014) noted that strategies for pooling annual ratio estimates of bycatch in U.S. marine mammal stock assessments (5 years are typically pooled to calculate average annual bycatch) are insufficient to overcome these problems. The problems of rare bycatch events combined with low observer coverage in the drift gillnet fishery were highlighted by Martin *et al*. (2015), who presented a Bayesian model-based alternative to annual ratio estimates, resulting in more stable interannual estimates with better precision for two test cases; humpback whales (*Megaptera novaeangliae*) and leatherback sea turtles. We applied the machine-learning approach of random forest trees (Breiman et al. 1984, 2001a, 2001b) to estimate bycatch for all species observed entangled in this fishery, with an emphasis on comparing ratio estimates and tree-based model estimates.

Methods

Modeling approach

Bycatch models were constructed using a two-step process, using random forest *classification trees* for variable selection (see *Variable Selection*). Variables selected for inclusion were then used in a *regression tree* random forest to estimate bycatch in unobserved fishing sets (see *Bycatch Estimation*).

1) <u>Variable selection (classification trees)</u>

The first step in developing bycatch models was variable selection using random forest classification trees in the R-package *randomForest* (Breiman *et al*. 1984, Breiman 2001a, 2001b, Liaw and Wiener 2002). Classification trees are recursive partitioning algorithms. Subsets of variables (default = $\sqrt{n}$ where n equals the number of variables) are randomly-selected at each tree node and the variable which results in the greatest variance reduction of the binary response is used to split the data into successive daughter nodes. Such variable splits continue until all observations in terminal nodes contain the same binary response variable or the terminal nodes contain a single observation. The mean of the observations in each terminal node represents the fitted value (estimate) for each observation in that node. Each classification tree is constructed from a bootstrap sample of data. Those data omitted from tree construction are referred to as 'out-of-bag' (OOB) data. Due to bootstrap sampling with replacement, OOB data represents approximately 1/3 of all data (Efron and Tibshirani 1997). The OOB data are introduced to constructed RF trees and classifications are made for all OOB data, based on variable characteristics of the OOB data, which determine the terminal node that the

OOB data are assigned to. In addition, each tree provides a unique expected value of the response variable in the OOB data, providing a direct measure of model uncertainty. The diversity of tree structures in random forests prevent overfitting of data that can occur with single trees and yield robust generalized predictive models where variables are informative (Breiman 2001a, 2001b).

The random forest (RF) variable selection model consists of classification trees, where the response is a binary category to be classified (bycatch presence/absence). Evaluation of the RF model is based on cross-validated classification accuracy: how often are OOB data correctly classified over all RF trees? The number of RF trees (n = 500 in this study) is based on the approximate number of RF trees required to return an asymptotic OOB error rate. Cross-validated bycatch presence/absence classifications for OOB data are summarized as a confusion matrix that includes the number of correctly and incorrectly classified bycatch presence / absence cases. All RF analyses in this analysis were created and implemented in the programming language R, version 3.5.1 (R Core Team 2018).

Observed bycatch in the fishery is considered a rare event. The most commonly-entangled species (short-beaked common dolphin, *Delphinus delphis*) is observed in approximately 4% of all observed fishing sets, while rarely-entangled species such as sperm whales are observed in <0.1% of all observed sets. Given so few entanglement events, determining which (or if) variables have explanatory power is challenging. Faced with high noise-to-signal ratios in bycatch data, the analyst must determine if node-splitting variables used in RF trees are spurious or reliable predictors of bycatch.

Our variable selection strategy for zero-inflated data was to boost the signal-to-noise ratio by oversampling fishing sets with bycatch. This is analogous to approaches that purposefully alter data class distributions to maximize the predictive accuracy of the minority data class of interest (Xie *et al*. 2009, Lin and Chen 2013). In our case, the minority class are fishing sets with observed bycatch. Classification trees were constructed using equal numbers of fishing sets with and without bycatch, implemented using the *randomForest* function '*sampsize*'. For example, variable selection for *D. delphis* was conducted by constructing individual classification trees with *n*=339 fishing sets with bycatch and *n*=339 sets without bycatch. Sets used in construction of each classification tree were sampled with replacement. Each RF included 500 classification trees. Variables were randomly selected for each RF, with a required minimum of two variables for tree construction and ranging up to the total number of variables available (n=14, Table 1).

A confusion matrix of correct and incorrect classification rates is generated for each RF and suite of variables. Confusion matrices represent the prediction accuracy of 500 RF trees on cross-validated data omitted during tree construction, referred to "out-of-bag" or OOB data (Breiman 2001). We are interested in the prediction accuracy for fishing sets with bycatch presence. In a bycatch presence/absence context, the ability of a RF model to correctly predict presence is known as 'sensitivity' and the ability to correctly predict absence is known as 'specificity' (Allouche *et al*. 2006). The overall accuracy of a RF model can be expressed as a metric called the 'true skill statistic' (TSS), introduced by Allouche et al. (2006). The TSS is calculated as follows, given the following confusion matrix:

Cross-Validated OOB Data

RF Model	Presence	Absence
Presence	*a*	*b*
Absence	*c*	*d*

where

(1) Overall Accuracy = $\frac{a+d}{a+b+c+d}$;

(2) Sensitivity = $\frac{a}{a+c}$;

(3) Specificity = $\frac{b}{b+d}$;

and

(4) TSS = Sensitivity + Specificity – 1

The TSS has a range from +1 (perfect prediction) to -1 (always inaccurate), with scores less than zero indicating a prediction accuracy no better than random chance (Allouche *et al.* 2006). We focus on 'sensitivity' as the variable selection metric in this study, because we are interested in the ability to correctly predict bycatch occurrence.

For a given species, the expected value for sensitivity if all variables lack predictive power is the proportion of observed fishing sets with bycatch presence. Another way of stating this is that randomly guessing which fishing sets contain bycatch would result in a correct classification rate equal to or less than the proportion of observed fishing sets with bycatch presence, which is ≤ 4% for all species in this study.

A total of 500 RF models were generated, each consisting of 500 trees and a different suite of randomly-selected variables. The RF model that minimized the classification rate error for bycatch presence (sensitivity) was used to select those variables that would be used in the bycatch estimation step (see Regression Trees). In the event of a tie in classification rate errors between different RF models, we chose the RF model that included the fewest variables, in the spirit of penalizing model complexity.

Use of the TSS sensitivity method for variable selection differs from the approach used by Carretta *et al*. (2017), which used the R-package *rfPermute* (Archer 2016) to estimate statistical p-values for individual variables, and only included variables that were 'significant' below an arbitrary threshold α-level. The TSS approach is more inclusive than relying on variable 'significance' and p-values, especially if a suite of 'weak' predictors have superior predictive ability over a smaller set of significant predictors (Breiman 2001). It is also consistent with quantitative approaches used to estimate the strength of presence / absence models (Allouche et al. 2006). Variables assessed for bycatch models included environmental and gear variables summarized in Table 1.

2) <u>Bycatch Estimation (regression trees)</u>

Variables for each species / taxon bycatch model were identified using the balanced random forest classification tree procedure described above and bycatch models were generated with random forest *regression trees*, because the response (bycatch per fishing set) is a rate to be estimated (Watters and Deriso 2000, Walsh and Kleiber 2001, Jiménez *et al*. 2009). Variables evaluated for bycatch models included a suite of fishing gear, oceanographic, and location variables described in Carretta *et al*. (2017) and summarized in Table 1. Small sample sizes for some species necessitated pooling of bycatch data across taxa. For example, only one bycatch event each was observed for killer whales (*Orcinus orca*) and striped dolphins (*Stenella coeruleoalba*), thus these species were pooled with observations of '*all.delphinoids',* for which a separate variable selection and bycatch model process was generated. Similarly, a single random forest model for *Kogia*-Ziphiid bycatch was based on pooling of data across all beaked whale species and pygmy sperm whales due to small sample sizes for individual species. For baleen whales where sample sizes were insufficient to assess variable importance (fin whale, *Balaenoptera physalus,* humpback whale, *Megaptera novaeangliae*), we used a default set of variables (*lat* + *lon* + *days*) in regression tree models, in recognition that most whale species in the California Current show seasonal / spatial movements within the region (Forney and Barlow 1998). Variables used in regression tree models for those species with sample sizes ≥4 observed entanglements are summarized in Table 2.

Random forest regression trees (n=500) were fully grown for all species models, where the number of tree nodes is generally greater for species with larger sample sizes. Predicted bycatch per set was generated by building random forests with all data, except one vessel fishing trip was omitted for cross-validation. Individual vessel trips averaged

5.8 sets fished (range = 1 – 19). The resulting random forest of 500 trees was then used to predict bycatch for each fishing set from the omitted fishing trip. Each tree provides a unique estimate of bycatch for each omitted set, which yields a distribution of 500 summed bycatch predictions for all 8,956 observed sets.

For a given species (s) in year y, the mean annual predicted bycatch per set ($\bar{b}_{s,y}$), was the mean predicted bycatch for all observed sets contained in year y, where random forest trees are constructed using all 28 years of data. Mean annual estimates of bycatch from regression trees ($\bar{T}_y$), were calculated as the mean annual predicted bycatch per set ($\bar{b}_{s,y}$), multiplied by the number of unobserved sets (u_y), plus the sum of observed bycatch of species s ($o_{s,y}$) in year y:

$$(1) \qquad \bar{T}_y = \bar{b}_{s,y} * u_y + \sum o_{s,y}$$

The approach of extrapolating predicted bycatch rates to unobserved fishing effort (u_y) reflects an assumption that observer data are representative of the fishery. Coefficients of variation (CV) of bycatch estimates were calculated as:

$$(2) \quad CV(\bar{T}_y) = \sqrt{var(\bar{b}_{s,y} * u_y)} \,/\, \bar{T}_y$$

where $var(\bar{b}_{s,y} * u_{s,y})$ is the variance of 500 predicted bycatch sums across *unobserved* sets in year *y*. Note that $CV(\bar{T}_y)$ describes parameter uncertainty (i.e., in the expected value for $\bar{T}_y$), not the uncertainty in the distribution for bycatch. For species / groups with sufficient sample sizes, we also estimated 95% confidence limits for estimates of $\bar{T}_y$ *,* using the 2.5th and 97.5th percentiles of bycatch predictions (see Results).

We also estimated mortality and serious injury (MSI) levels for all species, using the fraction of observed entanglements recorded as dead, injured, or 'unknown', to prorate estimates of unobserved bycatch. For example, of the 25 observed leatherback sea turtle entanglements in the fishery, 11 were released alive, 13 were released dead, and one was released in 'unknown' condition. Turtles released in unknown condition were conservatively treated as deaths. Of the 11 turtles released alive, 3 were considered injured to the point where survival was unlikely (NMFS 2013). In this case, the observed fraction (*f*) of deaths and injuries = 13 known deaths + 4 probable deaths 17/25 = 0.68 (NMFS 2013). Total MSI was calculated as the product of unobserved bycatch $(\bar{b}_{s,y} * u_y)$ and *f,* plus observed MSI. Uncertainty in estimates of MSI were included by treating the fraction *f* as a random binomial deviate, where the probability that unobserved bycatch resulted in mortality or injury (p_{mi}) = *rbinom*(*n* = number of forest trees, *size* = observed entanglements, *prob*=*f*), divided by the number of observed entanglements. Estimates of unobserved bycatch (one for each of 500 forest trees) were multiplied by a randomly drawn (with replacement) value of p_{mi}, yielding a distribution of unobserved MSI estimates of size = 500, to which observed MSI totals were added. Precision of MSI estimates were calculated as CVs using the same method as for total bycatch in Equation 2. Small species such as dolphins, porpoises, and pinnipeds are rarely released alive because they drown quickly in gillnets, thus, they have p_{mi} values equal to 1, and therefore MSI estimates are simply equal to $\bar{T}_y$, with the associated CV of $\bar{T}_y$.

Regression tree bycatch estimates were compared to ratio estimates for all years. Ratio estimates were calculated simply as the product of observed bycatch in year *y*, and the inverse of observer coverage for that year. Ratio estimate CVs were calculated via bootstrap, where sets in year *y* were resampled 9,999 times with replacement to generate a distribution of bycatch rates, from which the mean and variance were obtained. In addition to annual estimates, pooled multi-year bycatch regression tree and ratio estimates were generated for three time periods: 1990-2000, 2001-2017 and 2013-2017. The years 1990-2000 represent the pre-closure period of the fishery, when effort was permitted year-round in the PLCA. The years 2001-2017 represent the 'current state' of the fishery, as most fishing effort now occurs off southern California (Figure 1). Finally, the years 2013-2017 represent the most recent 5-year period for which bycatch estimates are available and reflect the number of years typically used to pool bycatch estimates in NMFS marine mammal stock assessment reports (NOAA 2016). Periods in excess of 5 years have been shown to be superior for pooling estimates when bycatch is based on annual ratio estimates and entanglements are rare (Carretta and Moore 2014), however, regression tree models which incorporate all available data for estimate reduce the need for such pooling.

Results

Variables identified as important predictors for each species / taxonomic group are summarized in Table 2. For most species, minimum OOB error rates for bycatch presence were achieved with RF models that included only 2 variables. Three species (Northern elephant seal, Pacific white-sided dolphin, and short-finned pilot whale each had 3 variables included in presence / absence models. Confusion matrices from presence / absence bycatch models using classification trees are shown in Table 3 for selected species.

Estimates of total bycatch and mortality / serious injury levels are presented in Tables 4-41. Bycatch estimates from regression trees were generally more stable across years and had better precision than corresponding ratio estimates. Precision gains from regression trees primarily resulted from the use of all 28 years of observer data in tree construction and estimation of mean bycatch rates based on covariates. This contrasts with previous use of ratio estimates that relied on a single year of data for estimating mean bycatch rates. In essence, the information contained in the full dataset provides a better understanding of long-term expected catch rates and covariate effects, which translates into better-informed annual and multi-year estimates.

For many species, bycatch estimates using regression trees and ratio methods show that estimated bycatch levels converge as the number of analysis years increases (Tables 4-41). For example, total estimates of beaked whale bycatch for the period 1990-2000 were approximately 221 (CV=0.01) and 220 (CV=0.17) whales, for regression tree and ratio methods respectively (Table 40). The lower CV of the regression tree estimate is, in part, due to using only 2 covariates in tree construction (*n.ping* + *slope*), which effectively limits the number of possible discrete predicted values in tree terminal nodes (fewer variables = reduced dimensionality). Intra-annually, beaked whale estimates are highly variable between methods, such as in 1991, when the estimate from regression trees was >35 whales, while the ratio estimate for the same year was zero whales due to an absence of observations that year. Effects and advantages of using regression trees over ratio methods to estimate bycatch are reviewed in the Discussion section for several species / groups.

Some annual regression tree bycatch estimates have rather large CVs, which occurs when the estimated bycatch is close to zero even though the standard error (absolute rather than relative error measure) might be small. This is especially apparent for rarely-entangled species such as striped dolphin and fin whale. In years with fewer observed sets, the precision of regression tree bycatch estimates is generally low, a consequence of fewer observations from which to calculate the predicted mean annual bycatch per set ($\bar{b}_{s,y}$). Regression tree estimate CVs also reflect the diversity of predictions from the random forest, which depends upon the variability in fishing set characteristics in year *y* used to extrapolate bycatch to unobserved fishing. . In the extreme, if all observed sets in year *y* had identical set characteristics (location, date, depth, etc.), then a random forest would predict the same mean bycatch rate for these sets, resulting in zero variance.

Discussion

Large differences between annual bycatch estimates using regression trees and ratio estimators are typically due to a combination of rarely-observed events and low observer coverage. For example, in 2010, two sperm whales were observed entangled in one fishing set, from only 59 observed sets that year and a total estimated fishing effort of 492 sets. The observed bycatch rate of 2 whales in 59 sets, combined with 12% annual observer coverage, yielded a ratio estimate of 16.7 whales (Table 21). In contrast, the regression tree estimate of bycatch for 2010 is 2.0 whales (2 observed + 0.04 whales estimated in 433 unobserved sets, which rounds to zero). Given the observed sperm whale bycatch rate in this fishery over 28 years (~ 1 animal for every 1,000 sets), it is highly unlikely that observed + unobserved bycatch in 2010 was approximately 17 whales, which reflects the ratio estimate. It is more likely that there were only two entanglements, both of which happened to be observed. Another problem with annual ratio estimates is when zero bycatch is observed, the resulting bycatch estimates are zero (with no variance estimate), even if undetected bycatch occurs. No sperm whale entanglements were observed in 648 sets in the first two years of the observer program (1990-1991, Table 21), when total fishing effort exceeded 9,000 sets. Resulting ratio estimates of sperm whale bycatch in 1990-1991 were zero (Julian and Beeson 1998), which is unrealistic, given the observed long-term bycatch rate of 1 whale in every 1,000 sets (a rate that could not be known after the first two years of the observer program). In contrast, summed 1990-1991 regression tree bycatch estimates are approximately 9 sperm whales, which is more realistic, given the level of fishing effort (Table 22). In 2017, there were an estimated 2.9 sperm whale entanglements, with 2 serious injuries / deaths (Table 22), despite there being no observations of sperm whales entangled since 2010. This is driven by the fact that a large fraction of the observed sets in 2017 were in deep water and in areas where previous entanglements occurred (Figure 4). In this case, the RF model for sperm whale bycatch is predicting higher-than-normal entanglement rates for 2017 (Figure 3), which are then propagated through to unobserved fishing effort. One feature of using regression trees for bycatch estimation is that trees predict some amount of bycatch in most years, even in the absence of observations. This is more in the spirit of a probabilistic estimation approach that moderates inter-annual volatility in estimates that can result from applying ratio estimates to rare bycatch events in the context of low observer coverage.

Bycatch reduction measures introduced into the fishery in 1996 included acoustic pingers, which resulted in significant reductions of short-beaked common dolphin bycatch (Barlow and Cameron 2003, Carretta and Barlow 2011) and the apparent elimination of beaked whale bycatch (Carretta *et al.* 2008). The efficacy of acoustic pingers in reducing bycatch for many cetacean species in this fishery is unknown, because most species lack sufficient observations to reliably test (Carretta and Barlow 2011). Short-beaked common dolphin are the most commonly entangled marine mammal in this fishery (Table 2), but both absolute bycatch and bycatch per fishing set has declined during 1990-2017 (Fig. 3). Bycatch per fishing set declined, even while fishing effort shifted to southern California waters (due to the PLCA closure) where common dolphin densities are highest (Becker *et al*. 2014), and during a period when the abundance of common dolphin increased (Barlow 2016). This is further evidence that pinger use, and not simply fishing effort reductions, are responsible for the observed decline in common dolphin bycatch rates. A prior study of bycatch reduction in this fishery identified only 2 species/groups with more statistically significant bycatch reductions than short-beaked common dolphin attributed to pingers: beaked whales and northern elephant seals (Carretta and Barlow 2011). In the present study, both species bycatch presence / absence models include pingers as an explanatory covariate.

Prior to the use of pingers in the fishery, estimated annual bycatch of all beaked whale species (including *Kogia*) from regression trees ranged between 20 to 40 animals (Table 40). During the pinger experiment of 1996-1997, when 47% of all observed sets utilized pingers (Carretta and Barlow 2011), beaked whale bycatch was estimated at 16 and 8 animals, respectively, despite an absence of observed bycatch in those years (Table 40). Beginning in 1998, the first full year that pingers were mandatory in the fishery, estimated beaked whale bycatch declined to near zero, which mirrors fishery observations of zero bycatch since 1996 (Table 40, Fig. 3). After 1997, most estimates of beaked whale bycatch are slightly positive, reflecting that the beaked whale random forest model is informed not only by the variable *n.ping*, but also by the variable *slope* (Table 2). Carretta *et al*. (2008) reported that acoustic pingers ‘eliminated’ beaked whale bycatch in this fishery, and that conclusion was based on the very small probability of observing zero bycatch in ~4,300 fishing sets over an 11-year period. Prior to the first experimental use of pingers in the fishery in 1996, there were 33 beaked whale entanglements observed from 3,303 observed sets (roughly one beaked whale per 100 sets). It is unknown if all beaked whale bycatch has been eliminated since pinger use began, because roughly 85% of all fishing effort is unobserved. However, there has now been zero beaked whale bycatch observed from over 5,600 observed fishing sets during the 22-year period 1996-2017. This observation is not due to a geographic shift in fishing effort resulting from PLCA implementation in 2001, as Carretta *et al*. (2008) reported that beaked whale bycatch rates were nearly equal inside and outside of the PLCA and that beaked whale bycatch had already dropped to zero in observed 2,670 sets after pingers were introduced, but prior to PLCA implementation. Although there has been an apparent decline in beaked whale abundance in the California Current during our study period (Moore and Barlow 2013), Carretta *et al*. (2008) calculated that the observation of zero beaked whale bycatch was statistically implausible even if beaked whale abundance had declined by 90%. Current evidence still identifies pingers as the most likely explanation for the reduction in beaked whale bycatch in the fishery.

Observations of short-finned pilot whale bycatch are rare in the fishery (10 events totaling 14 animals). Pilot whales are generally detected in the California Current during warm-water episodes (Barlow 2016) and the identification of the multivariate El Niño index (*mei.index*) as an important predictor variable supports these observations (Table 2). Short-finned pilot whales were the only cetacean species where *mei.index* was identified as a significant predictor variable (*mei.index* was also a significant predictor of bycatch for the seabird Northern Fulmar, *Fulmarus glacialis*). The mean annual *mei.index* for the 10 pilot whale bycatch events was 0.82 *vs* 0.36 for sets without pilot whale bycatch. However, the mean sea surface temperature (*sst)* was nearly identical for both sets with and without pilot whale bycatch, which is a function of the rarity of these events. Observed and predicted annual bycatch rates of short-finned pilot whales appear highly-correlated (Fig. 3), which is due mostly to the strong link between observed pilot whale bycatch and higher annual *mei.index* values. In addition to *mei.index*, the variable *days* was identified as an important predictor of pilot whale bycatch, which implies that seasonal factors influence the probability of bycatch within the California Current.

California sea lion bycatch levels declined from 1990-2017, which largely reflects declining fishing effort (Table 26). However, observed and estimated sea lion bycatch per fishing set *increased* during the same period (Fig. 3), due to an increasing sea lion population and implementation of the PLCA, which shifted existing gillnet effort to more shallow southern waters (Fig. 1) where sea lion breeding rookeries are located and where sea lion abundance is highest. Howorth (1994) and Stewart and Yochem (1987) reported that most California sea lion entanglements in synthetic debris and entangling nets were subadults, and Howorth (1994) suggested that smaller meshes were more likely to result in the entanglement of these age classes. Most sea lions observed entangled in the swordfish drift gillnet fishery are subadults and the highest bycatch rates occur in sets with the smallest mesh sizes (< 18 inches), though the variable *mesh* was not included in the final bycatch model (Table 2).

Martin *et al.* (2015) estimated leatherback sea turtle bycatch in this fishery for the 20-year period 1990-2009, with a total bycatch range of 104–242 leatherbacks (52–153 estimated deaths). Our estimates of total leatherback bycatch for the same 20-year period (~150-160 entanglements, ~ 110-120 estimated deaths, Table 32) are similar, and both studies estimate 10-25 annual leatherback entanglements in the first 8 years of the observer program. In both studies, estimated leatherback entanglements decline each year, reaching low levels after implementation of the PLCA in 2001 (Fig. 1), which Martin *et al.* (2015) reported to have the largest effect on reducing leatherback bycatch. The PLCA closure in 2001 shifted fishing effort southeast of preferred seasonal leatherback habitat (Eguchi *et al.* 2016), resulting in declines in observed and estimated bycatch. After 2001, estimated leatherback bycatch is between 0 and 2 turtles annually, which reflects both the PLCA effectiveness and declining fishing effort (Table 32). Prior to the PLCA (1990-2000), the observed bycatch rate of leatherbacks was 23 turtles from 5,973 fishing sets (0.0038 per set). Following the closure (2001-2017), the observed bycatch rate was

2 turtles from 2,983 fishing sets (0.0007 per set). Individual leatherback entanglements in 2009 and 2012 give a false impression of a high bycatch rate in those years, but this is actually an artifact of the small number of sets observed each year (Fig. 3). Our leatherback bycatch model included the variables *lat* + *n.ping.* Latitude can be thought of as a proxy variable for the PLCA (Fig. 1), as this region is in the northern part of the fishing area, where fishing has rarely-occurred since the closure began. The inclusion of the pinger variable in this model is interesting. There is no evidence that acoustic pingers act as a deterrent to leatherback turtles. Pingers effectively act as a binary variable in this study, as none were used prior to 1996 and most sets utilized between 30-40 pingers after this. Of the 8,956 observed fishing sets in this study, 3,939 (43%) represent sets without pingers. All sets without pingers occurred in the first 8 years of the observed data, prior to the PLCA implementation. Pingers may simply be acting as a proxy variable for the period before / after the PLCA implementation in this model. Based on a study of satellite-tagged leatherback turtles in the California Current, Eguchi *et al.* (2016) noted that the seasonal restrictions of the PLCA (15-Aug to 15-Nov) are nearly optimal for reducing leatherback bycatch in this fishery. It should be noted that observed declines in leatherback entanglements following implementation of the PLCA are also influenced by declines in drift gillnet fishery participation and a decline in Pacific leatherback nesting populations (Tapilatu *et al*. 2013).

Our bycatch data contained nearly 9,000 fishing sets spanning 28 years, and while it might be considered 'data rich' by some standards, bycatch for many species was represented by fewer than 5 entanglements. For rarely-entangled species, it was necessary to pool data across taxa to obtain variables for use in regression trees. The uncertainty in bycatch estimates for rarely-entangled species will always be large, but compared with intra-annual ratio estimates, the precision of model-based estimates is vastly improved by the use of many years of data. One consequence of multi-year pooling is that our precision estimates of annual bycatch reflect only the uncertainty from observed mean bycatch rates, and do not reflect variation in true annual bycatch. This problem decreases as the time period for data-pooling increases, but for annual estimates, our estimates of precision are likely underestimated relative to intra-annual variability in true bycatch rates. The management advantages of model-based bycatch estimation methods that utilize all available data are worth noting. The primary advantage is that annual bycatch estimates are less volatile, less biased, and more precise, especially where observer data are characterized by rare bycatch and low observer coverage. Reducing the volatility of year-to-year estimates of bycatch for rarely-entangled species is important in protected species management, where decisions involving regulation of a fishery require accurate and timely assessment of bycatch. This is especially so for rare event bycatch, where the absence of bycatch observations may result in the failure to detect a genuine bycatch problem due to low observer coverage. Conversely, the observation of a rare bycatch event in a low observer coverage situation can result in unrealistically high estimates of bycatch and contribute to short-term management responses that overestimate the risk to populations. Pooling of data (where appropriate) to improve estimates of mean bycatch rates is the first step towards such bias reduction, but as fishery conditions change over time, it is also necessary to identify and use fishery and environmental variables that may influence bycatch rates over time. For species where observed bycatch is so rare that no explanatory variables can be identified, use of random forests with a default set of variables (e.g. *lat* + *lon* + *days*) can still provide a 'null model' of bycatch that mirrors the overall mean bycatch rate, which can then be scaled up to total fishing effort. Such null models still represent a large improvement over calculating within-year bycatch rates previously used with ratio estimators in this fishery (Julian and Beeson 1998, Carretta *et al*. 2004).

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Figure 1. Observed fishing sets, 1990-2000 (L), 2001-2017 (R), and Pacific Leatherback Conservation Area (shaded).

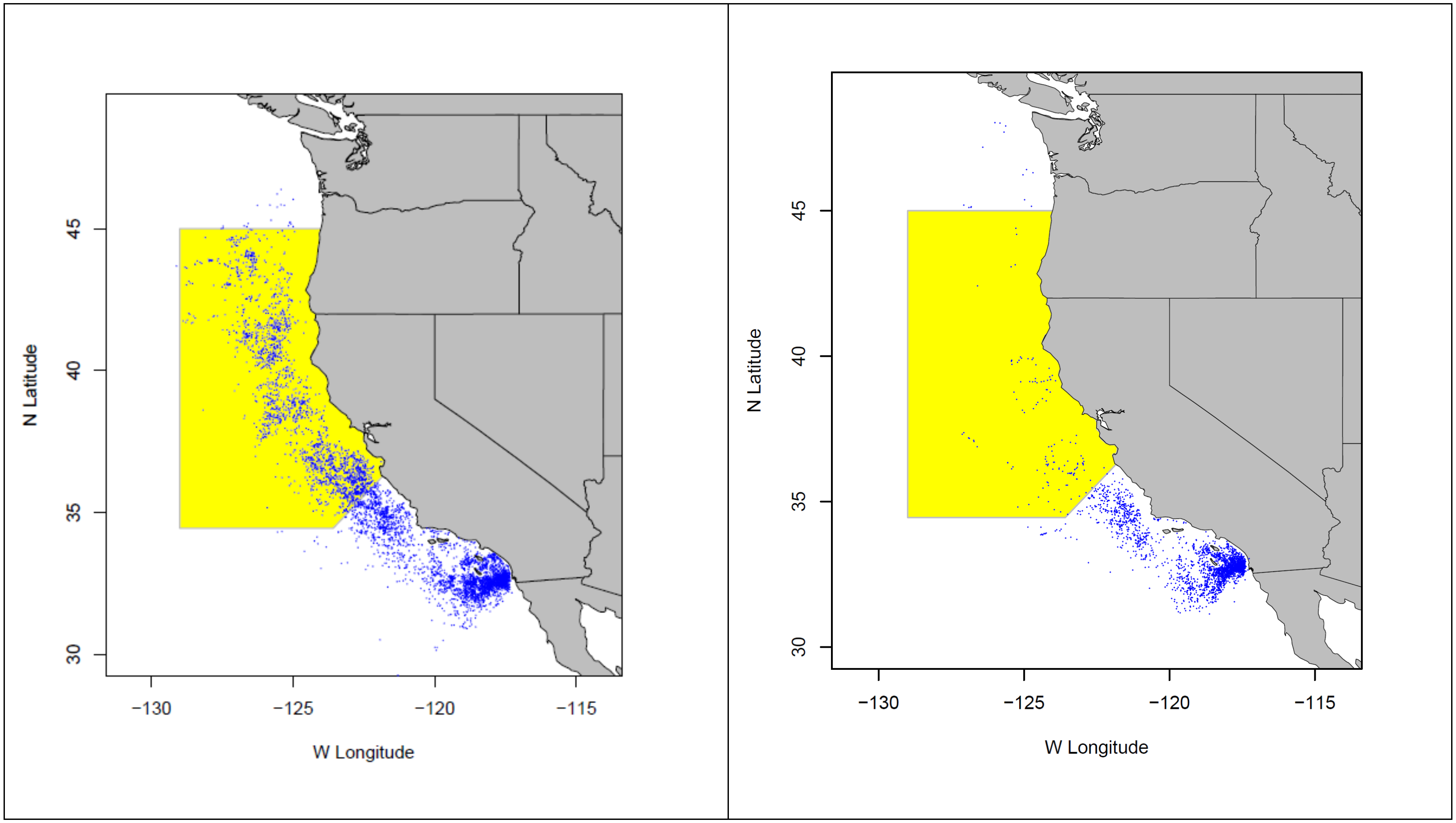


Figure 2. Observed and estimated number of fishing sets in the California large-mesh drift gillnet fishery, 1990-2017. Values in bars represent approximate fraction of annual observer coverage.

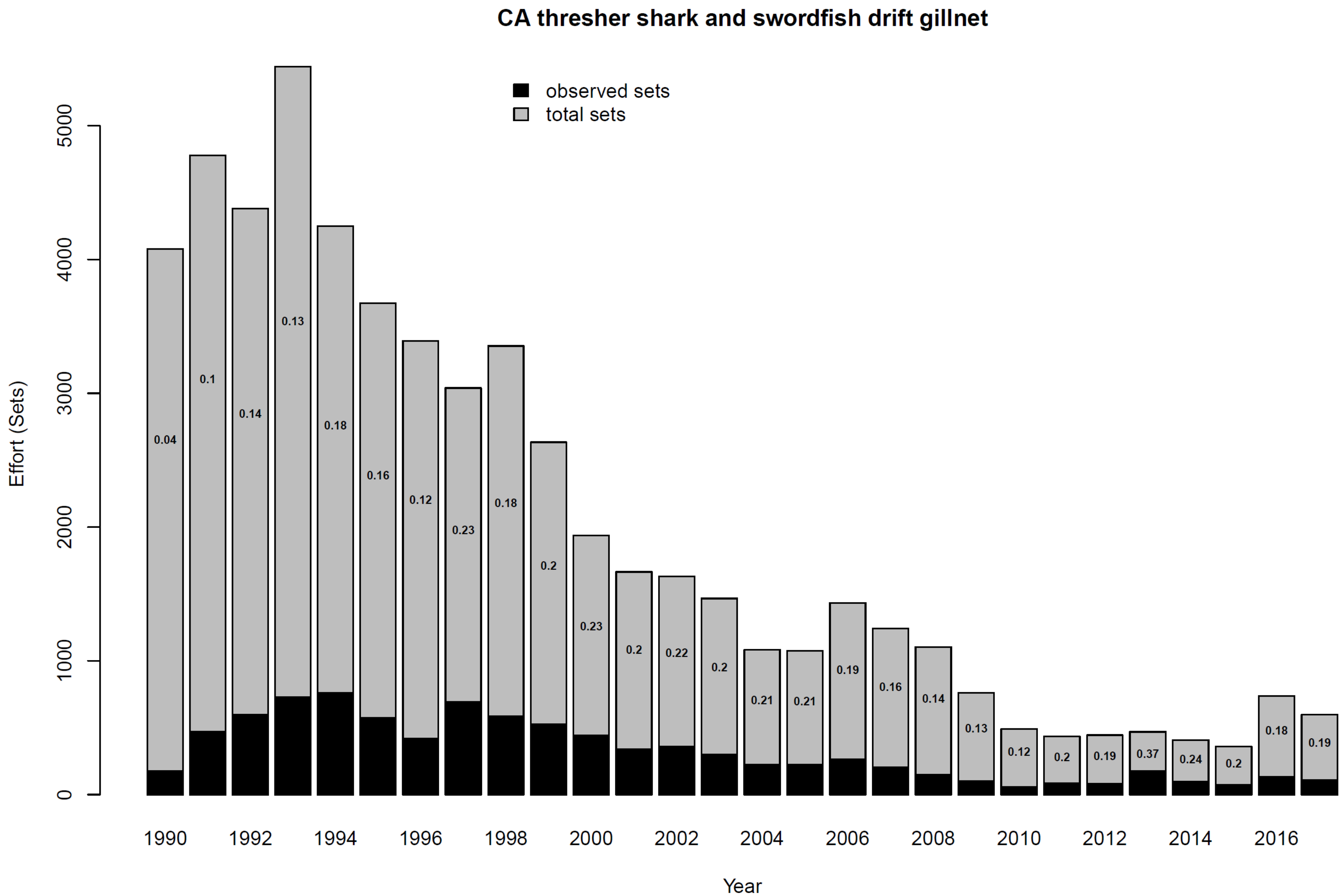
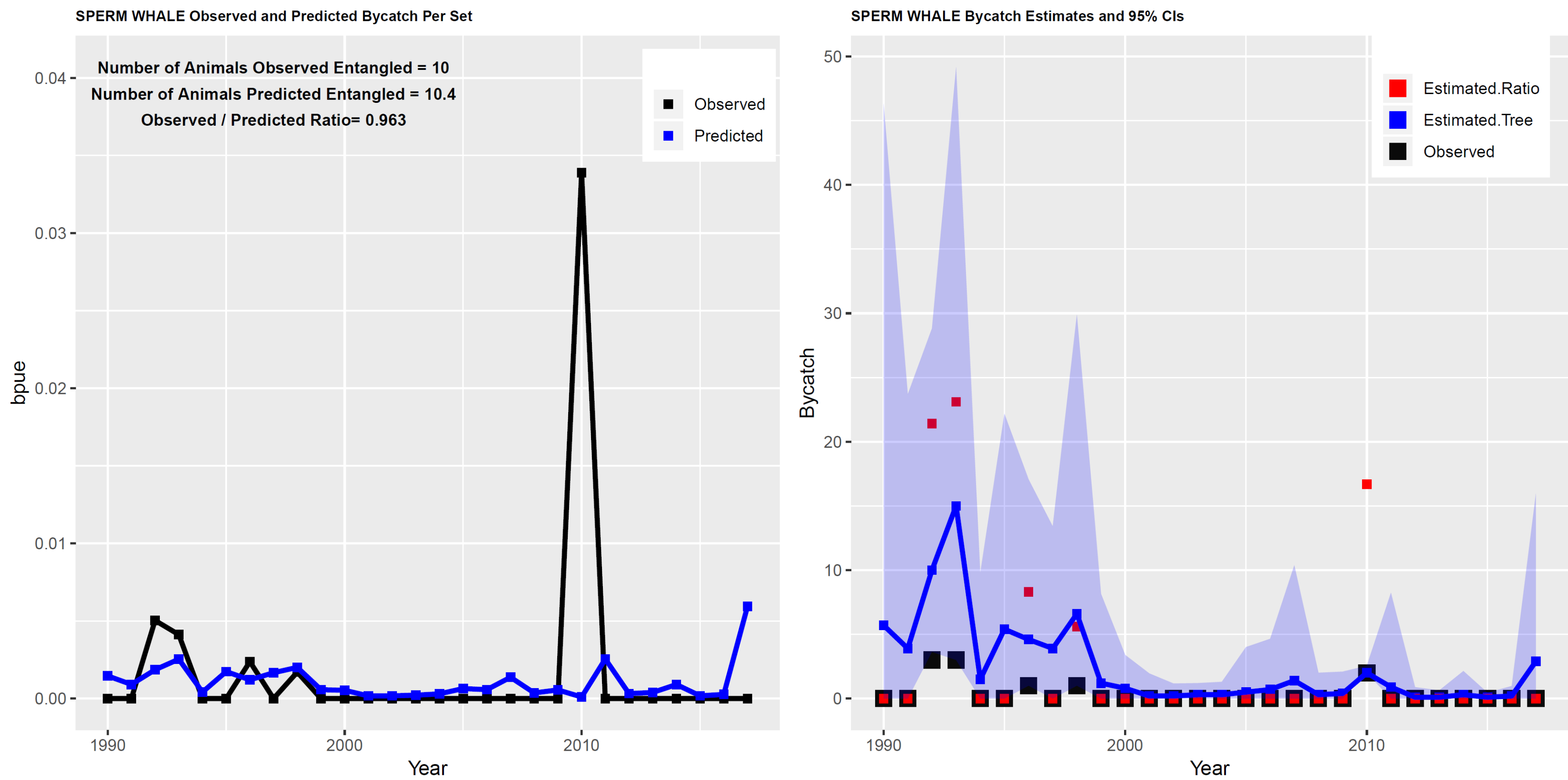


Figure 3. Observed and estimated bycatch for selected species / groups. The left panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 8,956 fishing sets. Right panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates.



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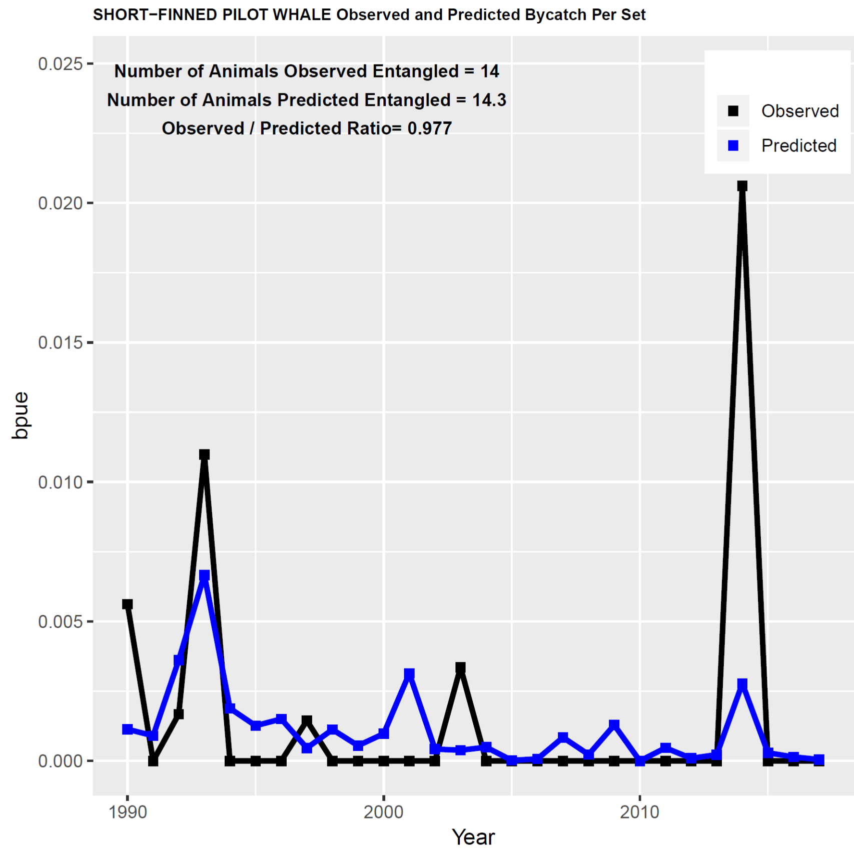

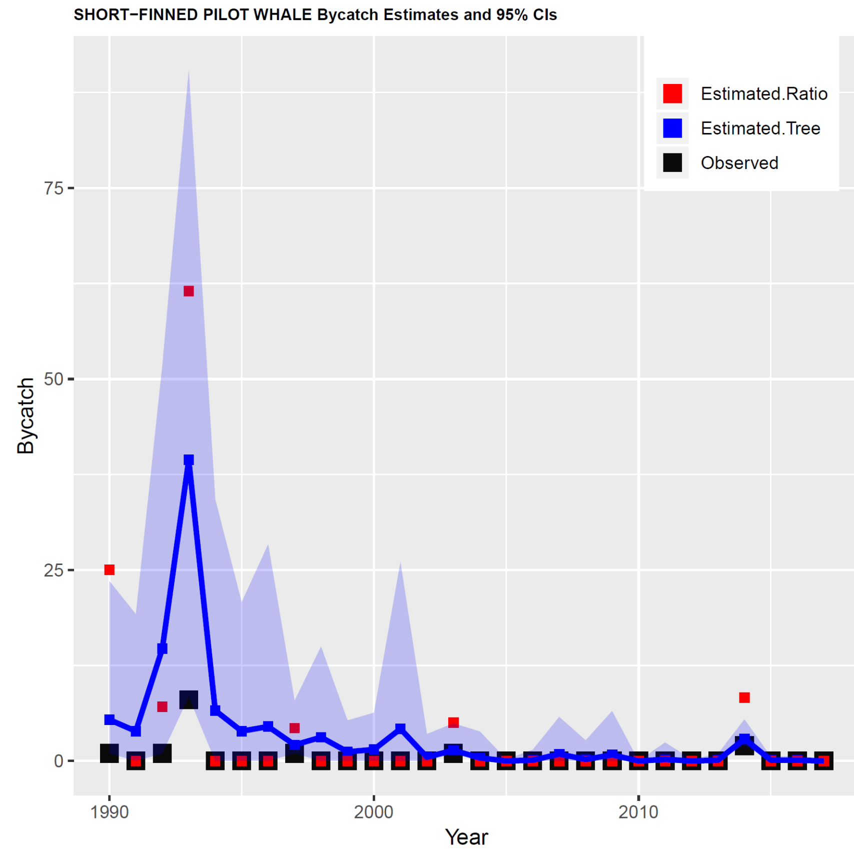

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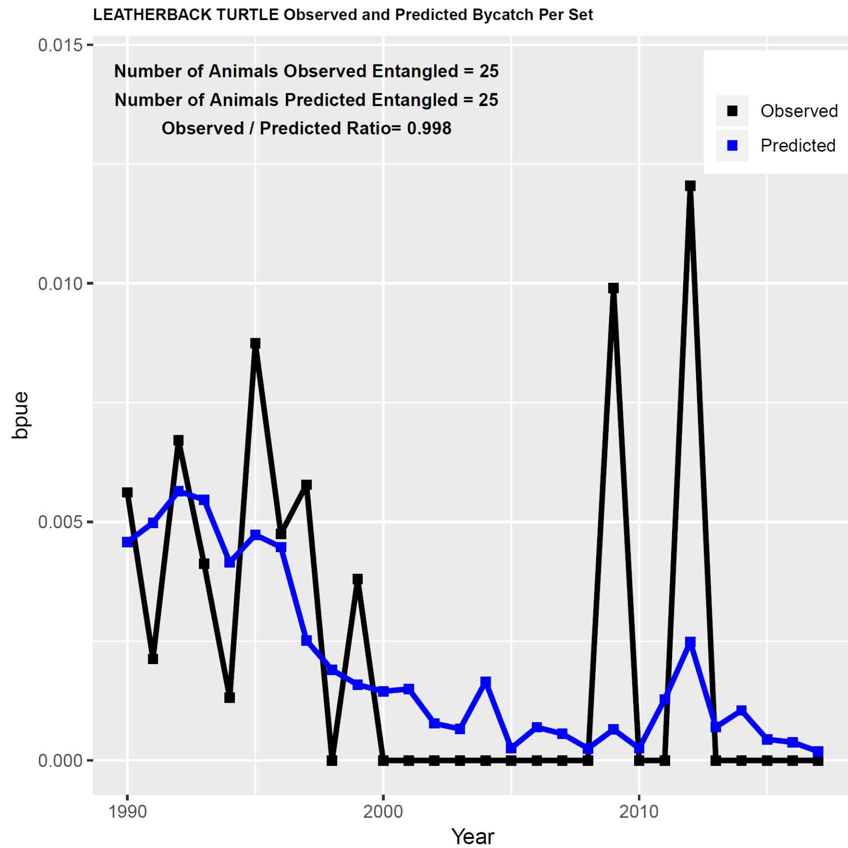

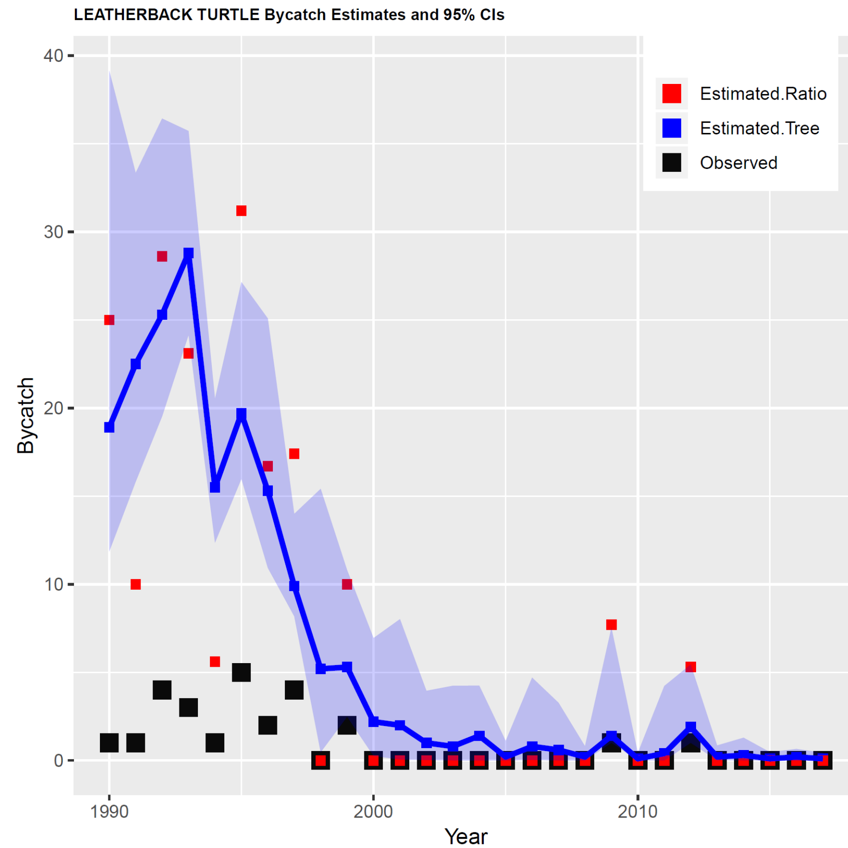

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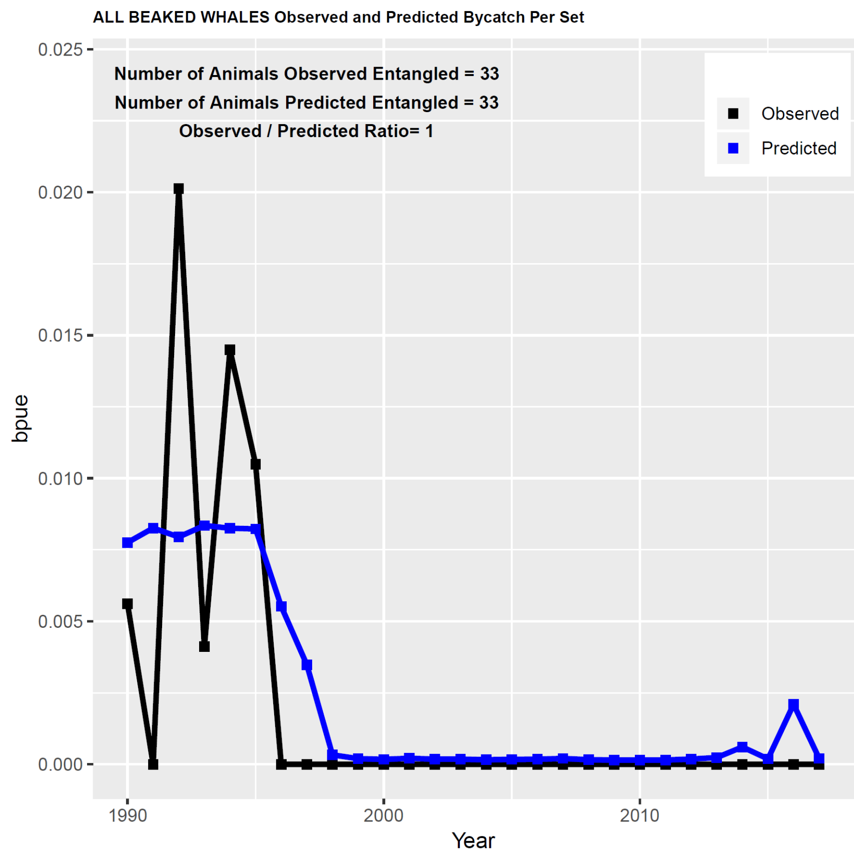

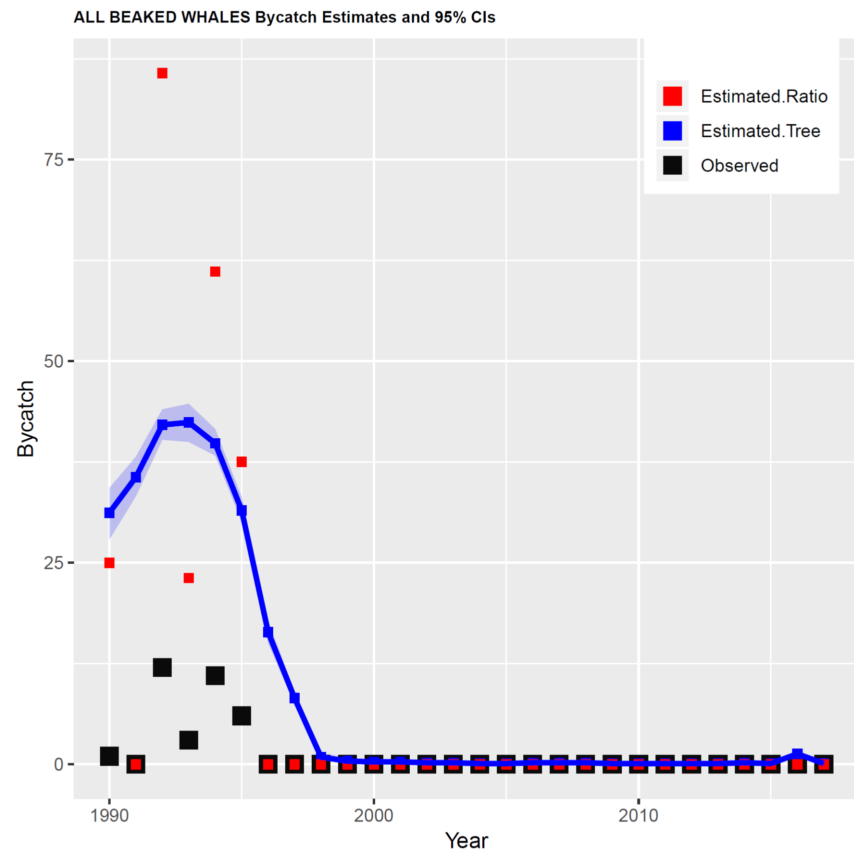

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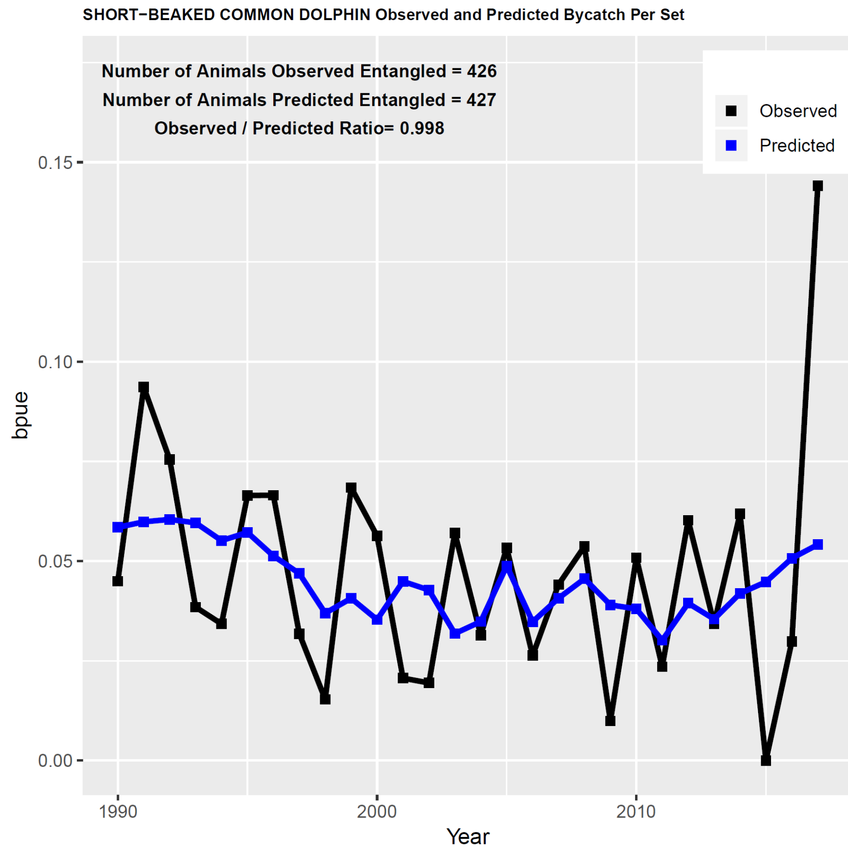

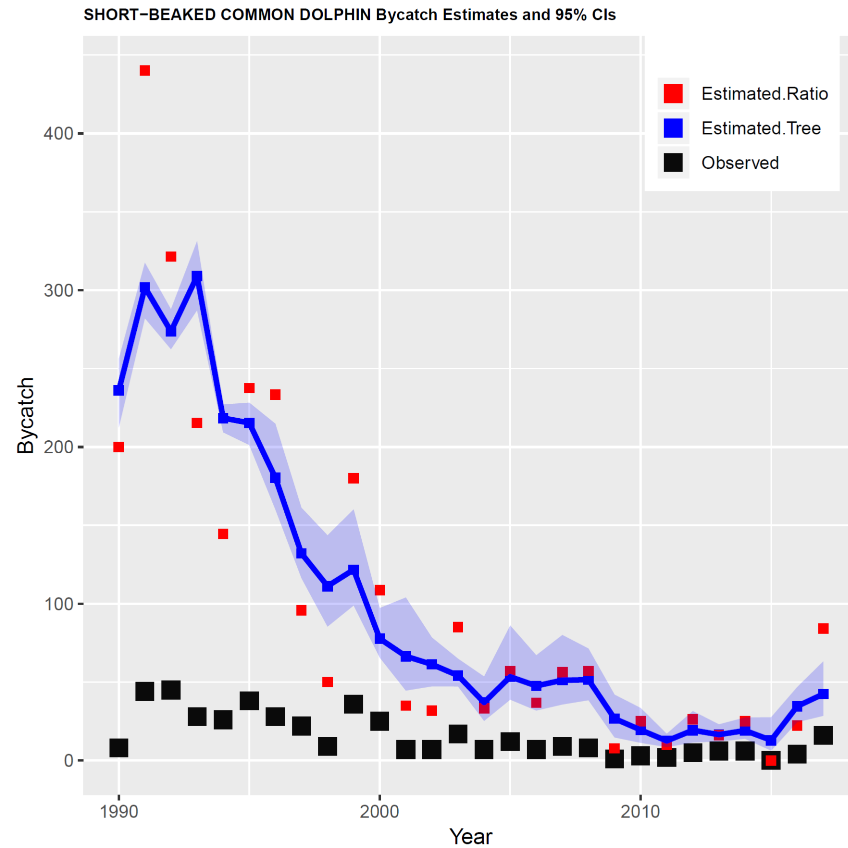

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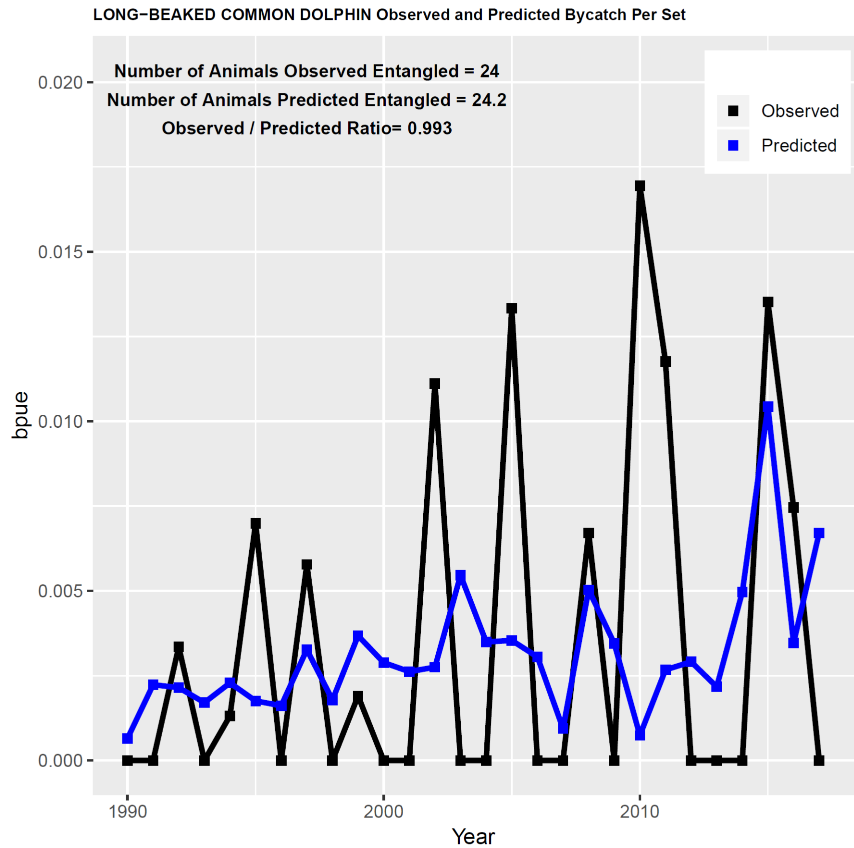

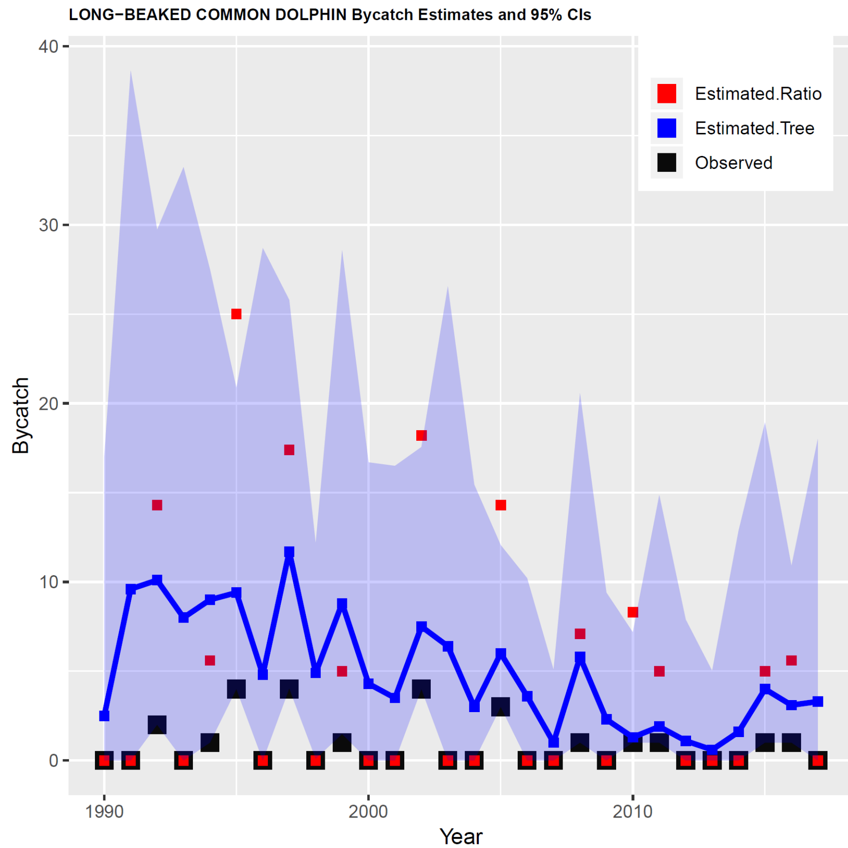

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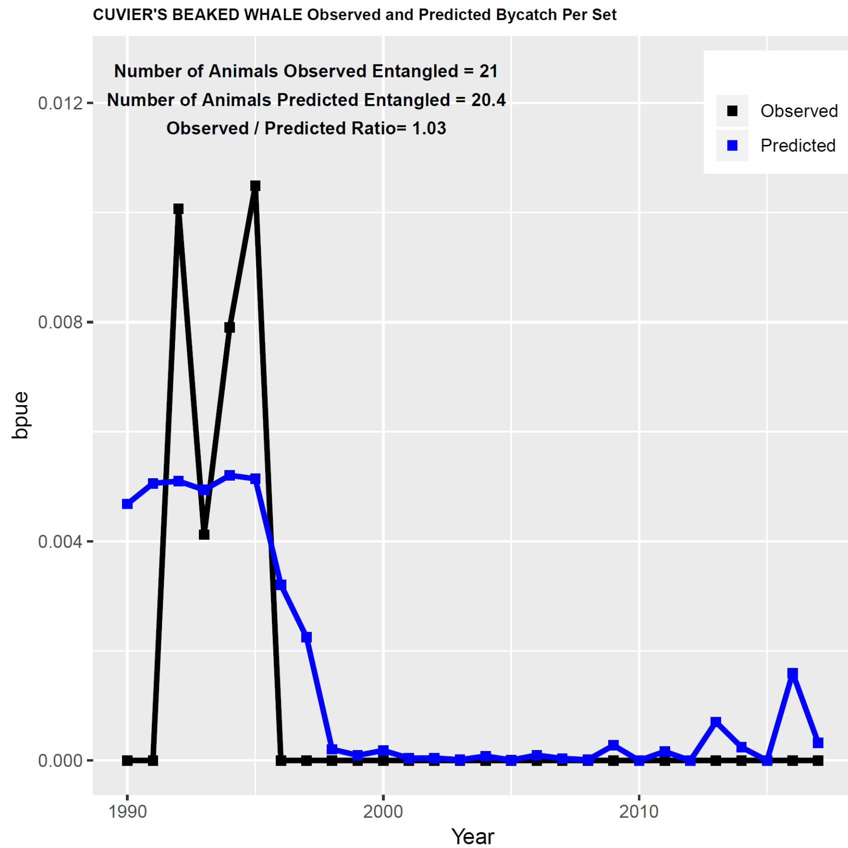

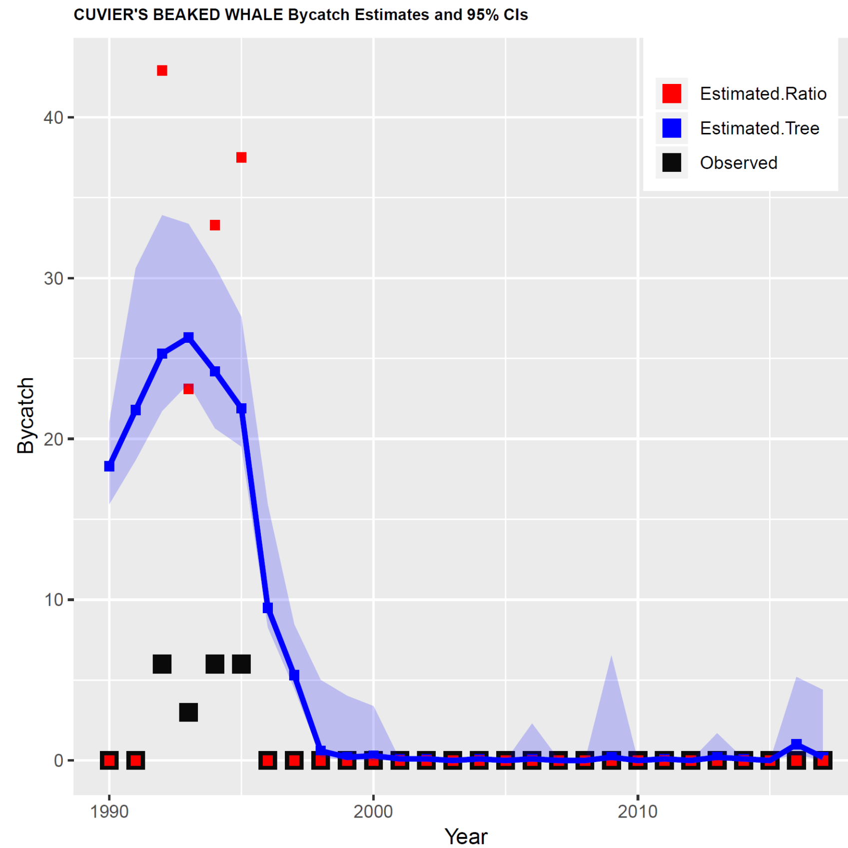

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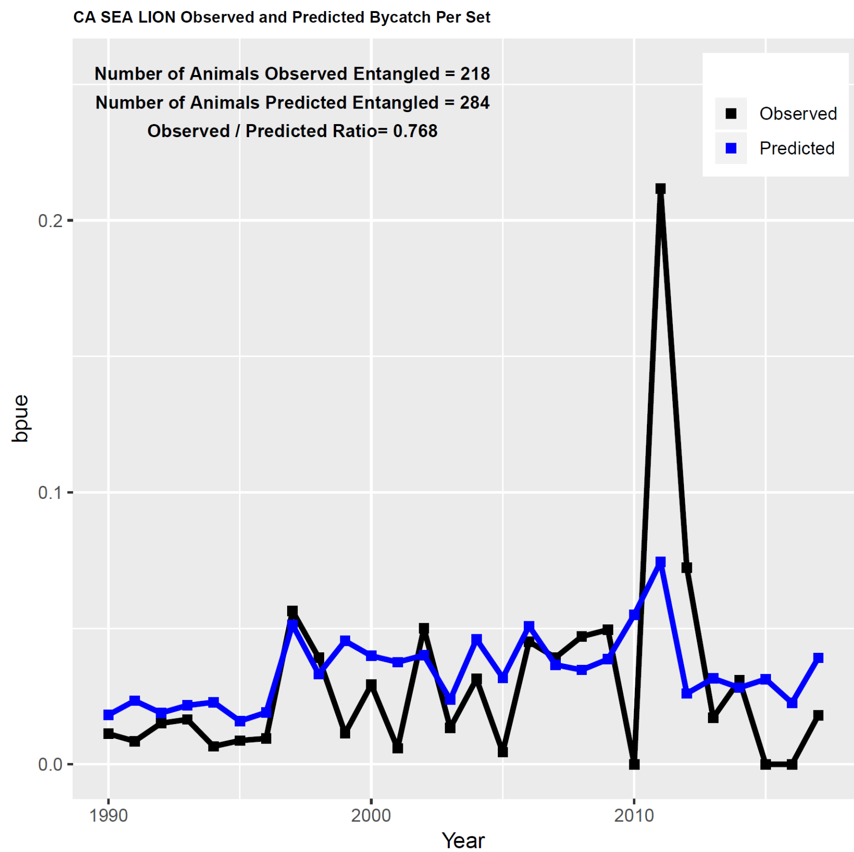

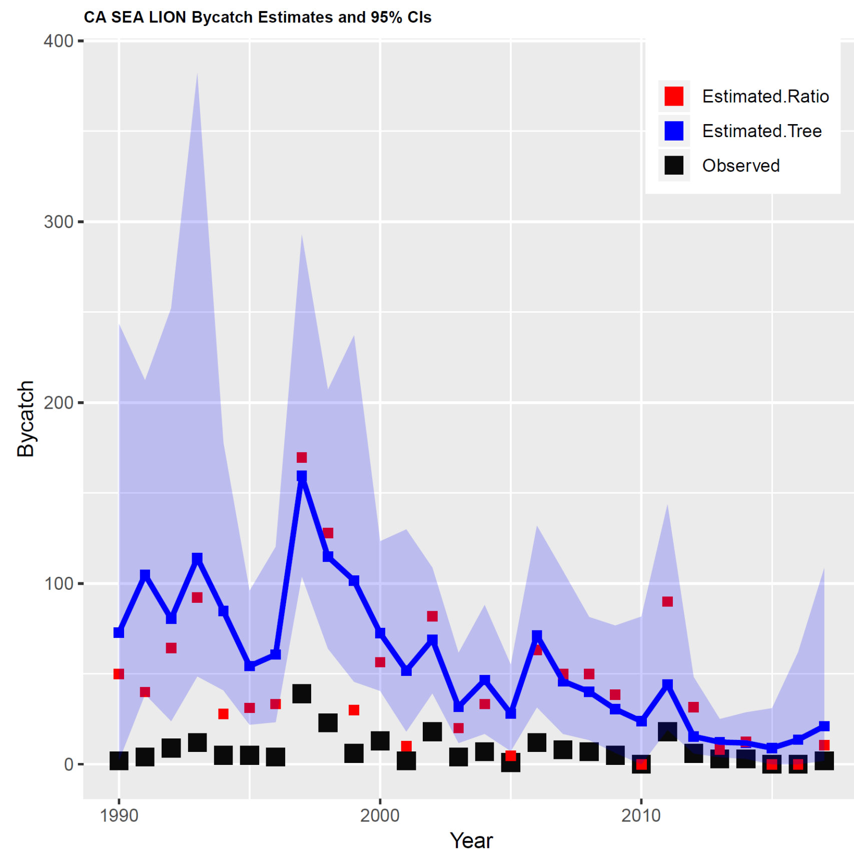

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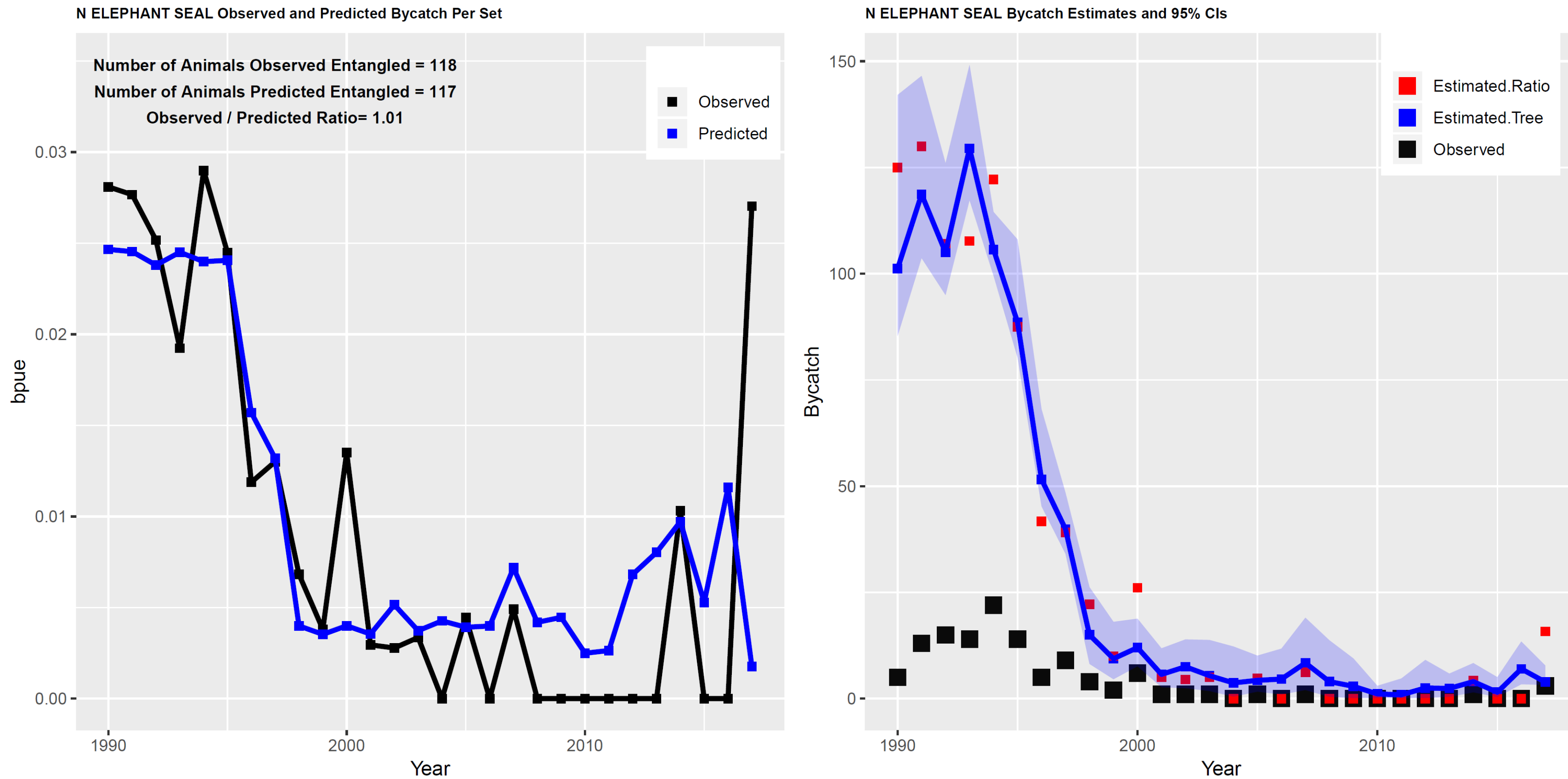

Figure 4. Observed drift gillnet fishing sets in 2017 (n=111).

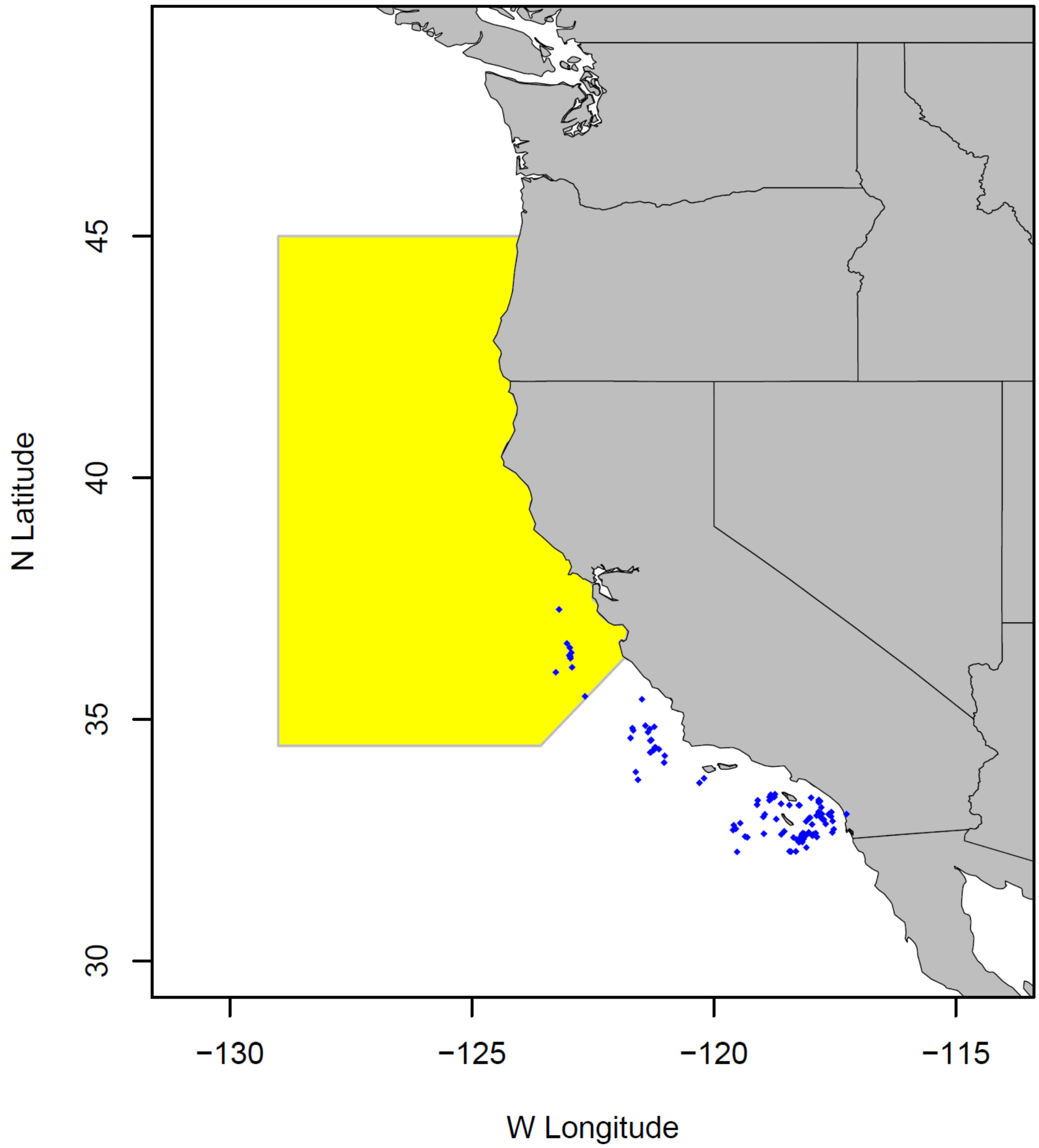

Table 1. Variables tested in random forest classification tree bycatch presence / absence models. A total of 500 random forest (RF) models were constructed, each consisting of 500 trees and each had a different set of variables (from n=2 to all 14 variables) selected for tree construction. The bootstrap set of variables that resulted in the lowest cross-validated error rate for bycatch presence (sensitivity) were the used in a regression tree framework to estimate bycatch. In the event of a tie in cross-validated error rates, the RF model with the fewest variables was chosen.

Variable Name	**Variable Description**	**Range of Values**
Days	Sequential day of year	1 -365
Depth	water depth when net was pulled (meters)	46 - 6584
drift.km	Drift distance between set and retrieval (km)	1 - 300
Extnd	top of net depth below surface in (feet)	3 - 99
height.net	Number of meshes from top to bottom of net	14 - 180
Lat	Latitude	24.5 - 48
length.net	Length of net (meters)	50 – 2000
Lon	Longitude	117 - 129
mei.index	Multivariate El Niño index(annual mean for Aug-Jan)	-1.3 to +2.1
mesh	mesh size in inches	14 - 28
n.ping	Number of acoustic pingers	0 - 49
Slope	Bathymetric slope, in degrees	0 - 90
soak	Soak time of net in hours	1 - 62
Sst	Sea surface temperature (C)	11.1 – 25.6

Table 2. Species / taxa groups bycatch summary, variable selection results, and True Skill Statistic (TSS) model performance metrics for random forest bycatch presence / absence models.

Species	Entanglement Events	Number Animals	Variable 1	Variable 2	Variable 3	Specificity	Sensitivity	Accuracy	TSS	Presence Correctly Classified
ALL DELPHINOIDS	490	644	depth.p	n.ping	-	0.7	0.468	0.48	0.168	343
Delphinus delphis, SHORT-BEAKED COMMON DOLPHIN	338	426	n.ping	height.net	-	0.683	0.446	0.455	0.129	231
Zalophus californianus, CALIFORNIA SEA LION	177	218	soak	extnd	-	0.655	0.416	0.421	0.071	116
Mirounga angustirostris, NORTHERN ELEPHANT SEAL	114	118	mei.index	n.ping	extnd	0.816	0.544	0.547	0.36	93
Lissodelphis borealis, NORTHERN RIGHT WHALE DOLPHIN	58	80	lon	extnd	-	0.81	0.634	0.635	0.444	47
ALL BEAKED WHALES	33	33	slope	n.ping	-	1	0.56	0.561	0.56	33
Grampus griseus, RISSO'S DOLPHIN	27	35	days	lon	-	0.741	0.83	0.83	0.571	20
Lagenorhynchus obliquidens, PACIFIC WHITE-SIDED DOLPHIN	27	36	lon	depth.p	mesh	0.593	0.837	0.836	0.429	16
Dermochelys coriacea, LEATHERBACK SEA TURTLE	25	25	lat	n.ping	-	0.84	0.711	0.711	0.551	21
Phocoenoides dalli, DALL'S PORPOISE	21	23	n.ping	mesh	-	0.905	0.635	0.636	0.54	19
Ziphius cavirostris, CUVIER'S BEAKED WHALE	21	21	depth.p	n.ping	-	1	0.643	0.644	0.643	21
Fulmarus glacialis, NORTHERN FULMAR	20	36	mei.index	extnd	-	0.95	0.827	0.828	0.777	19
Delphinus capensis, LONG-BEAKED COMMON DOLPHIN	18	24	lat	depth.p	-	0.833	0.802	0.802	0.635	15
Caretta caretta, LOGGERHEAD SEA TURTLE	14	16	lat	extnd	-	0.929	0.62	0.62	0.548	13
Globicephala macrorhynchus, SHORT-FINNED PILOT WHALE	10	14	days	mei.index	extnd	1	0.723	0.724	0.723	10
Physeter macrocephalus, SPERM WHALE	6	10	mei.index	depth.p	-	0.833	0.746	0.746	0.579	5
Mesoplodon hubbsi, HUBB'S BEAKED WHALE	5	5	days	mei.index	-	1	0.794	0.795	0.794	5
UNID. BIRD	5	5	slope	drift.km	-	0.8	0.797	0.797	0.597	4
Balaenoptera acutorostrata, MINKE WHALE	4	4	lat	soak	-	0.75	0.843	0.843	0.593	3
Eschrichtius robustus, GRAY WHALE	4	4	lat	lon	-	0.75	0.566	0.566	0.316	3

Table 3. Random forest confusion matrices for selected species presence / absence models. Classification error rates are shown for bycatch presence (Y) and absence (N) for out-of-bag (OOB) data not used in tree construction.

Leatherback sea turtle

	N	Y	class.error
N	6471	2475	0.27666
Y	4	21	0.16000

Cuvier's Beaked Whale

	N	Y	class.error
N	4989	3946	0.441634
Y	0	21	0.000000

Short-beaked common dolphin

	N	Y	class.error
N	3960	4658	0.5404966
Y	107	231	0.3165680

Long-beaked common dolphin

	N	Y	class.error
N	7122	1816	0.2031774
Y	3	15	0.1666667

Sperm whale

	N	Y	class.error
N	6977	1973	0.2204469
Y	1	5	0.1666667

ALL BEAKED WHALES

	N	Y	class.error
N	4999	3924	0.4397624
Y	0	33	0.0000000

Short-finned pilot whale

	N	Y	class.error
N	5088	3843	0.430299
Y	0	10	0.00000

California sea lion

	N	Y	class.error
N	3653	5126	0.5838934
Y	61	116	0.3446328

Northern right whale dolphin

	N	Y	class.error
N	5639	3259	0.3662621
Y	11	47	0.1896552

Pacific white-sided dolphin

	N	Y	class.error
N	7470	1459	0.1634002
Y	11	16	0.4074074

Risso's Dolphin

	N	Y	class.error
N	5584	3345	0.3746220
Y	7	20	0.2592593

Northern elephant seal

	N	Y	class.error
N	4698	4144	0.4686722
Y	21	93	0.1842105

Table 4. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for MINKE WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.5 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	2.6	2.6	2.4	0	−	1.4	2.5
1991	470	0.1	0	1.6	1.6	1.3	0	−	0.8	1.2
1992	596	0.14	0	1	1	1.3	0	−	0.5	1.5
1993	728	0.13	0	0.7	0.7	1.4	0	−	0.4	1.5
1994	759	0.18	1	2.1	3.1	0.76	5.6	1	2.1	0.69
1995	572	0.16	0	4	4	0.84	0	−	2	1
1996	421	0.12	1	1.3	2.3	0.89	8.3	1	1.6	0.71
1997	692	0.23	0	0.5	0.5	1.4	0	−	0.2	1.8
1998	587	0.18	0	0.3	0.3	1.7	0	−	0.2	1.4
1999	526	0.2	1	0.4	1.4	0.42	5	1	0.2	1.6
2000	444	0.23	0	0.5	0.5	1.9	0	−	0.2	2.1
2001	339	0.2	0	0.7	0.7	1.6	0	−	0.3	2.1
2002	360	0.22	0	0.1	0.1	1.1	0	−	0.1	1.3
2003	298	0.2	0	0.2	0.2	2.2	0	−	0.1	3.2
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.2	0.2	3	0	−	0.1	3.8
2007	204	0.16	0	2.8	2.8	0.98	0	−	1.3	1.3
2008	149	0.14	0	0.1	0.1	1.5	0	−	0	1.8
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0.1	0.1	2.3	0	−	0	2.3
2011	85	0.2	1	0	1	0	5	0.99	0	0
2012	83	0.19	0	0.1	0.1	2.2	0	−	0	2.6
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0.7	0.7	1.9	0	−	0.3	2
2015	74	0.2	0	0.3	0.3	3.6	0	−	0.1	4.3
2016	134	0.18	0	0.5	0.5	1.6	0	−	0.3	1.7
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	3	14	17	0.36	20	0.58	8.9	0.54
2001−2017	2983	0.19	1	5.6	6.6	0.5	5.3	0.99	2.8	0.84
2013−2017	591	0.23	0	1.4	1.4	1.2	0	−	0.7	1.4

Table 5. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for FIN WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.1	0.1	5	0	−	0.1	5
1991	470	0.1	0	0.1	0.1	11	0	−	0.1	11
1992	596	0.14	0	0.1	0.1	5.8	0	−	0.1	5.8
1993	728	0.13	0	0.3	0.3	3.7	0	−	0.3	3.7
1994	759	0.18	0	0.9	0.9	1.9	0	−	0.9	1.9
1995	572	0.16	0	0.3	0.3	2.5	0	−	0.3	2.5
1996	421	0.12	0	0	0	−	0	−	0	−
1997	692	0.23	0	0	0	−	0	−	0	−
1998	587	0.18	0	0.1	0.1	4.5	0	−	0.1	4.5
1999	526	0.2	1	0.4	1.4	0.76	5	0.99	1.4	0.76
2000	444	0.23	0	0.3	0.3	2.7	0	−	0.3	2.7
2001	339	0.2	0	0.2	0.2	2.8	0	−	0.2	2.8
2002	360	0.22	0	0.2	0.2	3.1	0	−	0.2	3.1
2003	298	0.2	0	0.3	0.3	3	0	−	0.3	3
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0.2	0.2	3.3	0	−	0.2	3.3
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0.3	0.3	2.9	0	−	0.3	2.9
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.1	0.1	3.1	0	−	0.1	3.1
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	3.1	4.1	0.8	6.7	1.02	4.1	0.8
2001−2017	2983	0.19	0	1.7	1.7	1.3	0	−	1.7	1.3
2013−2017	591	0.23	0	0.2	0.2	2.8	0	−	0.2	2.8

Table 6. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for GRAY WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.1	0.1	1.7	0	−	0.1	1.7
1991	470	0.1	0	0.1	0.1	0.93	0	−	0.1	0.93
1992	596	0.14	0	0.1	0.1	0.66	0	−	0.1	0.66
1993	728	0.13	0	0.1	0.1	0.96	0	−	0.1	0.96
1994	759	0.18	0	0.1	0.1	0.86	0	−	0.1	0.86
1995	572	0.16	0	0.6	0.6	0.76	0	−	0.6	0.76
1996	421	0.12	0	0.9	0.9	0.95	0	−	0.9	0.95
1997	692	0.23	0	0.1	0.1	0.66	0	−	0.1	0.66
1998	587	0.18	1	3.6	4.6	0.34	5.6	0.99	4.6	0.34
1999	526	0.2	1	3.7	4.7	0.11	5	1	4.7	0.11
2000	444	0.23	0	0.3	0.3	0.38	0	−	0.3	0.38
2001	339	0.2	0	0.3	0.3	0.5	0	−	0.3	0.5
2002	360	0.22	0	0.1	0.1	0.57	0	−	0.1	0.57
2003	298	0.2	0	0.1	0.1	0.51	0	−	0.1	0.51
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	1	3.1	4.1	0.15	4.8	1	4.1	0.15
2006	266	0.19	0	0.1	0.1	0.47	0	−	0.1	0.47
2007	204	0.16	0	0.2	0.2	0.38	0	−	0.2	0.38
2008	149	0.14	0	0.1	0.1	0.45	0	−	0.1	0.45
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0.2	0.2	0.67	0	−	0.2	0.67
2011	85	0.2	0	0.1	0.1	0.54	0	−	0.1	0.54
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	1	1.3	2.3	0.16	2.7	1	2.3	0.16
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	1.6	0	−	0.1	1.6
2017	111	0.19	0	0.2	0.2	1.1	0	−	0.2	1.1
1990−2000	5973	0.15	2	12.5	14.5	0.16	13.3	0.7	14.5	0.16
2001−2017	2983	0.19	2	8	10	0.12	10.5	0.69	10	0.12
2013−2017	591	0.23	1	2.8	3.8	0.2	4.3	0.99	3.8	0.2

Table 7. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for HUMPBACK WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.25 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	2.2	2.2	0.6	0	−	0.5	1.3
1991	470	0.1	0	1.2	1.2	0.5	0	−	0.3	1.3
1992	596	0.14	0	0.5	0.5	0.45	0	−	0.1	1.3
1993	728	0.13	0	1.2	1.2	0.51	0	−	0.3	1.3
1994	759	0.18	1	0.5	1.5	0.13	5.6	0.99	0.1	1.1
1995	572	0.16	0	1.5	1.5	0.51	0	−	0.4	1.2
1996	421	0.12	0	0.9	0.9	0.46	0	−	0.2	1.3
1997	692	0.23	0	0.6	0.6	0.5	0	−	0.2	1.1
1998	587	0.18	0	0.9	0.9	0.84	0	−	0.2	1.8
1999	526	0.2	1	2.9	3.9	0.4	5	1	0.7	1.1
2000	444	0.23	0	0.4	0.4	0.77	0	−	0.1	1.7
2001	339	0.2	0	0.7	0.7	1.1	0	−	0.2	1.9
2002	360	0.22	0	0.3	0.3	1.9	0	−	0.1	3.2
2003	298	0.2	0	0.5	0.5	0.98	0	−	0.1	1.6
2004	223	0.21	1	0	1	0	4.8	1	0	0
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.4	0.4	0.94	0	−	0.1	1.7
2007	204	0.16	0	0.1	0.1	2	0	−	0	3.4
2008	149	0.14	0	0.8	0.8	1.2	0	−	0.2	1.7
2009	101	0.13	0	0.8	0.8	1.2	0	−	0.2	2.1
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.1	0.1	2.4	0	−	0	3
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	1.9	0	−	0	2.9
2017	111	0.19	0	0.1	0.1	2	0	−	0	3.7
1990−2000	5973	0.15	2	12.9	14.9	0.19	13.3	0.71	3.4	1.1
2001−2017	2983	0.19	1	3.5	4.5	0.36	5.3	1	0.9	1.3
2013−2017	591	0.23	0	0.2	0.2	1.2	0	−	0	1.9

Table 8. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for SHORT−BEAKED COMMON DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	8	267.7	275.7	0.096	200	0.46	275.7	0.096
1991	470	0.1	44	256.1	300.1	0.063	440	0.2	300.1	0.063
1992	596	0.14	45	200.8	245.8	0.06	321.4	0.18	245.8	0.06
1993	728	0.13	28	255.4	283.4	0.088	215.4	0.28	283.4	0.088
1994	759	0.18	26	200	226	0.047	144.4	0.21	226	0.047
1995	572	0.16	38	200.5	238.5	0.074	237.5	0.23	238.5	0.074
1996	421	0.12	28	145.8	173.8	0.088	233.3	0.21	173.8	0.088
1997	692	0.23	22	104.3	126.3	0.084	95.7	0.24	126.3	0.084
1998	587	0.18	9	94.3	103.3	0.18	50	0.33	103.3	0.18
1999	526	0.2	36	79.5	115.5	0.12	180	0.24	115.5	0.12
2000	444	0.23	25	50.5	75.5	0.13	108.7	0.24	75.5	0.13
2001	339	0.2	7	45.4	52.4	0.22	35	0.42	52.4	0.22
2002	360	0.22	7	47.6	54.6	0.18	31.8	0.43	54.6	0.18
2003	298	0.2	17	51.8	68.8	0.19	85	0.31	68.8	0.19
2004	223	0.21	7	44	51	0.24	33.3	0.43	51	0.24
2005	225	0.21	12	33.6	45.6	0.2	57.1	0.28	45.6	0.2
2006	266	0.19	7	47.3	54.3	0.29	36.8	0.47	54.3	0.29
2007	204	0.16	9	53.1	62.1	0.23	56.2	0.36	62.1	0.23
2008	149	0.14	8	47.7	55.7	0.26	57.1	0.46	55.7	0.26
2009	101	0.13	1	20.5	21.5	0.33	7.7	1	21.5	0.33
2010	59	0.12	3	23	26	0.47	25	0.74	26	0.47
2011	85	0.2	2	12.9	14.9	0.38	10	0.69	14.9	0.38
2012	83	0.19	5	15.6	20.6	0.45	26.3	0.59	20.6	0.45
2013	175	0.37	6	9.5	15.5	0.24	16.2	0.4	15.5	0.24
2014	97	0.24	6	10.7	16.7	0.33	25	0.46	16.7	0.33
2015	74	0.2	0	10.5	10.5	0.57	0	−	10.5	0.57
2016	134	0.18	4	33.5	37.5	0.38	22.2	0.5	37.5	0.38
2017	111	0.19	16	17.9	33.9	0.21	84.2	0.36	33.9	0.21
1990−2000	5973	0.15	309	1745.3	2054.3	0.03	2060	0.07	2054.3	0.03
2001−2017	2983	0.19	117	514.3	631.3	0.07	615.8	0.11	631.3	0.07
2013−2017	591	0.23	32	77.9	109.9	0.15	139.1	0.23	109.9	0.15

Table 9. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for LONG−BEAKED COMMON DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	1.6	1.6	5.1	0	−	1.6	5.1
1991	470	0.1	0	9.1	9.1	1.3	0	−	9.1	1.3
1992	596	0.14	2	6.1	8.1	0.96	14.3	0.7	8.1	0.96
1993	728	0.13	0	5.3	5.3	1.2	0	−	5.3	1.2
1994	759	0.18	1	6.9	7.9	0.81	5.6	0.98	7.9	0.81
1995	572	0.16	4	6.1	10.1	0.49	25	1	10.1	0.49
1996	421	0.12	0	5.3	5.3	1.8	0	−	5.3	1.8
1997	692	0.23	4	5.3	9.3	0.55	17.4	0.62	9.3	0.55
1998	587	0.18	0	3.6	3.6	1	0	−	3.6	1
1999	526	0.2	1	4.4	5.4	0.74	5	1	5.4	0.74
2000	444	0.23	0	3.3	3.3	1.3	0	−	3.3	1.3
2001	339	0.2	0	4.8	4.8	0.71	0	−	4.8	0.71
2002	360	0.22	4	2.5	6.5	0.43	18.2	0.79	6.5	0.43
2003	298	0.2	0	8.9	8.9	1.4	0	−	8.9	1.4
2004	223	0.21	0	2.6	2.6	1.1	0	−	2.6	1.1
2005	225	0.21	3	2.2	5.2	0.52	14.3	0.58	5.2	0.52
2006	266	0.19	0	3.9	3.9	1	0	−	3.9	1
2007	204	0.16	0	0.6	0.6	3	0	−	0.6	3
2008	149	0.14	1	1.9	2.9	1.3	7.1	1	2.9	1.3
2009	101	0.13	0	1.1	1.1	1.8	0	−	1.1	1.8
2010	59	0.12	1	0.9	1.9	1.1	8.3	0.99	1.9	1.1
2011	85	0.2	1	4.4	5.4	1.2	5	1	5.4	1.2
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.2	0.2	1.9	0	−	0.2	1.9
2014	97	0.24	0	2.8	2.8	1.6	0	−	2.8	1.6
2015	74	0.2	1	1.7	2.7	1	5	0.99	2.7	1
2016	134	0.18	1	3.9	4.9	0.66	5.6	1	4.9	0.66
2017	111	0.19	0	2.4	2.4	1.2	0	−	2.4	1.2
1990−2000	5973	0.15	12	62.1	74.1	0.3	80	0.42	74.1	0.3
2001−2017	2983	0.19	12	45.8	57.8	0.32	63.2	0.35	57.8	0.32
2013−2017	591	0.23	2	9.6	11.6	0.53	8.7	0.71	11.6	0.53

Table 10. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for RISSO'S DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	29.4	29.4	1.1	0	−	29.4	1.1
1991	470	0.1	5	19.4	24.4	0.67	50	0.45	24.4	0.67
1992	596	0.14	5	37.1	42.1	0.52	35.7	0.45	42.1	0.52
1993	728	0.13	7	14	21	0.59	53.8	0.43	21	0.59
1994	759	0.18	1	11.8	12.8	0.8	5.6	0.98	12.8	0.8
1995	572	0.16	6	13.6	19.6	0.66	37.5	0.62	19.6	0.66
1996	421	0.12	0	6	6	1.5	0	−	6	1.5
1997	692	0.23	3	13.7	16.7	0.64	13	0.74	16.7	0.64
1998	587	0.18	0	10	10	0.92	0	−	10	0.92
1999	526	0.2	0	4.6	4.6	1.2	0	−	4.6	1.2
2000	444	0.23	2	5.6	7.6	0.75	8.7	0.71	7.6	0.75
2001	339	0.2	0	3.8	3.8	1.3	0	−	3.8	1.3
2002	360	0.22	0	3.4	3.4	1.5	0	−	3.4	1.5
2003	298	0.2	4	1.1	5.1	0.48	20	1	5.1	0.48
2004	223	0.21	0	2.5	2.5	1.4	0	−	2.5	1.4
2005	225	0.21	0	2.4	2.4	1.8	0	−	2.4	1.8
2006	266	0.19	0	3.4	3.4	1.8	0	−	3.4	1.8
2007	204	0.16	0	1.9	1.9	2	0	−	1.9	2
2008	149	0.14	1	2.3	3.3	1.5	7.1	0.99	3.3	1.5
2009	101	0.13	0	2.5	2.5	2.2	0	−	2.5	2.2
2010	59	0.12	0	0.8	0.8	3.7	0	−	0.8	3.7
2011	85	0.2	1	1.8	2.8	1.2	5	0.99	2.8	1.2
2012	83	0.19	0	1.1	1.1	2.3	0	−	1.1	2.3
2013	175	0.37	0	1.3	1.3	1.6	0	−	1.3	1.6
2014	97	0.24	0	0.7	0.7	3.1	0	−	0.7	3.1
2015	74	0.2	0	2.6	2.6	1.4	0	−	2.6	1.4
2016	134	0.18	0	3.1	3.1	2.2	0	−	3.1	2.2
2017	111	0.19	0	4.9	4.9	1.3	0	−	4.9	1.3
1990−2000	5973	0.15	29	154.4	183.4	0.23	193.3	0.22	183.4	0.23
2001−2017	2983	0.19	6	40.1	46.1	0.39	31.6	0.7	46.1	0.39
2013−2017	591	0.23	0	11.6	11.6	0.78	0	−	11.6	0.78

Table 11. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for SHORT−FINNED PILOT WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	19.4	20.4	0.83	25	0.99	20.4	0.83
1991	470	0.1	0	2.9	2.9	1.1	0	−	2.9	1.1
1992	596	0.14	1	7.2	8.2	0.49	7.1	0.99	8.2	0.49
1993	728	0.13	8	39.2	47.2	0.28	61.5	0.59	47.2	0.28
1994	759	0.18	0	2.8	2.8	0.76	0	−	2.8	0.76
1995	572	0.16	0	0.4	0.4	1.7	0	−	0.4	1.7
1996	421	0.12	0	0.2	0.2	2.6	0	−	0.2	2.6
1997	692	0.23	1	3.6	4.6	0.5	4.3	1	4.6	0.5
1998	587	0.18	0	0.4	0.4	1.6	0	−	0.4	1.6
1999	526	0.2	0	0.3	0.3	1.3	0	−	0.3	1.3
2000	444	0.23	0	0.1	0.1	1.8	0	−	0.1	1.8
2001	339	0.2	0	0.1	0.1	1.8	0	−	0.1	1.8
2002	360	0.22	0	2.2	2.2	1.1	0	−	2.2	1.1
2003	298	0.2	1	3.7	4.7	0.58	5	1	4.7	0.58
2004	223	0.21	0	0.5	0.5	1.6	0	−	0.5	1.6
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.5	0.5	1.6	0	−	0.5	1.6
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0.7	0.7	2.4	0	−	0.7	2.4
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	2	4.8	6.8	0.47	8.3	0.7	6.8	0.47
2015	74	0.2	0	0.1	0.1	2.1	0	−	0.1	2.1
2016	134	0.18	0	0.2	0.2	3.7	0	−	0.2	3.7
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	11	61	72	0.2	73.3	0.45	72	0.2
2001−2017	2983	0.19	3	14.8	17.8	0.33	15.8	0.58	17.8	0.33
2013−2017	591	0.23	2	5.3	7.3	0.47	8.7	0.7	7.3	0.47

Table 12. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for PAC. WHITE−SIDED DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	3	20.1	23.1	0.41	75	0.57	23.1	0.41
1991	470	0.1	5	21.1	26.1	0.26	50	0.67	26.1	0.26
1992	596	0.14	3	18.5	21.5	0.27	21.4	0.74	21.5	0.27
1993	728	0.13	2	32	34	0.49	15.4	0.71	34	0.49
1994	759	0.18	3	20.4	23.4	0.27	16.7	0.75	23.4	0.27
1995	572	0.16	1	13.3	14.3	0.27	6.2	1	14.3	0.27
1996	421	0.12	3	16	19	0.38	25	0.75	19	0.38
1997	692	0.23	3	10.2	13.2	0.37	13	0.58	13.2	0.37
1998	587	0.18	0	8.7	8.7	0.48	0	−	8.7	0.48
1999	526	0.2	0	12.5	12.5	0.62	0	−	12.5	0.62
2000	444	0.23	2	2.6	4.6	0.31	8.7	0.7	4.6	0.31
2001	339	0.2	2	2.3	4.3	0.42	10	0.71	4.3	0.42
2002	360	0.22	1	4.8	5.8	0.69	4.5	0.99	5.8	0.69
2003	298	0.2	0	1.4	1.4	0.76	0	−	1.4	0.76
2004	223	0.21	0	0.8	0.8	0.75	0	−	0.8	0.75
2005	225	0.21	0	1.3	1.3	0.79	0	−	1.3	0.79
2006	266	0.19	0	1.7	1.7	0.93	0	−	1.7	0.93
2007	204	0.16	1	0.9	1.9	0.41	6.2	1	1.9	0.41
2008	149	0.14	5	0.6	5.6	0.087	35.7	0.72	5.6	0.087
2009	101	0.13	2	0.1	2.1	0.069	15.4	0.99	2.1	0.069
2010	59	0.12	0	1.3	1.3	1.3	0	−	1.3	1.3
2011	85	0.2	0	0.7	0.7	0.92	0	−	0.7	0.92
2012	83	0.19	0	0.3	0.3	1.1	0	−	0.3	1.1
2013	175	0.37	0	0.7	0.7	0.77	0	−	0.7	0.77
2014	97	0.24	0	0.2	0.2	0.99	0	−	0.2	0.99
2015	74	0.2	0	1	1	1.3	0	−	1	1.3
2016	134	0.18	0	1.3	1.3	1.1	0	−	1.3	1.1
2017	111	0.19	0	2.3	2.3	1.4	0	−	2.3	1.4
1990−2000	5973	0.15	25	169.6	194.6	0.13	166.7	0.24	194.6	0.13
2001−2017	2983	0.19	11	22.8	33.8	0.21	57.9	0.41	33.8	0.21
2013−2017	591	0.23	0	5.1	5.1	0.59	0	−	5.1	0.59

Table 13. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for N. RIGHT WHALE DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	54.4	54.4	0.57	0	−	54.4	0.57
1991	470	0.1	7	37.4	44.4	0.3	70	0.43	44.4	0.3
1992	596	0.14	2	47.3	49.3	0.32	14.3	0.71	49.3	0.32
1993	728	0.13	7	48.6	55.6	0.23	53.8	0.42	55.6	0.23
1994	759	0.18	7	35	42	0.22	38.9	0.43	42	0.22
1995	572	0.16	9	27.2	36.2	0.34	56.2	0.65	36.2	0.34
1996	421	0.12	5	37.8	42.8	0.42	41.7	0.66	42.8	0.42
1997	692	0.23	5	19.4	24.4	0.29	21.7	0.44	24.4	0.29
1998	587	0.18	0	24.9	24.9	0.52	0	−	24.9	0.52
1999	526	0.2	3	15.3	18.3	0.32	15	0.58	18.3	0.32
2000	444	0.23	11	11.6	22.6	0.28	47.8	0.5	22.6	0.28
2001	339	0.2	5	11.6	16.6	0.47	25	0.53	16.6	0.47
2002	360	0.22	2	9.6	11.6	0.35	9.1	0.7	11.6	0.35
2003	298	0.2	1	5.8	6.8	0.69	5	0.98	6.8	0.69
2004	223	0.21	1	3.6	4.6	0.96	4.8	0.99	4.6	0.96
2005	225	0.21	0	8.8	8.8	1.1	0	−	8.8	1.1
2006	266	0.19	0	6.9	6.9	0.76	0	−	6.9	0.76
2007	204	0.16	1	6.3	7.3	0.61	6.2	0.99	7.3	0.61
2008	149	0.14	1	6.8	7.8	0.57	7.1	0.99	7.8	0.57
2009	101	0.13	0	2.8	2.8	1.1	0	−	2.8	1.1
2010	59	0.12	1	2.2	3.2	0.56	8.3	0.99	3.2	0.56
2011	85	0.2	1	9.3	10.3	0.82	5	0.99	10.3	0.82
2012	83	0.19	1	1.5	2.5	0.62	5.3	1	2.5	0.62
2013	175	0.37	2	2.8	4.8	0.4	5.4	0.99	4.8	0.4
2014	97	0.24	1	1.8	2.8	0.4	4.2	1	2.8	0.4
2015	74	0.2	0	2.6	2.6	0.64	0	−	2.6	0.64
2016	134	0.18	5	2.3	7.3	0.31	27.8	0.73	7.3	0.31
2017	111	0.19	2	3.6	5.6	0.67	10.5	0.71	5.6	0.67
1990−2000	5973	0.15	56	338.2	394.2	0.1	373.3	0.19	394.2	0.1
2001−2017	2983	0.19	24	90.8	114.8	0.18	126.3	0.25	114.8	0.18
2013−2017	591	0.23	10	14.1	24.1	0.22	43.5	0.44	24.1	0.22

Table 14. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for KILLER WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0	0	−	0	−	0	−
1991	470	0.1	0	1.4	1.4	2.1	0	−	1.4	2.1
1992	596	0.14	0	0.4	0.4	3.2	0	−	0.4	3.2
1993	728	0.13	0	0.4	0.4	3.4	0	−	0.4	3.4
1994	759	0.18	0	0	0	−	0	−	0	−
1995	572	0.16	1	0.4	1.4	0.85	6.2	1	1.4	0.85
1996	421	0.12	0	1.3	1.3	2.1	0	−	1.3	2.1
1997	692	0.23	0	0.1	0.1	3.9	0	−	0.1	3.9
1998	587	0.18	0	1.2	1.2	1.9	0	−	1.2	1.9
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0.1	0.1	4.1	0	−	0.1	4.1
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0.1	0.1	8.3	0	−	0.1	8.3
2006	266	0.19	0	0.2	0.2	4.2	0	−	0.2	4.2
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0.4	0.4	4	0	−	0.4	4
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5	6	0.82	6.7	1	6	0.82
2001−2017	2983	0.19	0	0.5	0.5	2.4	0	−	0.5	2.4
2013−2017	591	0.23	0	0	0	−	0	−	0	−

Table 15. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for DALL'S PORPOISE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	21.4	22.4	0.075	25	0.99	22.4	0.075
1991	470	0.1	2	21.3	23.3	0.063	20	0.71	23.3	0.063
1992	596	0.14	1	20.8	21.8	0.062	7.1	0.99	21.8	0.062
1993	728	0.13	9	24.7	33.7	0.039	69.2	0.37	33.7	0.039
1994	759	0.18	2	18.3	20.3	0.057	11.1	0.72	20.3	0.057
1995	572	0.16	1	17.6	18.6	0.058	6.2	0.99	18.6	0.058
1996	421	0.12	2	11.4	13.4	0.091	16.7	0.71	13.4	0.091
1997	692	0.23	4	6.6	10.6	0.18	17.4	0.61	10.6	0.18
1998	587	0.18	0	2	2	0.29	0	−	2	0.29
1999	526	0.2	0	1.4	1.4	0.65	0	−	1.4	0.65
2000	444	0.23	0	0.7	0.7	0.39	0	−	0.7	0.39
2001	339	0.2	0	0.5	0.5	0.52	0	−	0.5	0.52
2002	360	0.22	0	0.4	0.4	0.66	0	−	0.4	0.66
2003	298	0.2	0	0.3	0.3	0.56	0	−	0.3	0.56
2004	223	0.21	0	0.2	0.2	0.87	0	−	0.2	0.87
2005	225	0.21	0	0.7	0.7	0.82	0	−	0.7	0.82
2006	266	0.19	0	0.4	0.4	0.74	0	−	0.4	0.74
2007	204	0.16	0	0.2	0.2	0.8	0	−	0.2	0.8
2008	149	0.14	0	0.1	0.1	1.4	0	−	0.1	1.4
2009	101	0.13	0	0.1	0.1	1.7	0	−	0.1	1.7
2010	59	0.12	0	0.1	0.1	1.4	0	−	0.1	1.4
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.1	0.1	1	0	−	0.1	1
2013	175	0.37	0	0.1	0.1	0.92	0	−	0.1	0.92
2014	97	0.24	1	0.1	1.1	0.11	4.2	0.99	1.1	0.11
2015	74	0.2	0	0.1	0.1	1.1	0	−	0.1	1.1
2016	134	0.18	0	0.4	0.4	0.98	0	−	0.4	0.98
2017	111	0.19	0	0.3	0.3	0.82	0	−	0.3	0.82
1990−2000	5973	0.15	22	129.7	151.7	0.03	146.7	0.23	151.7	0.03
2001−2017	2983	0.19	1	4.4	5.4	0.19	5.3	0.99	5.4	0.19
2013−2017	591	0.23	1	1	2	0.23	4.3	1	2	0.23

Table 16. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for STRIPED DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0	0	−	0	−	0	−
1991	470	0.1	0	0	0	−	0	−	0	−
1992	596	0.14	0	1.1	1.1	2	0	−	1.1	2
1993	728	0.13	0	0.7	0.7	2.7	0	−	0.7	2.7
1994	759	0.18	1	1.6	2.6	0.97	5.6	1	2.6	0.97
1995	572	0.16	0	0	0	−	0	−	0	−
1996	421	0.12	0	0.2	0.2	5.9	0	−	0.2	5.9
1997	692	0.23	0	0.1	0.1	7.4	0	−	0.1	7.4
1998	587	0.18	0	0.2	0.2	3.1	0	−	0.2	3.1
1999	526	0.2	0	0.1	0.1	2.5	0	−	0.1	2.5
2000	444	0.23	0	0.1	0.1	4.3	0	−	0.1	4.3
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.1	0.1	5	0	−	0.1	5
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	4.6	5.6	0.81	6.7	1	5.6	0.81
2001−2017	2983	0.19	0	0.2	0.2	3.9	0	−	0.2	3.9
2013−2017	591	0.23	0	0.1	0.1	5	0	−	0.1	5

Table 17. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for BOTTLENOSE DOLPHIN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0	0	–	0	–	0	–
1991	470	0.1	0	0.7	0.7	6.4	0	–	0.7	6.4
1992	596	0.14	3	8.9	11.9	1.1	21.4	1	11.9	1.1
1993	728	0.13	0	2.6	2.6	2.6	0	–	2.6	2.6
1994	759	0.18	0	0.3	0.3	4.7	0	–	0.3	4.7
1995	572	0.16	0	0.1	0.1	7.9	0	–	0.1	7.9
1996	421	0.12	0	0	0	–	0	–	0	–
1997	692	0.23	0	0.3	0.3	4.8	0	–	0.3	4.8
1998	587	0.18	0	0.8	0.8	3.7	0	–	0.8	3.7
1999	526	0.2	0	1.3	1.3	2.8	0	–	1.3	2.8
2000	444	0.23	0	0.1	0.1	2.7	0	–	0.1	2.7
2001	339	0.2	0	0	0	–	0	–	0	–
2002	360	0.22	0	1	1	2.4	0	–	1	2.4
2003	298	0.2	0	0.7	0.7	2.1	0	–	0.7	2.1
2004	223	0.21	0	1.5	1.5	2	0	–	1.5	2
2005	225	0.21	0	0	0	–	0	–	0	–
2006	266	0.19	0	0.3	0.3	2.8	0	–	0.3	2.8
2007	204	0.16	0	0	0	–	0	–	0	–
2008	149	0.14	0	0.3	0.3	7.8	0	–	0.3	7.8
2009	101	0.13	0	0.7	0.7	4.9	0	–	0.7	4.9
2010	59	0.12	1	0	1	–	8.3	0.98	1	0
2011	85	0.2	0	0.1	0.1	2.6	0	–	0.1	2.6
2012	83	0.19	0	0.7	0.7	4	0	–	0.7	4
2013	175	0.37	0	0	0	–	0	–	0	–
2014	97	0.24	0	0.1	0.1	2.1	0	–	0.1	2.1
2015	74	0.2	0	0	0	–	0	–	0	–
2016	134	0.18	0	0	0	–	0	–	0	–
2017	111	0.19	0	0	0	–	0	–	0	–
1990–2000	5973	0.15	3	14.9	17.9	0.88	20	1	17.9	0.88
2001–2017	2983	0.19	1	5.4	6.4	0.95	5.3	0.99	6.4	0.95
2013–2017	591	0.23	0	0.2	0.2	3.9	0	–	0.2	3.9

Table 18. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for PYGMY SPERM WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	6.4	6.4	2.3	0	−	6.4	2.3
1991	470	0.1	0	0.2	0.2	6.7	0	−	0.2	6.7
1992	596	0.14	1	0.8	1.8	1.2	7.1	1	1.8	1.2
1993	728	0.13	1	1.1	2.1	1.2	7.7	1	2.1	1.2
1994	759	0.18	0	0.6	0.6	2.3	0	−	0.6	2.3
1995	572	0.16	0	1.8	1.8	1.5	0	−	1.8	1.5
1996	421	0.12	0	0.2	0.2	8.1	0	−	0.2	8.1
1997	692	0.23	0	1.4	1.4	1.2	0	−	1.4	1.2
1998	587	0.18	0	0	0	−	0	−	0	−
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0.1	0.1	7.2	0	−	0.1	7.2
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0.5	0.5	2.7	0	−	0.5	2.7
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	9.2	11.2	0.66	13.3	0.7	11.2	0.66
2001−2017	2983	0.19	0	0.4	0.4	2.7	0	−	0.4	2.7
2013−2017	591	0.23	0	0	0	−	0	−	0	−

Table 19. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for BAIRD'S BEAKED WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0	0	−	0	−	0	−
1991	470	0.1	0	0	0	−	0	−	0	−
1992	596	0.14	0	0.8	0.8	2.2	0	−	0.8	2.2
1993	728	0.13	0	2.2	2.2	1.4	0	−	2.2	1.4
1994	759	0.18	1	1.4	2.4	0.87	5.6	1	2.4	0.87
1995	572	0.16	0	0.2	0.2	4	0	−	0.2	4
1996	421	0.12	0	0	0	−	0	−	0	−
1997	692	0.23	0	0	0	−	0	−	0	−
1998	587	0.18	0	0.1	0.1	4.1	0	−	0.1	4.1
1999	526	0.2	0	0.1	0.1	3.1	0	−	0.1	3.1
2000	444	0.23	0	0.3	0.3	2.6	0	−	0.3	2.6
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5.6	6.6	0.7	6.7	1.01	6.6	0.7
2001−2017	2983	0.19	0	0	0	−	0	−	0	−
2013−2017	591	0.23	0	0	0	−	0	−	0	−

Table 20. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for HUBB'S BEAKED WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	1.8	1.8	0.27	0	−	1.8	0.27
1991	470	0.1	0	3.3	3.3	0.13	0	−	3.3	0.13
1992	596	0.14	3	12.1	15.1	0.083	21.4	0.58	15.1	0.083
1993	728	0.13	0	3.6	3.6	0.12	0	−	3.6	0.12
1994	759	0.18	2	6.4	8.4	0.062	11.1	0.7	8.4	0.062
1995	572	0.16	0	1.4	1.4	0.19	0	−	1.4	0.19
1996	421	0.12	0	0.9	0.9	0.22	0	−	0.9	0.22
1997	692	0.23	0	1.1	1.1	0.13	0	−	1.1	0.13
1998	587	0.18	0	0	0	−	0	−	0	−
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0	0	−	0	−	0	−
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	0.95	0	−	0.1	0.95
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	5	29.3	34.3	0.04	33.3	0.45	34.3	0.04
2001−2017	2983	0.19	0	0.1	0.1	0.77	0	−	0.1	0.77
2013−2017	591	0.23	0	0.1	0.1	0.81	0	−	0.1	0.81

Table 21. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for STEJNEGER'S BEAKED WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0	0	−	0	−	0	−
1991	470	0.1	0	1.1	1.1	2.7	0	−	1.1	2.7
1992	596	0.14	0	0.7	0.7	2.2	0	−	0.7	2.2
1993	728	0.13	0	1.6	1.6	2	0	−	1.6	2
1994	759	0.18	1	0.9	1.9	0.96	5.6	0.99	1.9	0.96
1995	572	0.16	0	0	0	−	0	−	0	−
1996	421	0.12	0	0	0	−	0	−	0	−
1997	692	0.23	0	0.2	0.2	4.2	0	−	0.2	4.2
1998	587	0.18	0	0.3	0.3	3.5	0	−	0.3	3.5
1999	526	0.2	0	0.1	0.1	2.5	0	−	0.1	2.5
2000	444	0.23	0	0.2	0.2	4.1	0	−	0.2	4.1
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5	6	0.8	6.7	0.99	6	0.8
2001−2017	2983	0.19	0	0	0	−	0	−	0	−
2013−2017	591	0.23	0	0	0	−	0	−	0	−

Table 22. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for SPERM WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.7 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	5.7	5.7	2.2	0	−	3.9	2.3
1991	470	0.1	0	3.9	3.9	2	0	−	2.7	2.2
1992	596	0.14	3	7	10	0.68	21.4	0.99	5.9	0.9
1993	728	0.13	3	12	15	0.89	23.1	0.74	10.2	0.93
1994	759	0.18	0	1.5	1.5	1.6	0	−	1	1.8
1995	572	0.16	0	5.4	5.4	1.2	0	−	3.8	1.3
1996	421	0.12	1	3.6	4.6	0.87	8.3	1	3.5	0.85
1997	692	0.23	0	3.9	3.9	0.93	0	−	2.7	0.97
1998	587	0.18	1	5.6	6.6	1.1	5.6	0.97	4.9	1.1
1999	526	0.2	0	1.2	1.2	1.8	0	−	0.9	1.8
2000	444	0.23	0	0.8	0.8	1.3	0	−	0.5	1.5
2001	339	0.2	0	0.2	0.2	2.5	0	−	0.2	2.5
2002	360	0.22	0	0.2	0.2	1.5	0	−	0.2	1.5
2003	298	0.2	0	0.3	0.3	1.4	0	−	0.2	1.4
2004	223	0.21	0	0.3	0.3	1.5	0	−	0.2	1.5
2005	225	0.21	0	0.5	0.5	2.1	0	−	0.4	2.1
2006	266	0.19	0	0.7	0.7	1.9	0	−	0.5	2
2007	204	0.16	0	1.4	1.4	2.2	0	−	1	2.2
2008	149	0.14	0	0.3	0.3	1.7	0	−	0.2	1.7
2009	101	0.13	0	0.4	0.4	2.2	0	−	0.3	2.5
2010	59	0.12	2	0	2	0	16.7	1	2	0
2011	85	0.2	0	0.9	0.9	2.6	0	−	0.6	2.7
2012	83	0.19	0	0.1	0.1	2.1	0	−	0.1	2.1
2013	175	0.37	0	0.1	0.1	1.5	0	−	0.1	1.5
2014	97	0.24	0	0.3	0.3	2.6	0	−	0.2	2.7
2015	74	0.2	0	0.1	0.1	2.5	0	−	0	2.7
2016	134	0.18	0	0.2	0.2	1.8	0	−	0.1	2
2017	111	0.19	0	2.9	2.9	1.7	0	−	2	1.7
1990−2000	5973	0.15	8	48.7	56.7	0.35	53.3	0.5	39.4	0.41
2001−2017	2983	0.19	2	8.6	10.6	0.6	10.5	1.01	7.9	0.57
2013−2017	591	0.23	0	2.9	2.9	1.3	0	−	2	1.4

Table 23. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for CUVIER'S BEAKED WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.95 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	18.3	18.3	0.088	0	−	17.3	0.1
1991	470	0.1	0	21.8	21.8	0.15	0	−	20.7	0.16
1992	596	0.14	6	19.3	25.3	0.13	42.9	0.41	24.3	0.13
1993	728	0.13	3	23.3	26.3	0.12	23.1	0.58	25.2	0.12
1994	759	0.18	6	18.2	24.2	0.11	33.3	0.41	23.3	0.11
1995	572	0.16	6	15.9	21.9	0.12	37.5	0.41	20.2	0.14
1996	421	0.12	0	9.5	9.5	0.17	0	−	9.1	0.17
1997	692	0.23	0	5.3	5.3	0.2	0	−	5	0.2
1998	587	0.18	0	0.6	0.6	1.8	0	−	0.5	1.8
1999	526	0.2	0	0.2	0.2	3.9	0	−	0.2	3.9
2000	444	0.23	0	0.3	0.3	3.3	0	−	0.3	3.3
2001	339	0.2	0	0.1	0.1	6.8	0	−	0.1	6.9
2002	360	0.22	0	0.1	0.1	7.9	0	−	0.1	7.7
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0.1	0.1	7.4	0	−	0.1	7.4
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.1	0.1	6.1	0	−	0.1	5.9
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0.2	0.2	5.9	0	−	0.2	5.8
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0.1	0.1	8.4	0	−	0.1	8.5
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.2	0.2	2.7	0	−	0.2	2.7
2014	97	0.24	0	0.1	0.1	0.3	0	−	0.1	0.31
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	1	1	1	0	−	0.9	1
2017	111	0.19	0	0.2	0.2	4.8	0	−	0.1	4.9
1990−2000	5973	0.15	21	116.5	137.5	0.05	140	0.21	131.1	0.07
2001−2017	2983	0.19	0	2.2	2.2	1	0	−	2.1	1
2013−2017	591	0.23	0	1.3	1.3	1.1	0	−	1.3	1.1

Table 24. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. ZIPHIID. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	1.2	1.2	0.29	0	−	1.2	0.29
1991	470	0.1	0	1.8	1.8	0.15	0	−	1.8	0.15
1992	596	0.14	2	7.9	9.9	0.098	14.3	0.72	9.9	0.098
1993	728	0.13	0	2	2	0.14	0	−	2	0.14
1994	759	0.18	1	3.4	4.4	0.079	5.6	1	4.4	0.079
1995	572	0.16	0	0.9	0.9	0.22	0	−	0.9	0.22
1996	421	0.12	0	0.6	0.6	0.25	0	−	0.6	0.25
1997	692	0.23	0	0.6	0.6	0.15	0	−	0.6	0.15
1998	587	0.18	0	0	0	−	0	−	0	−
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0	0	−	0	−	0	−
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	3	17.5	20.5	0.05	20	0.58	20.5	0.05
2001−2017	2983	0.19	0	0	0	−	0	−	0	−
2013−2017	591	0.23	0	0	0	−	0	−	0	−

Table 25. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. MESOPLODON. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	0.5	1.5	1.5	25	1	1.5	1.5
1991	470	0.1	0	0.2	0.2	0.65	0	−	0.2	0.65
1992	596	0.14	1	2.5	3.5	0.99	7.1	0.99	3.5	0.99
1993	728	0.13	0	2	2	1	0	−	2	1
1994	759	0.18	0	2.7	2.7	1.3	0	−	2.7	1.3
1995	572	0.16	0	0.3	0.3	1	0	−	0.3	1
1996	421	0.12	0	0.4	0.4	0.52	0	−	0.4	0.52
1997	692	0.23	0	0.2	0.2	1.1	0	−	0.2	1.1
1998	587	0.18	0	0.6	0.6	1.8	0	−	0.6	1.8
1999	526	0.2	0	0.1	0.1	4.5	0	−	0.1	4.5
2000	444	0.23	0	0.5	0.5	2.3	0	−	0.5	2.3
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0.1	0.1	0.86	0	−	0.1	0.86
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.1	0.1	1.2	0	−	0.1	1.2
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	10.6	12.6	0.53	13.3	0.7	12.6	0.53
2001−2017	2983	0.19	0	0.6	0.6	0.28	0	−	0.6	0.28
2013−2017	591	0.23	0	0.1	0.1	0.53	0	−	0.1	0.53

Table 26. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for CA SEA LION. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.98 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	2	70.8	72.8	0.86	50	0.99	71.5	0.87
1991	470	0.1	4	100.8	104.8	0.46	40	0.5	103	0.46
1992	596	0.14	9	71.4	80.4	0.75	64.3	0.33	79.1	0.75
1993	728	0.13	12	102.1	114.1	0.61	92.3	0.33	112.2	0.61
1994	759	0.18	5	79.7	84.7	0.46	27.8	0.44	82.2	0.47
1995	572	0.16	5	49.3	54.3	0.38	31.2	0.44	52.4	0.38
1996	421	0.12	4	56.7	60.7	0.43	33.3	0.49	59.7	0.43
1997	692	0.23	39	120.6	159.6	0.27	169.6	0.3	156.4	0.27
1998	587	0.18	23	91.8	114.8	0.31	127.8	0.24	113.1	0.31
1999	526	0.2	6	95.6	101.6	0.48	30	0.41	100.8	0.47
2000	444	0.23	13	59.5	72.5	0.28	56.5	0.33	70.4	0.28
2001	339	0.2	2	49.8	51.8	0.53	10	0.7	50.9	0.53
2002	360	0.22	18	51	69	0.26	81.8	0.24	68	0.26
2003	298	0.2	4	27.8	31.8	0.4	20	0.5	31.3	0.4
2004	223	0.21	7	39.6	46.6	0.4	33.3	0.37	44.9	0.41
2005	225	0.21	1	27	28	0.49	4.8	1	27.5	0.49
2006	266	0.19	12	59.3	71.3	0.38	63.2	0.37	70.2	0.37
2007	204	0.16	8	38	46	0.51	50	0.39	45.3	0.5
2008	149	0.14	7	33.1	40.1	0.43	50	0.42	39.5	0.43
2009	101	0.13	5	25.5	30.5	0.65	38.5	0.43	30	0.65
2010	59	0.12	0	23.8	23.8	1.2	0	−	23.4	1.2
2011	85	0.2	18	26.1	44.1	0.69	90	0.53	43.6	0.69
2012	83	0.19	6	9.4	15.4	0.93	31.6	0.39	15.3	0.92
2013	175	0.37	3	9.3	12.3	0.49	8.1	0.57	12.2	0.49
2014	97	0.24	3	8.8	11.8	0.64	12.5	1	11.6	0.64
2015	74	0.2	0	9	9	0.99	0	−	8.8	0.99
2016	134	0.18	0	13.6	13.6	1.1	0	−	13.4	1.1
2017	111	0.19	2	19.1	21.1	1.1	10.5	0.71	20.7	1.1
1990−2000	5973	0.15	122	1009.1	1131.1	0.15	813.3	0.13	1110	0.15
2001−2017	2983	0.19	96	464.1	560.1	0.13	505.3	0.14	550.7	0.13
2013−2017	591	0.23	8	60.3	68.3	0.4	34.8	0.47	67.2	0.4

Table 27. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for STELLER'S SEA LION. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.9	0.9	3.7	0	−	0.9	3.7
1991	470	0.1	0	0.4	0.4	0.54	0	−	0.4	0.54
1992	596	0.14	1	2.5	3.5	0.96	7.1	1	3.5	0.96
1993	728	0.13	0	0.6	0.6	1.9	0	−	0.6	1.9
1994	759	0.18	1	0.5	1.5	0.74	5.6	1	1.5	0.74
1995	572	0.16	0	2.4	2.4	1.1	0	−	2.4	1.1
1996	421	0.12	0	0.3	0.3	4.1	0	−	0.3	4.1
1997	692	0.23	0	0.2	0.2	1.7	0	−	0.2	1.7
1998	587	0.18	0	0.2	0.2	1.5	0	−	0.2	1.5
1999	526	0.2	0	0.2	0.2	1.7	0	−	0.2	1.7
2000	444	0.23	0	0.2	0.2	0.47	0	−	0.2	0.47
2001	339	0.2	0	0.1	0.1	0.61	0	−	0.1	0.61
2002	360	0.22	0	0.1	0.1	0.58	0	−	0.1	0.58
2003	298	0.2	0	0.1	0.1	2.2	0	−	0.1	2.2
2004	223	0.21	0	0.1	0.1	0.76	0	−	0.1	0.76
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.1	0.1	3.7	0	−	0.1	3.7
2007	204	0.16	0	0.1	0.1	0.73	0	−	0.1	0.73
2008	149	0.14	0	0.1	0.1	1.1	0	−	0.1	1.1
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	8	10	0.5	13.3	0.71	10	0.5
2001−2017	2983	0.19	0	0.9	0.9	0.54	0	−	0.9	0.54
2013−2017	591	0.23	0	0.1	0.1	0.56	0	−	0.1	0.56

Table 28. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. PINNIPED. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.2	0.2	1.3	0	−	0.2	1.3
1991	470	0.1	0	0.2	0.2	1.1	0	−	0.2	1.1
1992	596	0.14	0	0.2	0.2	0.95	0	−	0.2	0.95
1993	728	0.13	0	0.3	0.3	0.8	0	−	0.3	0.8
1994	759	0.18	0	0.1	0.1	0.79	0	−	0.1	0.79
1995	572	0.16	0	0.1	0.1	1	0	−	0.1	1
1996	421	0.12	0	0.9	0.9	0.66	0	−	0.9	0.66
1997	692	0.23	0	0.5	0.5	0.7	0	−	0.5	0.7
1998	587	0.18	2	0.9	2.9	0.21	11.1	0.71	2.9	0.21
1999	526	0.2	0	0.5	0.5	0.81	0	−	0.5	0.81
2000	444	0.23	0	0.5	0.5	0.64	0	−	0.5	0.64
2001	339	0.2	0	0.6	0.6	1	0	−	0.6	1
2002	360	0.22	0	0.3	0.3	0.75	0	−	0.3	0.75
2003	298	0.2	0	0.6	0.6	0.93	0	−	0.6	0.93
2004	223	0.21	0	0.3	0.3	0.87	0	−	0.3	0.87
2005	225	0.21	0	0.2	0.2	0.87	0	−	0.2	0.87
2006	266	0.19	0	0.2	0.2	1	0	−	0.2	1
2007	204	0.16	0	0.3	0.3	0.97	0	−	0.3	0.97
2008	149	0.14	0	1.3	1.3	1	0	−	1.3	1
2009	101	0.13	0	1.2	1.2	1.5	0	−	1.2	1.5
2010	59	0.12	0	0.1	0.1	2.4	0	−	0.1	2.4
2011	85	0.2	0	0.3	0.3	1.3	0	−	0.3	1.3
2012	83	0.19	0	0.1	0.1	1.3	0	−	0.1	1.3
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.2	0.2	1.3	0	−	0.2	1.3
2017	111	0.19	0	0.2	0.2	1.5	0	−	0.2	1.5
1990−2000	5973	0.15	2	5	7	0.19	13.3	0.71	7	0.19
2001−2017	2983	0.19	0	4.9	4.9	0.36	0	−	4.9	0.36
2013−2017	591	0.23	0	0.3	0.3	0.84	0	−	0.3	0.84

Table 29. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for N ELEPHANT SEAL. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	5	96.2	101.2	0.17	125	0.44	101.2	0.17
1991	470	0.1	13	105.7	118.7	0.096	130	0.27	118.7	0.096
1992	596	0.14	15	90	105	0.077	107.1	0.25	105	0.077
1993	728	0.13	14	115.5	129.5	0.065	107.7	0.28	129.5	0.065
1994	759	0.18	22	83.7	105.7	0.039	122.2	0.24	105.7	0.039
1995	572	0.16	14	74.6	88.6	0.086	87.5	0.28	88.6	0.086
1996	421	0.12	5	46.6	51.6	0.11	41.7	0.44	51.6	0.11
1997	692	0.23	9	30.9	39.9	0.095	39.1	0.33	39.9	0.095
1998	587	0.18	4	11	15	0.32	22.2	0.5	15	0.32
1999	526	0.2	2	7.4	9.4	0.4	10	0.7	9.4	0.4
2000	444	0.23	6	6	12	0.26	26.1	0.4	12	0.26
2001	339	0.2	1	4.7	5.7	0.46	5	1	5.7	0.46
2002	360	0.22	1	6.5	7.5	0.42	4.5	1	7.5	0.42
2003	298	0.2	1	4.4	5.4	0.62	5	1	5.4	0.62
2004	223	0.21	0	3.7	3.7	0.87	0	−	3.7	0.87
2005	225	0.21	1	3.3	4.3	0.58	4.8	1	4.3	0.58
2006	266	0.19	0	4.6	4.6	0.69	0	−	4.6	0.69
2007	204	0.16	1	7.4	8.4	0.57	6.2	0.99	8.4	0.57
2008	149	0.14	0	4	4	0.94	0	−	4	0.94
2009	101	0.13	0	2.9	2.9	1.1	0	−	2.9	1.1
2010	59	0.12	0	1.1	1.1	0.9	0	−	1.1	0.9
2011	85	0.2	0	0.9	0.9	1.4	0	−	0.9	1.4
2012	83	0.19	0	2.5	2.5	1	0	−	2.5	1
2013	175	0.37	0	2.4	2.4	0.64	0	−	2.4	0.64
2014	97	0.24	1	3	4	0.54	4.2	1	4	0.54
2015	74	0.2	0	1.5	1.5	0.94	0	−	1.5	0.94
2016	134	0.18	0	7	7	0.43	0	−	7	0.43
2017	111	0.19	3	0.9	3.9	0.24	15.8	0.56	3.9	0.24
1990−2000	5973	0.15	109	595	704	0.03	726.7	0.1	704	0.03
2001−2017	2983	0.19	9	62.6	71.6	0.15	47.4	0.33	71.6	0.15
2013−2017	591	0.23	4	15.1	19.1	0.24	17.4	0.5	19.1	0.24

Table 30. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for LOGGERHEAD TURTLE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.25 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	15.5	15.5	0.92	0	−	4	1.1
1991	470	0.1	0	12.9	12.9	0.56	0	−	3.3	0.74
1992	596	0.14	2	6	8	0.4	14.3	0.71	2.5	0.44
1993	728	0.13	5	6.4	11.4	0.25	38.5	0.44	1.5	0.74
1994	759	0.18	0	3.3	3.3	0.43	0	−	0.8	0.66
1995	572	0.16	0	2.4	2.4	0.7	0	−	0.6	0.87
1996	421	0.12	0	2.4	2.4	0.82	0	−	0.6	0.88
1997	692	0.23	3	7.2	10.2	0.41	13	0.57	2.8	0.48
1998	587	0.18	4	3.8	7.8	0.28	22.2	0.79	3	0.25
1999	526	0.2	0	2.8	2.8	0.6	0	−	0.7	0.77
2000	444	0.23	0	2.9	2.9	0.71	0	−	0.8	0.81
2001	339	0.2	1	2.7	3.7	0.52	5	1	0.7	0.94
2002	360	0.22	0	1	1	0.76	0	−	0.2	1.1
2003	298	0.2	0	4.8	4.8	0.88	0	−	1.2	1.1
2004	223	0.21	0	1.1	1.1	0.9	0	−	0.3	1.1
2005	225	0.21	0	0.3	0.3	1.5	0	−	0.1	1.9
2006	266	0.19	1	2	3	0.5	5.3	1	0.5	0.96
2007	204	0.16	0	4.7	4.7	1.2	0	−	1.2	1.3
2008	149	0.14	0	0.2	0.2	1.2	0	−	0.1	1.3
2009	101	0.13	0	2.3	2.3	1.5	0	−	0.6	1.8
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.1	0.1	2.2	0	−	0	2.5
2013	175	0.37	0	0.1	0.1	1.3	0	−	0	1.5
2014	97	0.24	0	0.2	0.2	2.4	0	−	0	2.8
2015	74	0.2	0	1.5	1.5	0.73	0	−	0.4	0.86
2016	134	0.18	0	0.3	0.3	1	0	−	0.1	1.2
2017	111	0.19	0	1.8	1.8	1.7	0	−	0.4	1.9
1990−2000	5973	0.15	14	58.8	72.8	0.17	93.3	0.32	18.9	0.39
2001−2017	2983	0.19	2	22	24	0.33	10.5	0.71	5.5	0.59
2013−2017	591	0.23	0	3.2	3.2	0.81	0	−	0.8	1

Table 31. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for GREEN TURTLE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	7.1	7.1	2.3	0	−	7.1	2.3
1991	470	0.1	0	0.1	0.1	1.6	0	−	0.1	1.6
1992	596	0.14	0	0.9	0.9	3.1	0	−	0.9	3.1
1993	728	0.13	0	0.1	0.1	2.5	0	−	0.1	2.5
1994	759	0.18	0	0	0	−	0	−	0	−
1995	572	0.16	0	0	0	−	0	−	0	−
1996	421	0.12	0	0.1	0.1	1.5	0	−	0.1	1.5
1997	692	0.23	0	0.1	0.1	1.6	0	−	0.1	1.6
1998	587	0.18	0	0	0	−	0	−	0	−
1999	526	0.2	1	0.2	1.2	0.62	5	0.99	1.2	0.62
2000	444	0.23	0	0.2	0.2	3.3	0	−	0.2	3.3
2001	339	0.2	0	0.1	0.1	3.9	0	−	0.1	3.9
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0.1	0.1	4.3	0	−	0.1	4.3
2004	223	0.21	0	0.2	0.2	4	0	−	0.2	4
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0.1	0.1	9.2	0	−	0.1	9.2
2009	101	0.13	0	0.1	0.1	4	0	−	0.1	4
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.1	0.1	5.4	0	−	0.1	5.4
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0.6	0.6	2.3	0	−	0.6	2.3
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	3.9	4.9	1.1	6.7	0.99	4.9	1.1
2001−2017	2983	0.19	0	1.5	1.5	1.5	0	−	1.5	1.5
2013−2017	591	0.23	0	0.7	0.7	2.3	0	−	0.7	2.3

Table 32. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for LEATHERBACK TURTLE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.68 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	17.9	18.9	0.4	25	1	13.2	0.41
1991	470	0.1	1	21.5	22.5	0.22	10	1	14.4	0.28
1992	596	0.14	4	21.3	25.3	0.18	28.6	0.49	16.5	0.22
1993	728	0.13	3	25.8	28.8	0.1	23.1	0.58	20.6	0.15
1994	759	0.18	1	14.5	15.5	0.13	5.6	1	9.8	0.19
1995	572	0.16	5	14.7	19.7	0.14	31.2	0.45	13.9	0.18
1996	421	0.12	2	13.3	15.3	0.25	16.7	0.71	11	0.26
1997	692	0.23	4	5.9	9.9	0.16	17.4	0.5	6	0.21
1998	587	0.18	0	5.2	5.2	0.92	0	−	3.6	0.95
1999	526	0.2	2	3.3	5.3	0.43	10	0.72	2.3	0.74
2000	444	0.23	0	2.2	2.2	0.87	0	−	1.5	0.87
2001	339	0.2	0	2	2	1.1	0	−	1.4	1.2
2002	360	0.22	0	1	1	1.1	0	−	0.7	1.2
2003	298	0.2	0	0.8	0.8	1.7	0	−	0.5	1.7
2004	223	0.21	0	1.4	1.4	1.2	0	−	1	1.3
2005	225	0.21	0	0.2	0.2	1.8	0	−	0.1	1.8
2006	266	0.19	0	0.8	0.8	1.4	0	−	0.6	1.3
2007	204	0.16	0	0.6	0.6	2.2	0	−	0.4	2.2
2008	149	0.14	0	0.2	0.2	2.3	0	−	0.2	2.3
2009	101	0.13	1	0.4	1.4	0.87	7.7	1	0.3	3.1
2010	59	0.12	0	0.1	0.1	1.1	0	−	0.1	1.1
2011	85	0.2	0	0.4	0.4	2.5	0	−	0.3	2.4
2012	83	0.19	1	0.9	1.9	0.7	5.3	0.98	0.6	1.5
2013	175	0.37	0	0.2	0.2	1.3	0	−	0.1	1.4
2014	97	0.24	0	0.3	0.3	1.1	0	−	0.2	1.2
2015	74	0.2	0	0.1	0.1	1	0	−	0.1	1.1
2016	134	0.18	0	0.2	0.2	0.84	0	−	0.2	0.87
2017	111	0.19	0	0.1	0.1	1.3	0	−	0.1	1.3
1990−2000	5973	0.15	23	132.2	155.2	0.07	153.3	0.21	103.6	0.14
2001−2017	2983	0.19	2	10.3	12.3	0.34	10.5	0.71	7	0.43
2013−2017	591	0.23	0	1.1	1.1	0.64	0	−	0.7	0.64

Table 33. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for OLIVE RIDLEY TURTLE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.1	0.1	4.6	0	−	0	0
1991	470	0.1	0	0.2	0.2	3.7	0	−	0	0
1992	596	0.14	0	0	0	−	0	−	0	−
1993	728	0.13	0	0.1	0.1	6.8	0	−	0	0
1994	759	0.18	0	0.5	0.5	2.6	0	−	0	0
1995	572	0.16	0	0.3	0.3	4	0	−	0	0
1996	421	0.12	0	0.7	0.7	2.8	0	−	0	0
1997	692	0.23	0	0.1	0.1	3	0	−	0	0
1998	587	0.18	0	0.1	0.1	2.6	0	−	0	0
1999	526	0.2	1	1	2	1.1	5	1	0	0
2000	444	0.23	0	0.2	0.2	2.5	0	−	0	0
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0.1	0.1	3.2	0	−	0	0
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0.1	0.1	3.9	0	−	0	0
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0.1	0.1	4.1	0	−	0	0
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.2	0.2	2.5	0	−	0	0
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	3.9	4.9	0.84	6.7	1.01	0	−
2001−2017	2983	0.19	0	0.9	0.9	1.6	0	−	0	−
2013−2017	591	0.23	0	0.4	0.4	2.3	0	−	0	−

Table 34. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. TURTLE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.33 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	2.1	2.1	0.83	0	−	0.7	1.4
1991	470	0.1	0	3.7	3.7	0.47	0	−	1.2	1.1
1992	596	0.14	0	2.2	2.2	0.59	0	−	0.7	1.2
1993	728	0.13	3	3.1	6.1	0.22	23.1	0.58	2	0.49
1994	759	0.18	0	3.3	3.3	0.37	0	−	1.1	0.96
1995	572	0.16	0	1.9	1.9	0.39	0	−	0.6	1
1996	421	0.12	0	1.2	1.2	0.48	0	−	0.4	1
1997	692	0.23	0	1.1	1.1	0.48	0	−	0.4	1
1998	587	0.18	0	0.1	0.1	1.6	0	−	0	2.5
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0.1	0.1	2.4	0	−	0	2.7
2001	339	0.2	0	0.1	0.1	2.4	0	−	0	3.4
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.1	0.1	3	0	−	0	3.6
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	0.73	0	−	0	1.2
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	3	17.3	20.3	0.14	20	0.57	6.7	0.7
2001−2017	2983	0.19	0	0.4	0.4	0.85	0	−	0.2	1.4
2013−2017	591	0.23	0	0.1	0.1	1	0	−	0	1.5

Table 35. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. BIRD. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	1.3	2.3	0.86	25	1	2.3	0.86
1991	470	0.1	0	7.5	7.5	0.79	0	−	7.5	0.79
1992	596	0.14	1	4.5	5.5	0.7	7.1	0.99	5.5	0.7
1993	728	0.13	0	2.9	2.9	0.72	0	−	2.9	0.72
1994	759	0.18	1	2.7	3.7	0.55	5.6	0.98	3.7	0.55
1995	572	0.16	0	1.4	1.4	1	0	−	1.4	1
1996	421	0.12	0	1.2	1.2	0.85	0	−	1.2	0.85
1997	692	0.23	1	0.8	1.8	0.37	4.3	0.99	1.8	0.37
1998	587	0.18	0	2.6	2.6	0.99	0	−	2.6	0.99
1999	526	0.2	0	0.2	0.2	3.2	0	−	0.2	3.2
2000	444	0.23	0	0.2	0.2	3	0	−	0.2	3
2001	339	0.2	0	0.1	0.1	1.6	0	−	0.1	1.6
2002	360	0.22	1	0.1	1.1	0.083	4.5	1	1.1	0.083
2003	298	0.2	0	0.3	0.3	1.9	0	−	0.3	1.9
2004	223	0.21	0	0.4	0.4	2.9	0	−	0.4	2.9
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	1.2	1.2	1.6	0	−	1.2	1.6
2007	204	0.16	0	0.1	0.1	4.6	0	−	0.1	4.6
2008	149	0.14	0	0.1	0.1	7.8	0	−	0.1	7.8
2009	101	0.13	0	0.1	0.1	0.87	0	−	0.1	0.87
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.1	0.1	0.8	0	−	0.1	0.8
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0.1	0.1	1.1	0	−	0.1	1.1
2016	134	0.18	0	0.2	0.2	2.6	0	−	0.2	2.6
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	4	23.3	27.3	0.28	26.7	0.5	27.3	0.28
2001−2017	2983	0.19	1	2.8	3.8	0.62	5.3	0.98	3.8	0.62
2013−2017	591	0.23	0	0.4	0.4	0.98	0	−	0.4	0.98

Table 36. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. CORMORANT. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.1	0.1	9.4	0	−	0.1	9.4
1991	470	0.1	0	1	1	2.8	0	−	1	2.8
1992	596	0.14	0	0	0	−	0	−	0	−
1993	728	0.13	0	0.1	0.1	7.9	0	−	0.1	7.9
1994	759	0.18	0	0.6	0.6	2.9	0	−	0.6	2.9
1995	572	0.16	0	1	1	2	0	−	1	2
1996	421	0.12	0	0.3	0.3	4.5	0	−	0.3	4.5
1997	692	0.23	0	0	0	−	0	−	0	−
1998	587	0.18	0	0.1	0.1	5.4	0	−	0.1	5.4
1999	526	0.2	0	0.3	0.3	3.5	0	−	0.3	3.5
2000	444	0.23	0	0.3	0.3	3	0	−	0.3	3
2001	339	0.2	0	0.1	0.1	8.2	0	−	0.1	8.2
2002	360	0.22	0	0.1	0.1	6.8	0	−	0.1	6.8
2003	298	0.2	1	0.1	1.1	0.51	5	1	1.1	0.51
2004	223	0.21	0	0.2	0.2	2.9	0	−	0.2	2.9
2005	225	0.21	0	0.3	0.3	4.6	0	−	0.3	4.6
2006	266	0.19	0	0.2	0.2	3	0	−	0.2	3
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0.4	0.4	3.5	0	−	0.4	3.5
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0.1	0.1	8.9	0	−	0.1	8.9
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0.1	0.1	3.6	0	−	0.1	3.6
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0	0	−	0	−	0	−
2017	111	0.19	0	0.1	0.1	5.8	0	−	0.1	5.8
1990−2000	5973	0.15	0	4.1	4.1	1.1	0	−	4.1	1.1
2001−2017	2983	0.19	1	1.8	2.8	0.93	5.3	1.02	2.8	0.93
2013−2017	591	0.23	0	0.3	0.3	3	0	−	0.3	3

Table 37. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for NORTHERN FULMAR. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.14 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	9.2	9.2	4.8	0	−	1.3	6
1991	470	0.1	0	4.7	4.7	2.5	0	−	0.6	2.4
1992	596	0.14	0	2.9	2.9	2.6	0	−	0.4	3
1993	728	0.13	0	2.3	2.3	2.7	0	−	0.3	2.7
1994	759	0.18	0	3.1	3.1	1.9	0	−	0.5	2.1
1995	572	0.16	0	4.1	4.1	1.9	0	−	0.5	2.6
1996	421	0.12	0	11.9	11.9	1.3	0	−	1.6	1.4
1997	692	0.23	0	6.3	6.3	1.4	0	−	0.8	1.6
1998	587	0.18	0	11.6	11.6	1.2	0	−	1.6	1.3
1999	526	0.2	0	20.1	20.1	0.85	0	−	2.8	1
2000	444	0.23	16	28.2	44.2	0.32	69.6	0.36	6.8	0.4
2001	339	0.2	0	5.6	5.6	1.4	0	−	0.8	1.8
2002	360	0.22	1	4.9	5.9	0.99	4.5	0.99	0.7	1.4
2003	298	0.2	14	22.7	36.7	0.49	70	0.41	5.2	0.53
2004	223	0.21	0	4.4	4.4	1.8	0	−	0.6	1.8
2005	225	0.21	5	7.7	12.7	0.71	23.8	0.83	1.1	1.4
2006	266	0.19	0	6.5	6.5	1.4	0	−	0.9	1.6
2007	204	0.16	0	5.8	5.8	1.7	0	−	0.8	1.7
2008	149	0.14	0	6.7	6.7	1.9	0	−	0.9	2.1
2009	101	0.13	0	5.3	5.3	2.1	0	−	0.7	2.3
2010	59	0.12	0	3.9	3.9	1.9	0	−	0.6	1.8
2011	85	0.2	0	2.4	2.4	1.9	0	−	0.3	2.3
2012	83	0.19	0	3.4	3.4	2	0	−	0.5	2
2013	175	0.37	0	4.4	4.4	1.7	0	−	0.6	2
2014	97	0.24	0	1.5	1.5	2.5	0	−	0.2	3.1
2015	74	0.2	0	1.8	1.8	2.9	0	−	0.3	2.7
2016	134	0.18	0	1.2	1.2	2.6	0	−	0.2	2.7
2017	111	0.19	0	3.4	3.4	1.9	0	−	0.4	2.3
1990−2000	5973	0.15	16	132.2	148.2	0.32	106.7	0.36	21	0.46
2001−2017	2983	0.19	20	94.6	114.6	0.34	105.3	0.36	15	0.5
2013−2017	591	0.23	0	15.3	15.3	1.1	0	−	2.1	1.3

Table 38. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. WHALE. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.5 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	0.6	0.6	2.2	0	−	0.3	3
1991	470	0.1	0	0.1	0.1	0.52	0	−	0.1	0.87
1992	596	0.14	0	0.1	0.1	0.47	0	−	0.1	0.82
1993	728	0.13	1	0.3	1.3	0.16	7.7	0.99	1.1	0.12
1994	759	0.18	0	0.2	0.2	1.1	0	−	0.1	1.2
1995	572	0.16	0	0.5	0.5	1.6	0	−	0.2	1.9
1996	421	0.12	0	0.2	0.2	0.36	0	−	0.1	0.88
1997	692	0.23	0	0.2	0.2	0.27	0	−	0.1	0.77
1998	587	0.18	0	0.9	0.9	0.86	0	−	0.4	1.3
1999	526	0.2	0	1.8	1.8	0.62	0	−	0.9	1
2000	444	0.23	0	0.3	0.3	0.22	0	−	0.2	0.81
2001	339	0.2	0	0.3	0.3	0.23	0	−	0.2	0.77
2002	360	0.22	0	0.4	0.4	0.2	0	−	0.2	0.76
2003	298	0.2	1	0.3	1.3	0.062	5	1	0.2	0.75
2004	223	0.21	0	0.2	0.2	0.28	0	−	0.1	0.76
2005	225	0.21	0	0.3	0.3	0.26	0	−	0.1	0.79
2006	266	0.19	0	1	1	0.9	0	−	0.5	1.4
2007	204	0.16	0	0.3	0.3	0.29	0	−	0.2	0.78
2008	149	0.14	0	0.4	0.4	0.29	0	−	0.2	0.78
2009	101	0.13	0	1	1	1	0	−	0.5	1.5
2010	59	0.12	0	0.1	0.1	0.6	0	−	0	1
2011	85	0.2	0	0.1	0.1	0.38	0	−	0	0.85
2012	83	0.19	0	0.1	0.1	0.41	0	−	0	0.81
2013	175	0.37	0	0.1	0.1	0.36	0	−	0	0.84
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0.1	0.1	0.47	0	−	0	0.98
2016	134	0.18	0	0.1	0.1	0.47	0	−	0.1	0.94
2017	111	0.19	0	0.1	0.1	0.52	0	−	0	0.95
1990−2000	5973	0.15	1	6.1	7.1	0.3	6.7	1.01	3.9	0.65
2001−2017	2983	0.19	1	4.5	5.5	0.2	5.3	1	2.3	0.76
2013−2017	591	0.23	0	0.4	0.4	0.22	0	−	0.2	0.72

Table 39. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for UNID. CETACEAN. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	0	1.1	1.1	0.24	0	−	1.1	0.24
1991	470	0.1	1	2.7	3.7	0.74	10	1	3.7	0.74
1992	596	0.14	1	1.9	2.9	0.74	7.1	1	2.9	0.74
1993	728	0.13	0	1.4	1.4	0.17	0	−	1.4	0.17
1994	759	0.18	0	1.1	1.1	0.16	0	−	1.1	0.16
1995	572	0.16	0	1.4	1.4	0.94	0	−	1.4	0.94
1996	421	0.12	0	1.7	1.7	1.5	0	−	1.7	1.5
1997	692	0.23	0	0.9	0.9	1.1	0	−	0.9	1.1
1998	587	0.18	0	0.5	0.5	2.5	0	−	0.5	2.5
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0	0	−	0	−	0	−
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0	0	−	0	−	0	−
2003	298	0.2	0	0.4	0.4	3.2	0	−	0.4	3.2
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0.2	0.2	2.3	0	−	0.2	2.3
2006	266	0.19	0	0.1	0.1	3.9	0	−	0.1	3.9
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0	0	−	0	−	0	−
2009	101	0.13	0	0	0	−	0	−	0	−
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	0	−	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	1.2	0	−	0.1	1.2
2017	111	0.19	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	11.4	13.4	0.34	13.3	0.71	13.4	0.34
2001−2017	2983	0.19	0	0.8	0.8	1.8	0	−	0.8	1.8
2013−2017	591	0.23	0	0.1	0.1	3.9	0	−	0.1	3.9

Table 40. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for ALL BEAKED WHALES. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 0.97 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	1	30.2	31.2	0.053	25	0.99	30.2	0.062
1991	470	0.1	0	35.6	35.6	0.035	0	−	34.5	0.045
1992	596	0.14	12	30.1	42.1	0.024	85.7	0.28	41.1	0.034
1993	728	0.13	3	39.4	42.4	0.03	23.1	0.58	41.3	0.041
1994	759	0.18	11	28.8	39.8	0.021	61.1	0.3	38.9	0.03
1995	572	0.16	6	25.5	31.5	0.025	37.5	0.4	29.7	0.035
1996	421	0.12	0	16.4	16.4	0.044	0	−	15.9	0.052
1997	692	0.23	0	8.2	8.2	0.046	0	−	7.9	0.055
1998	587	0.18	0	0.9	0.9	0.25	0	−	0.9	0.25
1999	526	0.2	0	0.4	0.4	0.38	0	−	0.4	0.38
2000	444	0.23	0	0.3	0.3	0.44	0	−	0.3	0.44
2001	339	0.2	0	0.3	0.3	0.46	0	−	0.3	0.47
2002	360	0.22	0	0.2	0.2	0.5	0	−	0.2	0.5
2003	298	0.2	0	0.2	0.2	0.58	0	−	0.2	0.58
2004	223	0.21	0	0.1	0.1	0.67	0	−	0.1	0.68
2005	225	0.21	0	0.1	0.1	0.67	0	−	0.1	0.67
2006	266	0.19	0	0.2	0.2	0.73	0	−	0.2	0.73
2007	204	0.16	0	0.2	0.2	0.68	0	−	0.2	0.69
2008	149	0.14	0	0.2	0.2	0.9	0	−	0.2	0.9
2009	101	0.13	0	0.1	0.1	0.99	0	−	0.1	0.99
2010	59	0.12	0	0.1	0.1	1.3	0	−	0.1	1.3
2011	85	0.2	0	0.1	0.1	1.1	0	−	0.1	1.1
2012	83	0.19	0	0.1	0.1	1.1	0	−	0.1	1.2
2013	175	0.37	0	0.1	0.1	0.68	0	−	0.1	0.67
2014	97	0.24	0	0.2	0.2	0.37	0	−	0.2	0.37
2015	74	0.2	0	0.1	0.1	1.2	0	−	0.1	1.2
2016	134	0.18	0	1.3	1.3	0.15	0	−	1.2	0.15
2017	111	0.19	0	0.1	0.1	0.74	0	−	0.1	0.74
1990−2000	5973	0.15	33	188.3	221.3	0.01	220	0.17	214.3	0.03
2001−2017	2983	0.19	0	3.5	3.5	0.14	0	−	3.4	0.14
2013−2017	591	0.23	0	1.4	1.4	0.15	0	−	1.4	0.15

Table 41. Observed sets (Obs.Sets), observer coverage (Obs.Cov), and observed bycatch (Obs.Bycatch) for ALL DELPHINOIDS. Unobserved bycatch estimated from regression trees (Tree.Est) and total bycatch (Bycatch.Tot) are shown with corresponding ratio estimates (Ratio.Est). Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations resulting in death or serious injury. The probability that a bycatch event resulted in mortality or serious injury was 1 for this species. Precision for all estimates are given as CVs.

Year	Obs.Sets	Obs.Cov	Obs.Bycatch	Tree.Est	Bycatch.Tot	CV.Bycatch.Tot	Ratio.Est	CV.Ratio.Est	MSI	CV.MSI
1990	178	0.04	13	379.3	392.3	0.17	325	0.33	392.3	0.17
1991	470	0.1	63	375.5	438.5	0.039	630	0.16	438.5	0.039
1992	596	0.14	62	336	398	0.04	442.9	0.16	398	0.04
1993	728	0.13	61	429.1	490.1	0.037	469.2	0.18	490.1	0.037
1994	759	0.18	41	328.5	369.5	0.039	227.8	0.17	369.5	0.039
1995	572	0.16	60	281.2	341.2	0.04	375	0.2	341.2	0.04
1996	421	0.12	38	223.9	261.9	0.074	316.7	0.19	261.9	0.074
1997	692	0.23	42	177.9	219.9	0.07	182.6	0.17	219.9	0.07
1998	587	0.18	9	171.3	180.3	0.15	50	0.33	180.3	0.15
1999	526	0.2	40	117.2	157.2	0.1	200	0.23	157.2	0.1
2000	444	0.23	40	75.6	115.6	0.1	173.9	0.21	115.6	0.1
2001	339	0.2	14	73.2	87.2	0.15	70	0.3	87.2	0.15
2002	360	0.22	14	68.2	82.2	0.16	63.6	0.33	82.2	0.16
2003	298	0.2	23	60.2	83.2	0.16	115	0.29	83.2	0.16
2004	223	0.21	8	48.8	56.8	0.21	38.1	0.39	56.8	0.21
2005	225	0.21	15	40.9	55.9	0.16	71.4	0.26	55.9	0.16
2006	266	0.19	7	57.4	64.4	0.2	36.8	0.47	64.4	0.2
2007	204	0.16	11	57.1	68.1	0.19	68.8	0.32	68.1	0.19
2008	149	0.14	16	50.1	66.1	0.18	114.3	0.37	66.1	0.18
2009	101	0.13	3	42.8	45.8	0.4	23.1	0.72	45.8	0.4
2010	59	0.12	6	27.8	33.8	0.31	50	0.45	33.8	0.31
2011	85	0.2	5	20.2	25.2	0.27	25	0.44	25.2	0.27
2012	83	0.19	6	20.1	26.1	0.28	31.6	0.52	26.1	0.28
2013	175	0.37	8	16.9	24.9	0.23	21.6	0.39	24.9	0.23
2014	97	0.24	10	22	32	0.28	41.7	0.33	32	0.28
2015	74	0.2	1	22.1	23.1	0.31	5	1	23.1	0.31
2016	134	0.18	10	51.6	61.6	0.22	55.6	0.41	61.6	0.22
2017	111	0.19	18	32.7	50.7	0.3	94.7	0.32	50.7	0.3
1990−2000	5973	0.15	469	2770.5	3239.5	0.02	3126.7	0.06	3239.5	0.02
2001−2017	2983	0.19	175	709.3	884.3	0.06	921.1	0.09	884.3	0.06
2013−2017	591	0.23	47	139.2	186.2	0.12	204.3	0.19	186.2	0.12