NOAA Technical Memorandum NMFS

JULY 2020

ESTIMATES OF MARINE MAMMAL, SEA TURTLE, AND SEABIRD BYCATCH IN THE CALIFORNIA LARGE-MESH DRIFT GILLNET FISHERY: 1990-2018.

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NOAA-TM-NMFS-SWFSC-632

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. 2020. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery:1990-2018, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-632.

Table of Contents

Figures

Tables

Abstract

Bycatch of marine mammals, sea turtles, and seabirds in the California swordfish drift gillnet fishery during 1990-2018 is estimated using random forest regression trees. Tree estimates are 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 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 1990-2018, technicians in the NMFS West Coast Regional Office fishery observer program observed 9,085 sets from an estimated 56,871 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, 2019). Here, we present updated estimates of bycatch using both methods, using one additional year of observer data from 2018. 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) discussed challenges in identifying predictor variables for a U.S. longline fishery in the context of rare event bycatch, while Curtis and Carretta (2020) developed a tool for use in assessing observer coverage levels necessary to detect rare events and estimate bycatch with varying precision goals. Carretta and Moore (2014) noted that strategies to provide mean annual estimates of bycatch in U.S. marine mammal stock assessments (5 years are pooled) are insufficient to overcome such problems. Estimation problems associated with low observer coverage and rare events 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, first, using random forest *classification trees* for variable selection (see *Variable Selection*). Second, variables selected for inclusion were 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 to be classified is bycatch presence or 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 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. A RF of 500 classification trees was 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 500 individual classification trees with *n*=340 fishing sets with bycatch and *n*=340 sets without bycatch. Fishing sets used in construction of each classification tree were sampled with replacement. Each RF included randomly selected variables for tree construction, ranging from a minimum of three variables for consideration and potentially including all 12 variables in Table 1. A total of 1,000 RFs were generated, each with a unique variable set. The individual RF that minimized the OOB error rate for bycatch presence was used to identify which variables would be used to estimate total bycatch (see 'Regression Trees'). In the case of ties in classification rate errors between different RF models, we chose the model that included the fewest variables, in the spirit of penalizing model complexity.

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, or OOB data (Breiman 2001). We are interested in the prediction accuracy for fishing sets with bycatch presence. In a bycatch presence - absence context, a RF model's ability 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, 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 ranges from +1 (perfect prediction) to -1 (always inaccurate), with scores less than zero indicating 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 each species, the expected value for sensitivity if all variables lack predictive power is the proportion of observed fishing sets with bycatch presence. In other words, randomly guessing which fishing sets have bycatch yields in a correct classification rate ≤ than the proportion of observed fishing sets with bycatch, or ≤ 4% for all species in this study.

Use of the TSS sensitivity metric for variable selection differs from the method used by Carretta *et al*. (2017), where the R-package *rfPermute* (Archer 2016) was used to estimate statistical p-values for each variable, and only variables that were 'significant' below an arbitrary threshold α-level were used in RF models. The TSS approach is more inclusive than reliance on variable 'significance' and can improve model performance if a suite of 'non-significant' predictors have superior predictive ability over smaller suites of significant predictors (Breiman 2001). Use of the TSS metric is also consistent with quantitative approaches used to estimate the strength of presence / absence models (Allouche et al. 2006). Variables evaluated for bycatch models included a suite of fishing gear, oceanographic, and location variables described 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). 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 and their deep-diving habits. 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 species with observed sample sizes ≥4 are shown 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 is obtained by building random forests with all data, except one fishing trip is omitted for cross-validation. Individual vessel trips averaged 5.8 sets fished (range = 1 – 19). The resulting random forest of 500 trees was used to predict bycatch for each fishing set in 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 9,085 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 29 years of data. Mean annual estimates of bycatch from regression trees ($\bar{T}_{s,y}$), 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*:

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

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:

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

where $var\left(\bar{b}_{s,y} * u_{s,y}\right)$ is the variance of 500 predicted bycatch sums across observed sets in year *y*. The variance includes a finite population correction (*fpc*) (Snedecor and Cochran 1967) to account for incomplete observer coverage, where

$$(3)\ fpc = \sqrt{\frac{total\ effort - observed\ effort}{total\ effort - 1}}$$

and

$$(4) \quad \sqrt{var(\bar{b}_{s,y} * u_{s,y})} = sd(\bar{b}_{s,y} * u_{s,y}) * fpc.$$

For all bycatch estimates, our value for *fpc* = 0.91 (*total effort* = 56,871 sets, *observed effort* = 9,085 sets). 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 $\bar{T}_y$, using the 2.5th and 97.5th percentiles of all 500 summed 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 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 MSI estimates was estimated by treating *f* as a random binomial deviate, based on observed entanglement and injury/death sample sizes for each species. Estimates of unobserved bycatch (one for each of 500 forest trees) were multiplied by a randomly drawn (with replacement) value of *f*, 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 as in Equation 2. Small species such as dolphins, porpoises, and pinnipeds are rarely released alive because they drown quickly in gillnets, thus, they have f 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 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, 2001-2018 and 2014-2018. The years 1990-2000 represent the pre-closure period of the fishery, when effort was permitted year-round in the PLCA. The years 2001-2018 represent the 'current state' of the fishery, as most fishing effort now occurs off southern California (Figure 1). Finally, the years 2014-2018 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 are known 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 estimation reduces 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 3 of 12 variables tested. Model performance measures (variables selected, sensitivity, selectivity, TSS metrics) for selected species are given in Table 2.

Estimates of total bycatch and mortality and serious injury levels are shown in Tables 3-40. Bycatch estimates from regression trees were more stable across years and had better precision than corresponding ratio estimates. Precision gains from regression trees primarily resulted from the use of all 29 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 one year of data for estimating mean bycatch rates. In sum, the information contained in the full dataset provides a better estimate of long-term expected bycatch rates and covariate effects, which translates into better 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 3-40). For example, total estimates of beaked whale bycatch during 1990-2000 were approximately 224 (CV=0.03) and 220 (CV=0.17) whales, for regression tree and ratio methods respectively (Table 39). The lower CV of the regression tree estimate is, in part, due to using only 3 covariates in tree construction (*depth.p* + *n.ping* + *extnd*), which effectively limits the number of possible discrete predicted values in terminal nodes of RF trees (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 due to an absence of observations that year. Effects and advantages of using regression trees over ratio estimates are reviewed in the Discussion.

Some annual regression tree bycatch estimates have rather large CVs (>1), which occurs when estimated bycatch is near zero even though the standard error (absolute rather than relative error measure) might be small. This is 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 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 2.1 whales (2 observed + 0.1 whales estimated in 433 unobserved sets). Given the observed sperm whale bycatch rate in this fishery over 29 years (~ 1 animal for every 1,000 sets), it is highly unlikely that observed + unobserved bycatch in 2010 was approximately 17 whales. 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 observed bycatch is zero, the resulting bycatch estimate is 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 predicted after the first two years of the observer program). In contrast, summed 1990-1991 regression tree bycatch estimates are approximately 3 sperm whales, which is more realistic, given the level of fishing effort (Table 21). 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. The most-recent estimate of sperm whale bycatch in 2018 (1.7 entanglements) results from a high estimate of bycatch per unit effort, reflecting fishing set characteristics that year. However, total fishing effort was relatively low, so the total estimated bycatch is considerably less than it was in the 1990s when effort was high. An examination of 2018 data reveals that observed fishing depths included some of the highest values in the time series (Figure 5), though mean and median depths are lower than observations from the 1990s when most sperm whale entanglements were observed. The sperm whale model included the variables *depth.p* + *sst* + *extnd* and the interaction of these variables, especially the high values for *depth.p* are likely responsible for the high predicted bycatch per unit effort, even in the absence of observed bycatch that year.

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 enough observations for reliable statistical tests (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 1990-2018 (Fig. 3-1). Bycatch per fishing set declined, even while fishing effort shifted to southern California waters (due to the PLCA closure) where short-beaked common dolphin densities are highest (Becker *et al*. 2014), and during a time when short-beaked common dolphin abundance increased (Barlow 2016). This is further evidence that pinger use, and not simply reduced fishing effort, are responsible for the decline in short-beaked common dolphin bycatch rates. A prior study of bycatch reduction in this fishery identified only 2 species/groups with more statistically significant bycatch reductions attributed to pingers than short-beaked common dolphin: 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 (Table 2). Current evidence still identifies pingers as the most likely factor in reducing beaked whale bycatch in the fishery. Although no beaked whale bycatch has been observed in the fishery since 1995 (Carretta *et al.* 2008), estimates of bycatch (Table 39) are slightly positive in years since. This reflects that in addition to pingers, other variables such as *depth* and *extnd* are also responsible for current estimates (Figure 3-5 and Table 2).

California sea lion bycatch levels declined from 1990-2018, which largely reflects declining fishing effort (Table 25). However, observed and estimated sea lion bycatch per fishing set *increased* during the same period (Fig. 3-2), due to an increasing sea lion population and implementation of the PLCA, which shifted gillnet effort to more shallow southern waters closer to sea lion breeding rookeries where abundance is highest. Howorth (1994) and Stewart and Yochem (1987) reported that most California sea lion entanglements in synthetic debris and 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 in). The sea lion bycatch model included the variables *mesh* + *depth.p* + *extnd* (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

(~ 137 entanglements, ~ 107 estimated deaths, Table 31) are similar, and both studies estimate 9-25 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 PLCA implementation in 2001 (Fig. 1), which Martin *et al.* (2015) reported as the driving factor in reducing leatherback bycatch. The PLCA closure shifted fishing effort outside of preferred summer / autumn leatherback habitat, resulting in declines in observed bycatch (Eguchi *et al.* 2016). After 2001, estimated leatherback bycatch is between 0 and 2.5 turtles annually, which reflects both PLCA effectiveness and declining fishing effort (Table 31). Prior to the PLCA (1990-2000), the observed leatherback bycatch rate was 23 turtles in 5,973 fishing sets (0.0038 per set). After the closure (2001-2018), the observed bycatch rate was 2 turtles in 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, because they are artifacts of the small number of sets observed (Fig. 3-8). Our leatherback bycatch model included the variables *lon + sst + extnd.* Longitude is a proxy variable for the PLCA (Fig. 1), as more western longitudes occur only in the northern part of the fishing area, where fishing effort is now rare since the closure began. Based on 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. Observed reductions in leatherback entanglements following PLCA implementation are also driven by declines in fishing effort and Pacific leatherback nesting populations (Tapilatu *et al*. 2013).

Our bycatch data contained over 9,000 fishing sets spanning 29 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 greatly improved by multi-year data pooling. One consequence of multi-year pooling is that annual estimate precision reflects only the uncertainty from observed mean bycatch rates, and does not reflect variation in true annual bycatch. This problem decreases with increased data-pooling, but for annual estimates, our estimation precision is likely underestimated relative to intra-annual variability in true bycatch rates. Management advantages of model-based bycatch estimation methods that utilize all available data are 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 annual estimation volatility is important in protected species management, where decisions involving fishery regulation require accurate and timely assessment of bycatch. This is especially true for rare event bycatch, where an 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 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), 2001-2018 (R), and Pacific Leatherback Conservation Area (shaded).

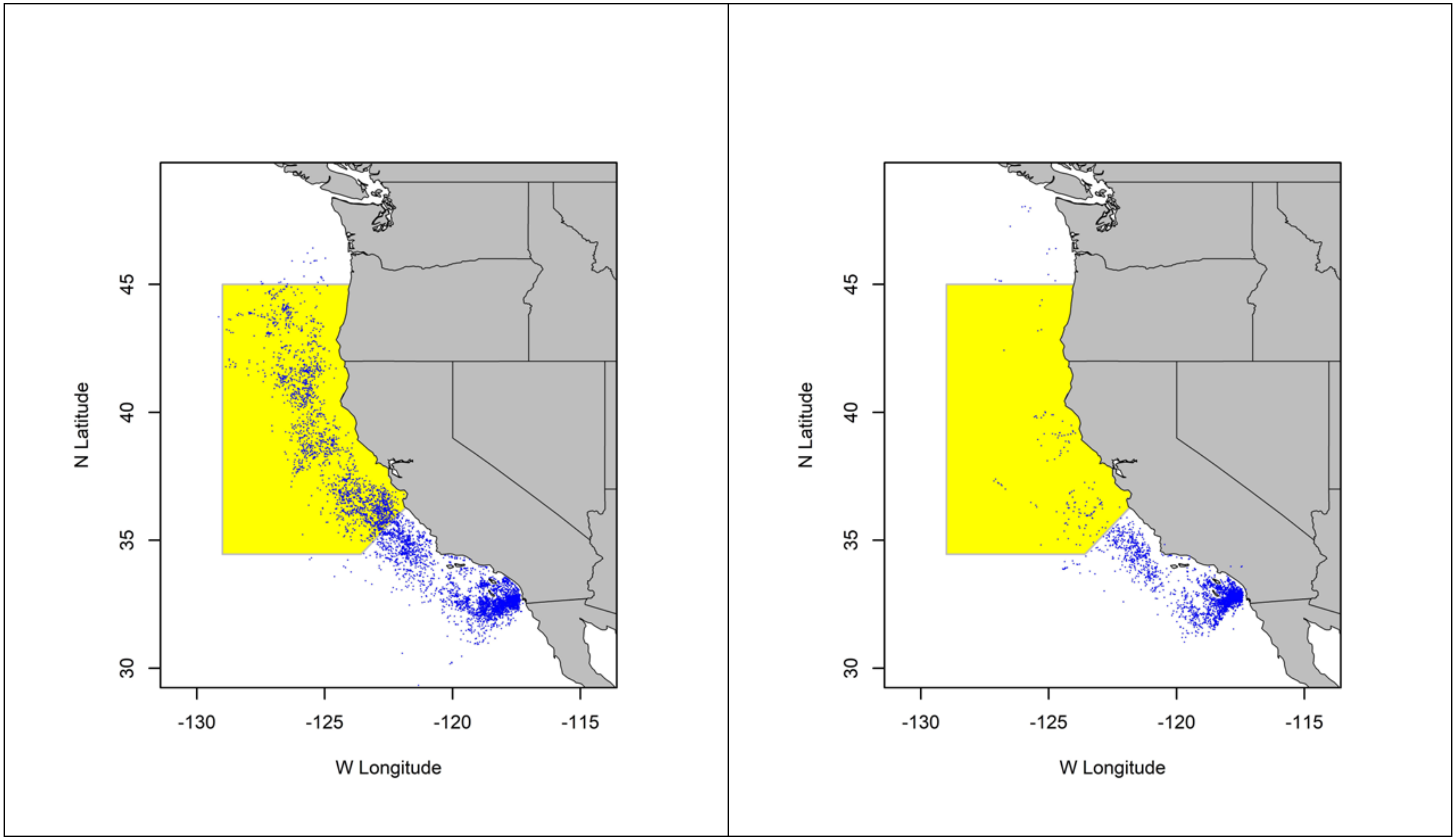

Figure 2. Observed and estimated number of fishing sets in the California large-mesh drift gillnet fishery, 1990-2018. Values in bars represent approximate fraction of annual observer coverage.

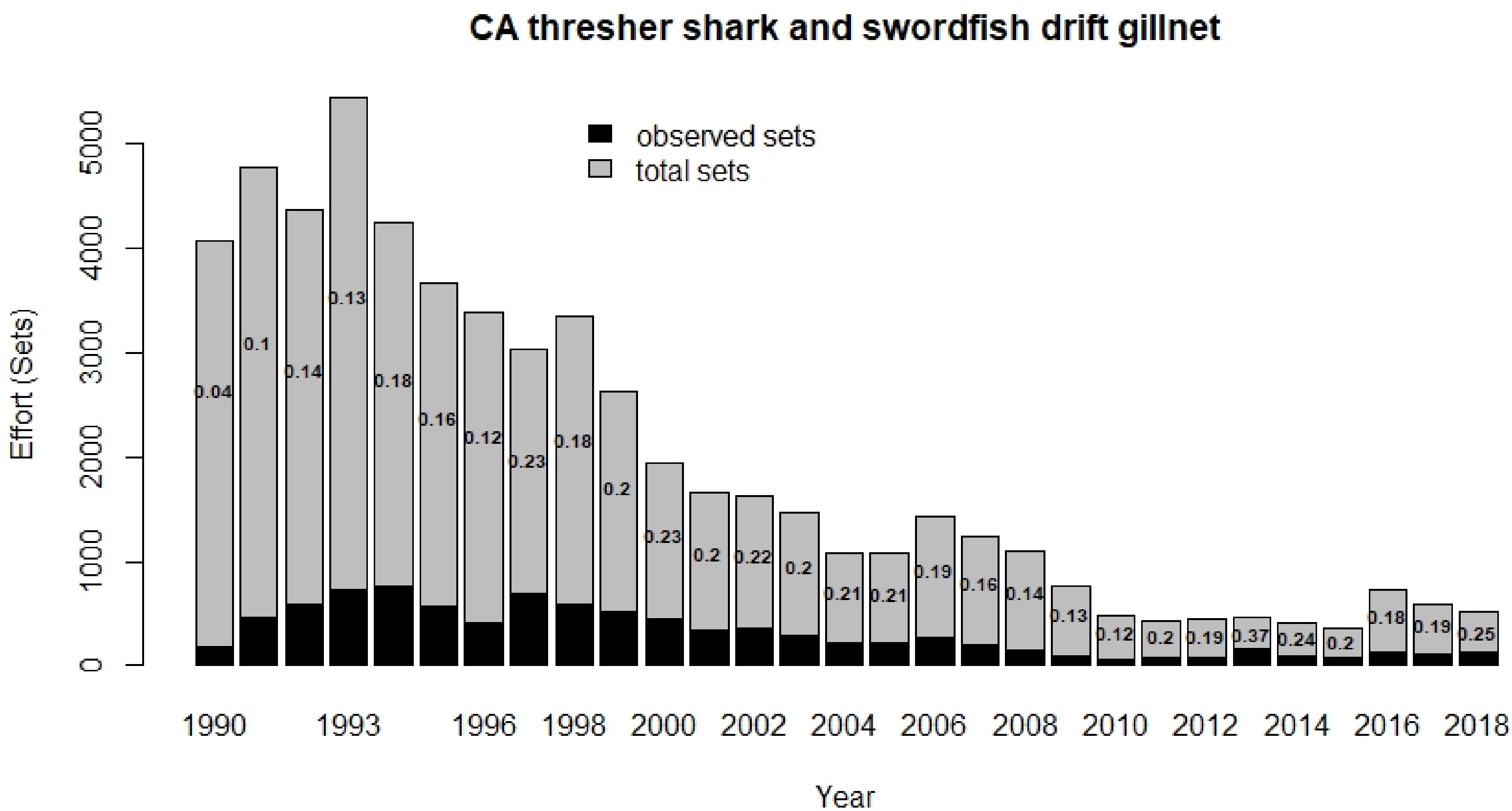

Figure 3-1. Observed and estimated bycatch of short-beaked common dolphin. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

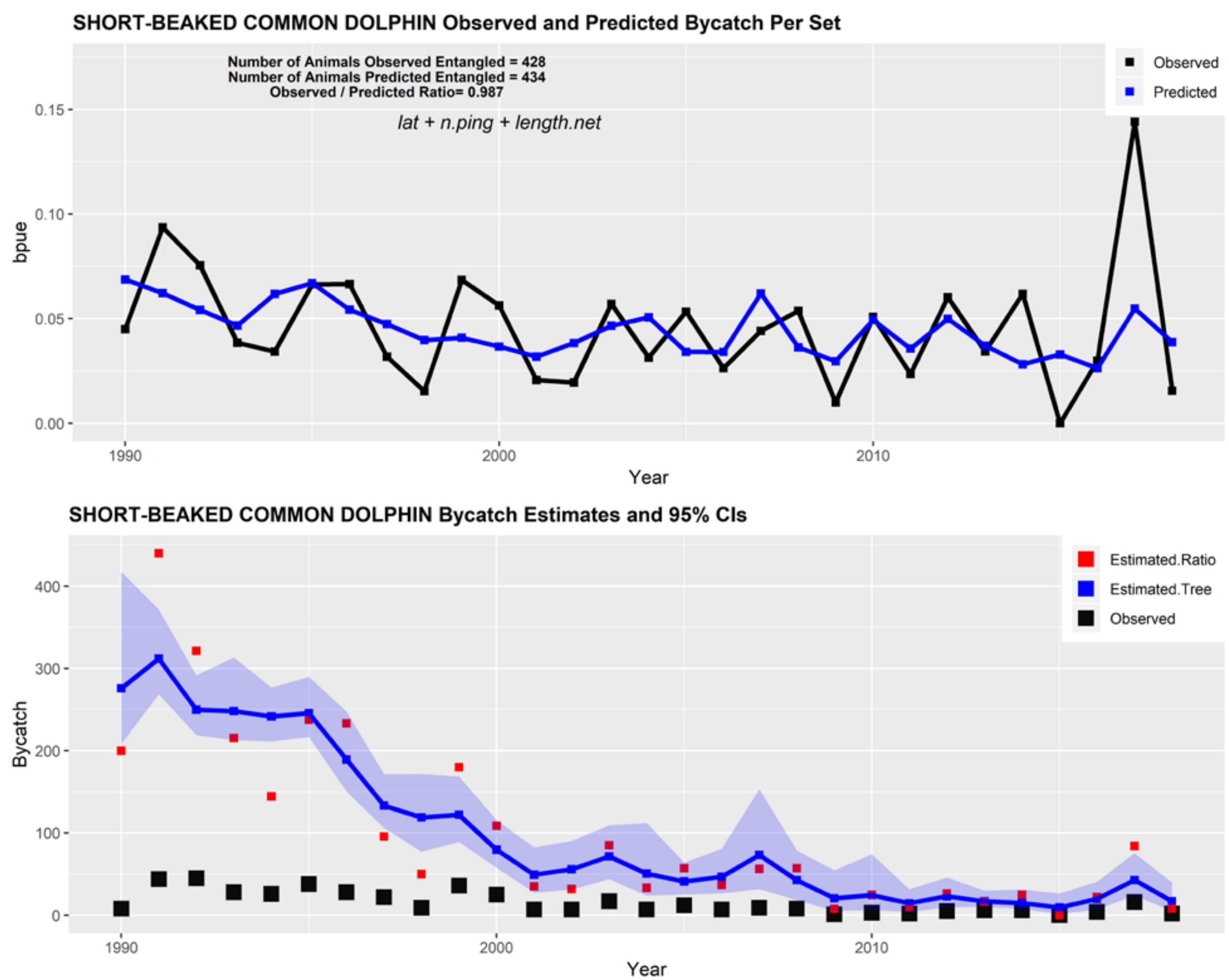

Figure 3-2. Observed and estimated bycatch of California sea lion. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

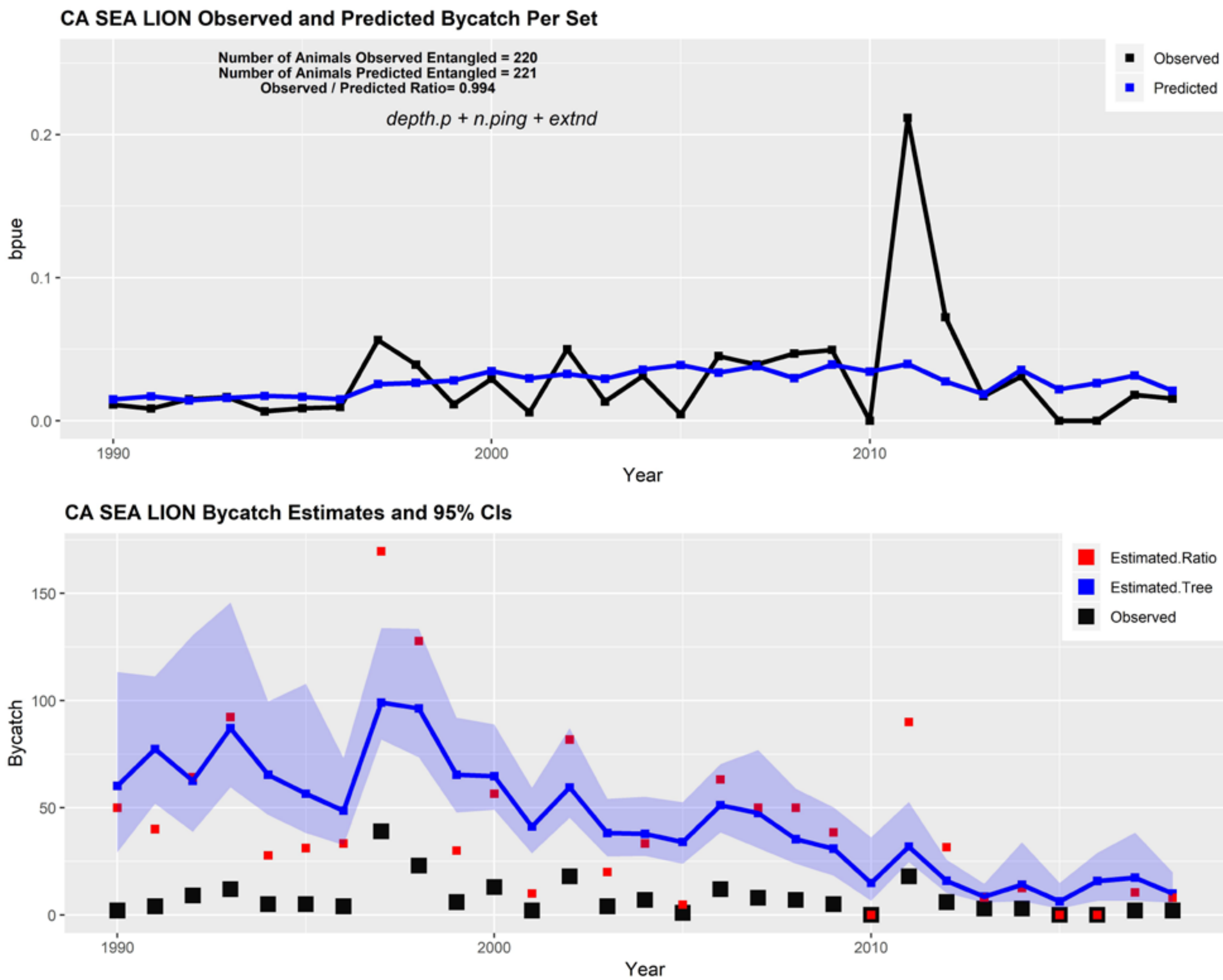

Figure 3-3. Observed and estimated bycatch of northern elephant seal. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

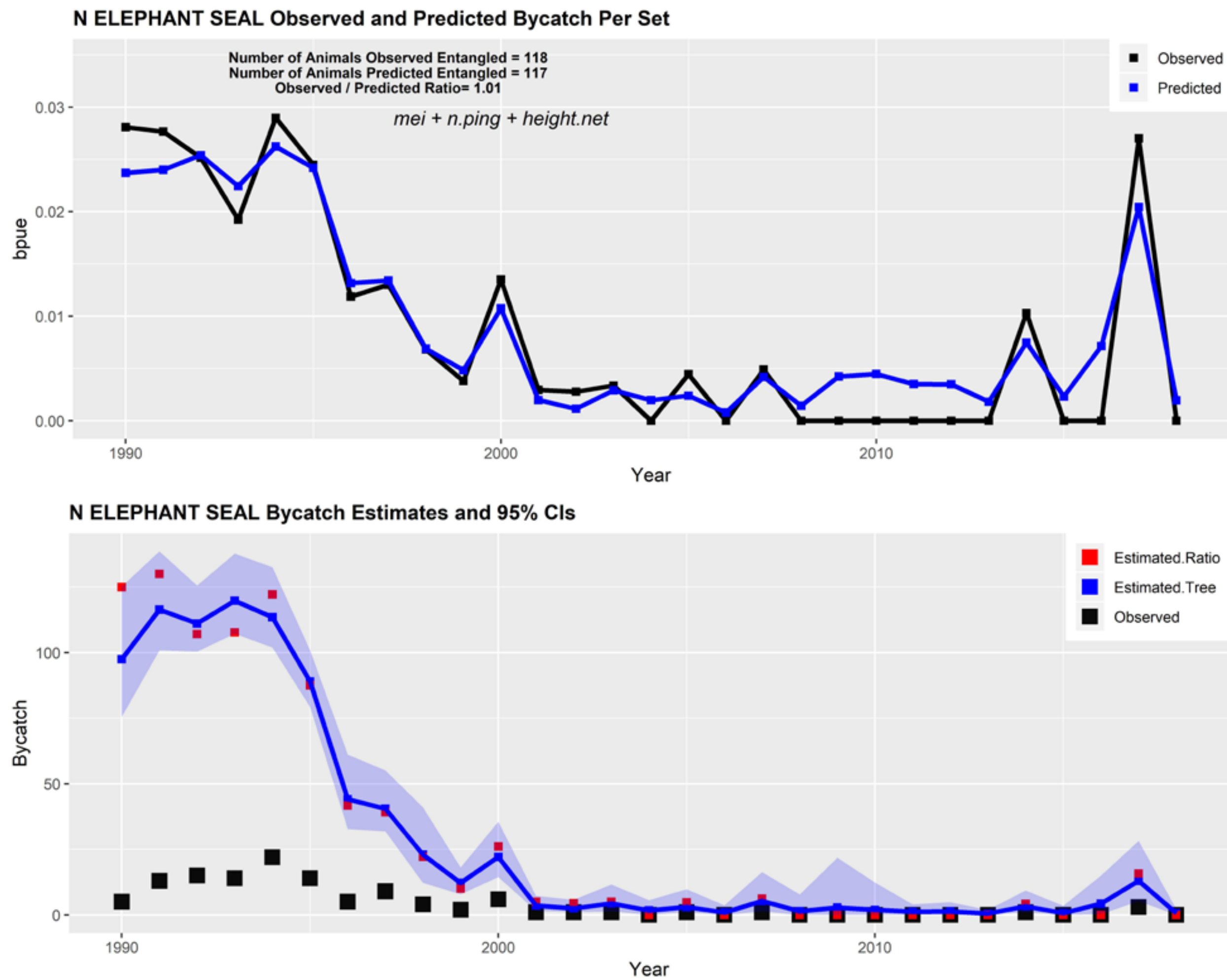

Figure 3-4. Observed and estimated bycatch of northern right whale dolphin. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

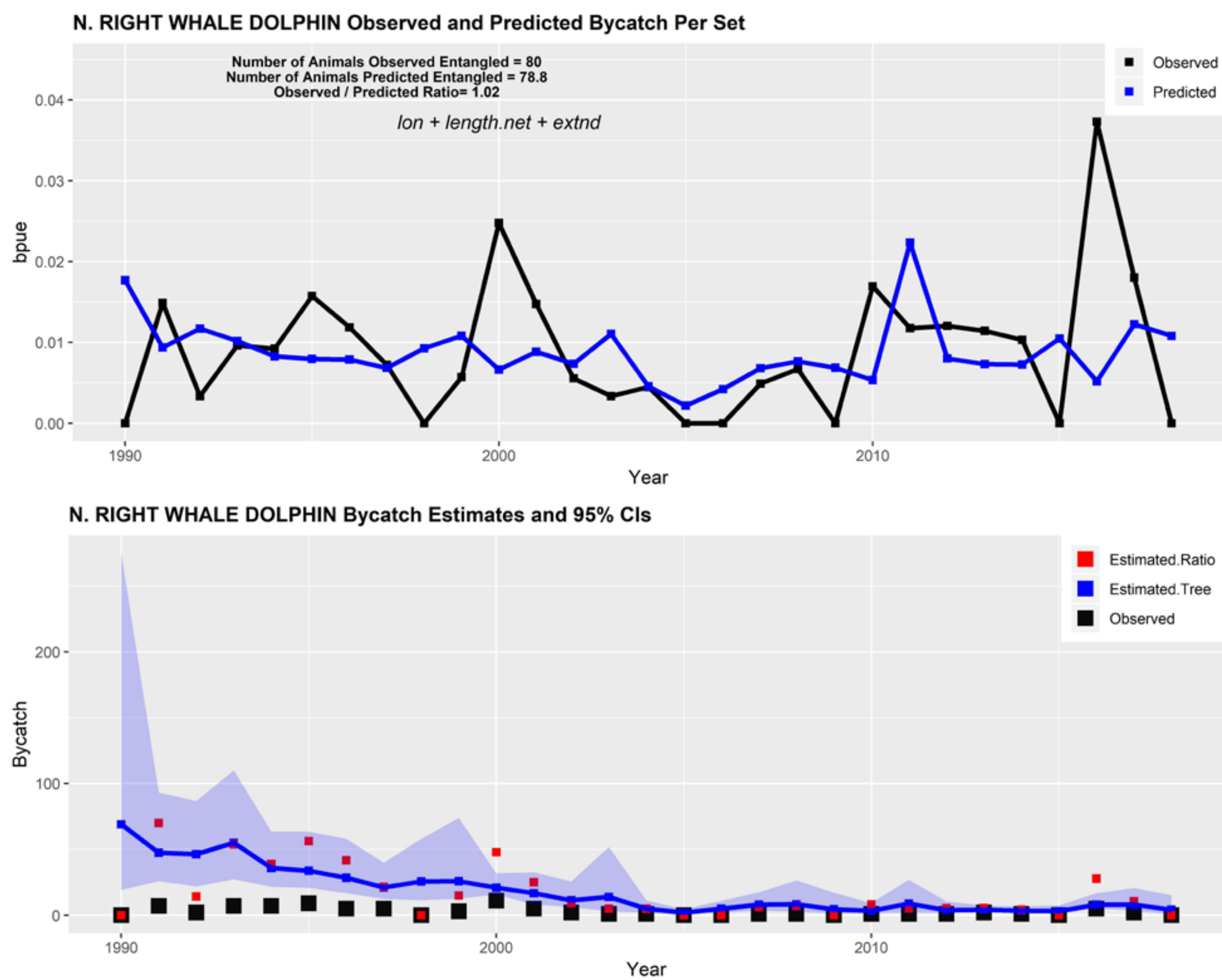

Figure 3-5. Observed and estimated bycatch of all beaked whales. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

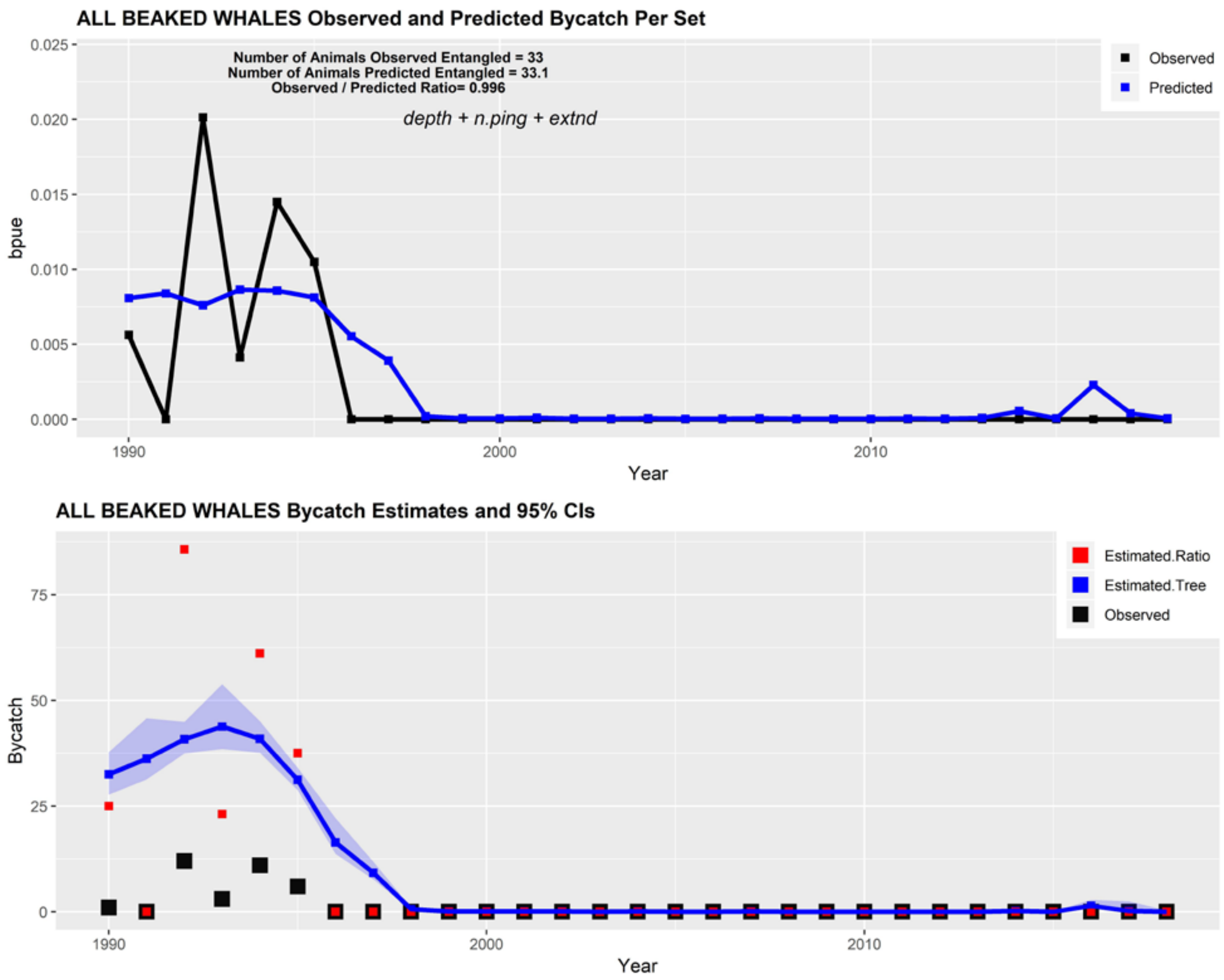

Figure 3-6. Observed and estimated bycatch of Risso's dolphin. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

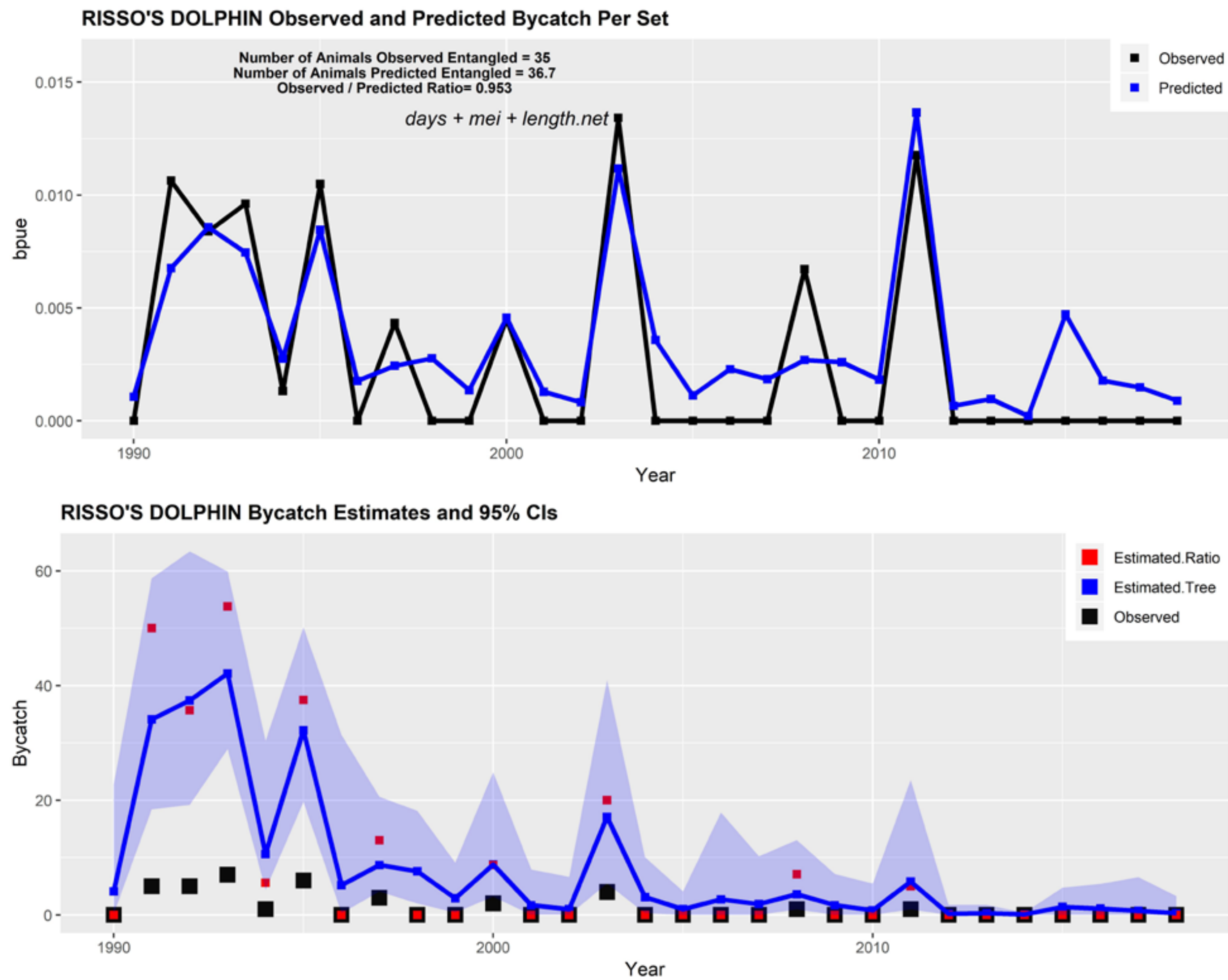

Figure 3-7. Observed and estimated bycatch of Pacific white-sided dolphin. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

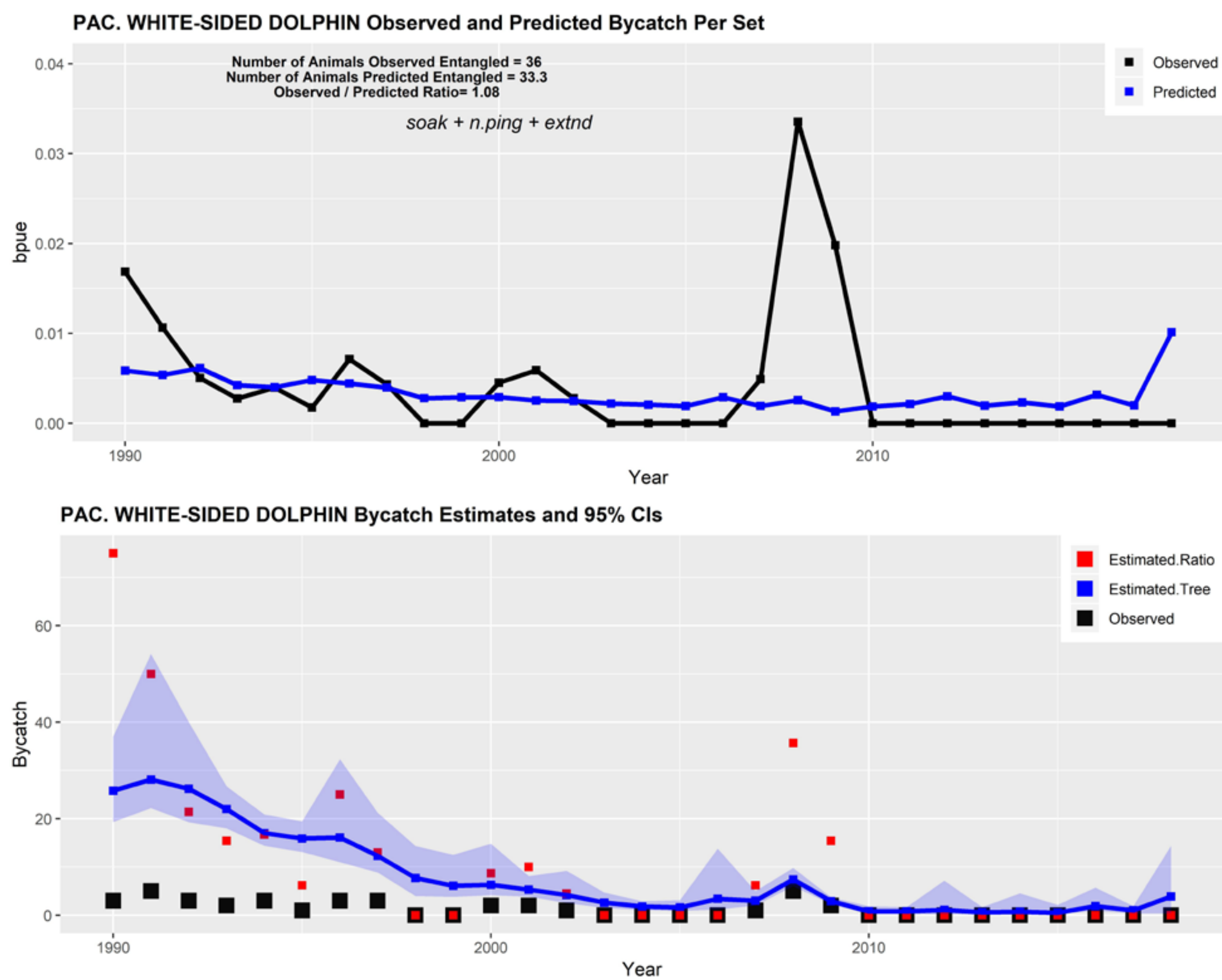

Figure 3-8. Observed and estimated bycatch of leatherback sea turtles. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

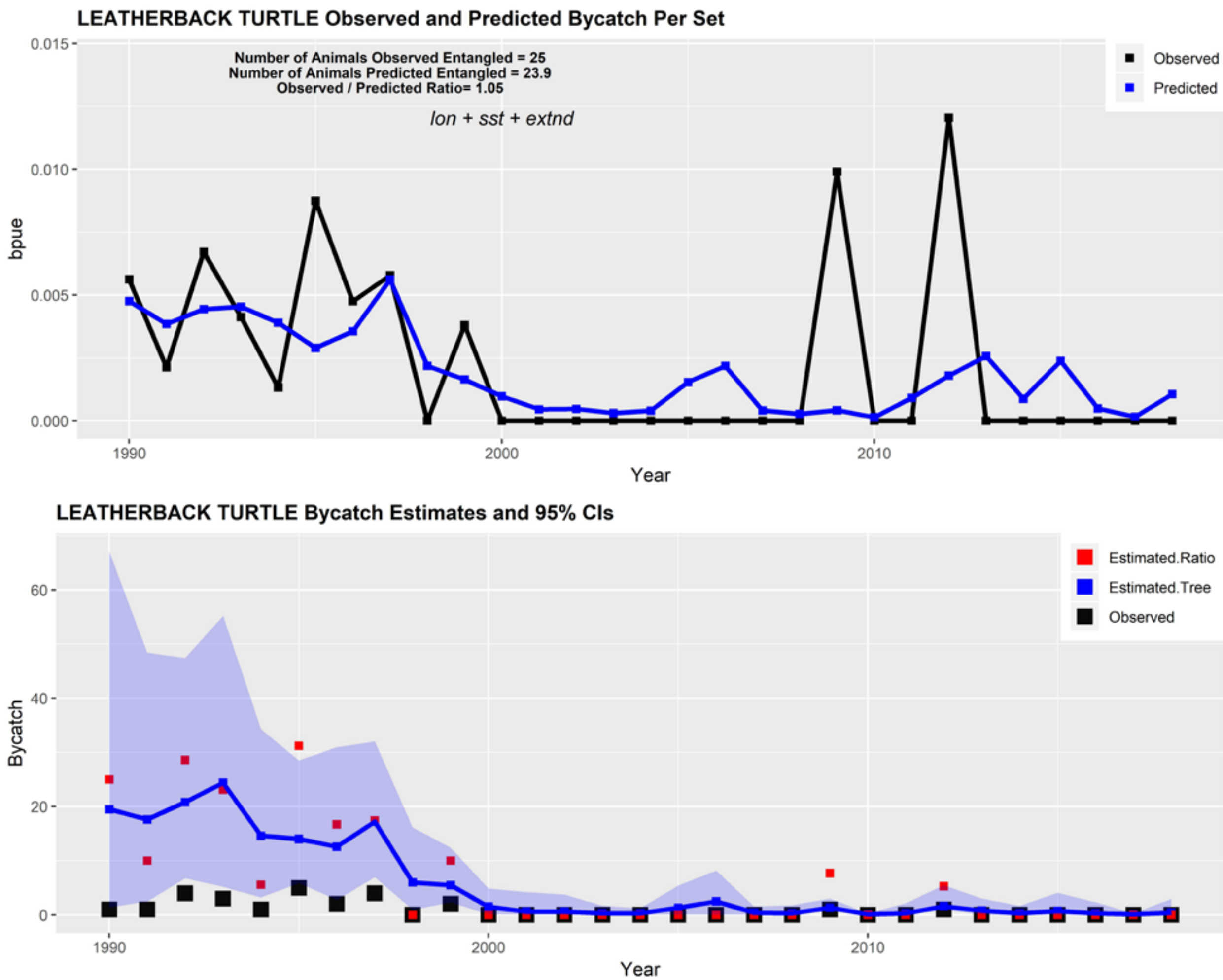

Figure 3-9. Observed and estimated bycatch of Dall's porpoise. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

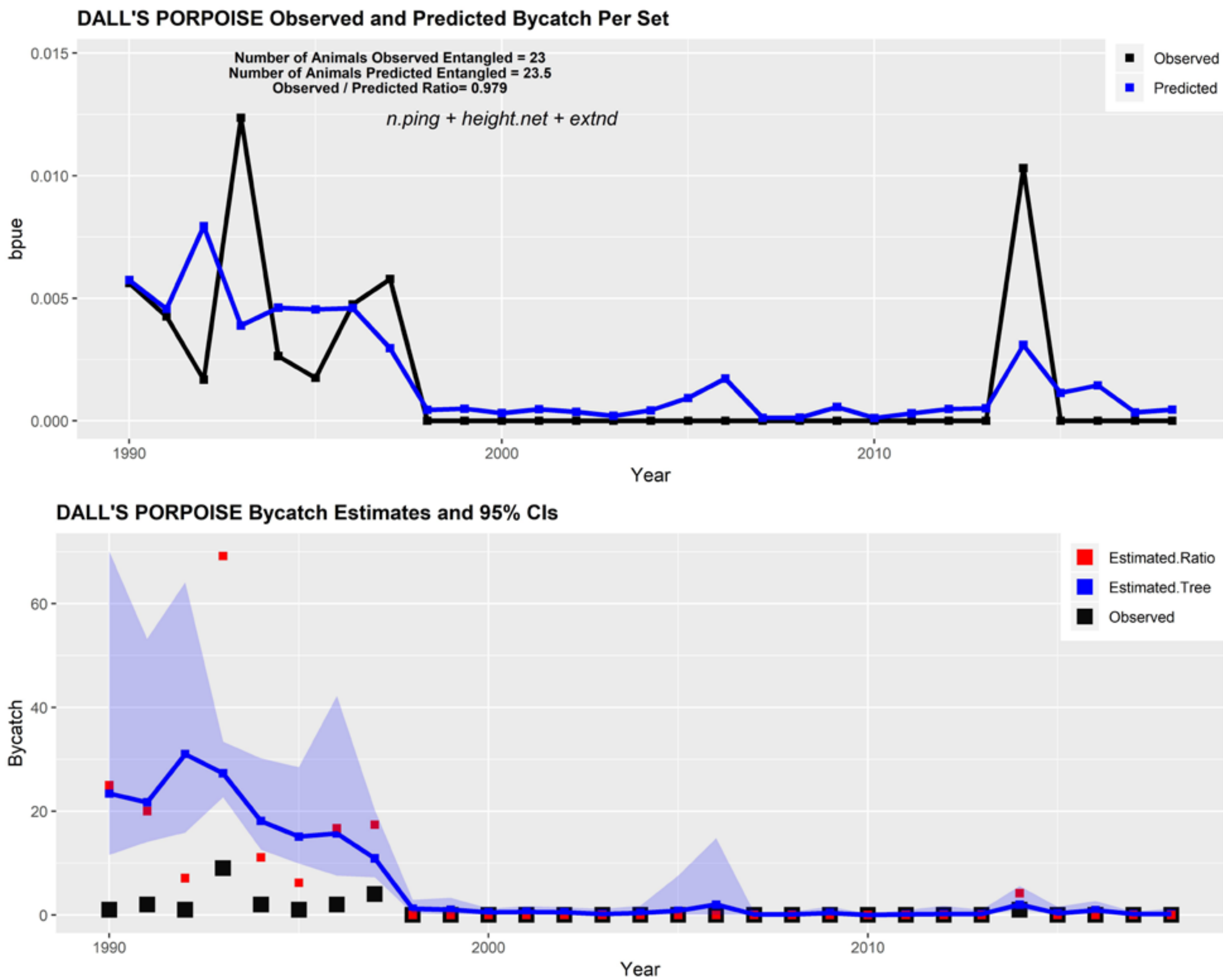

Figure 3-10. Observed and estimated bycatch of Cuvier's beaked whale. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

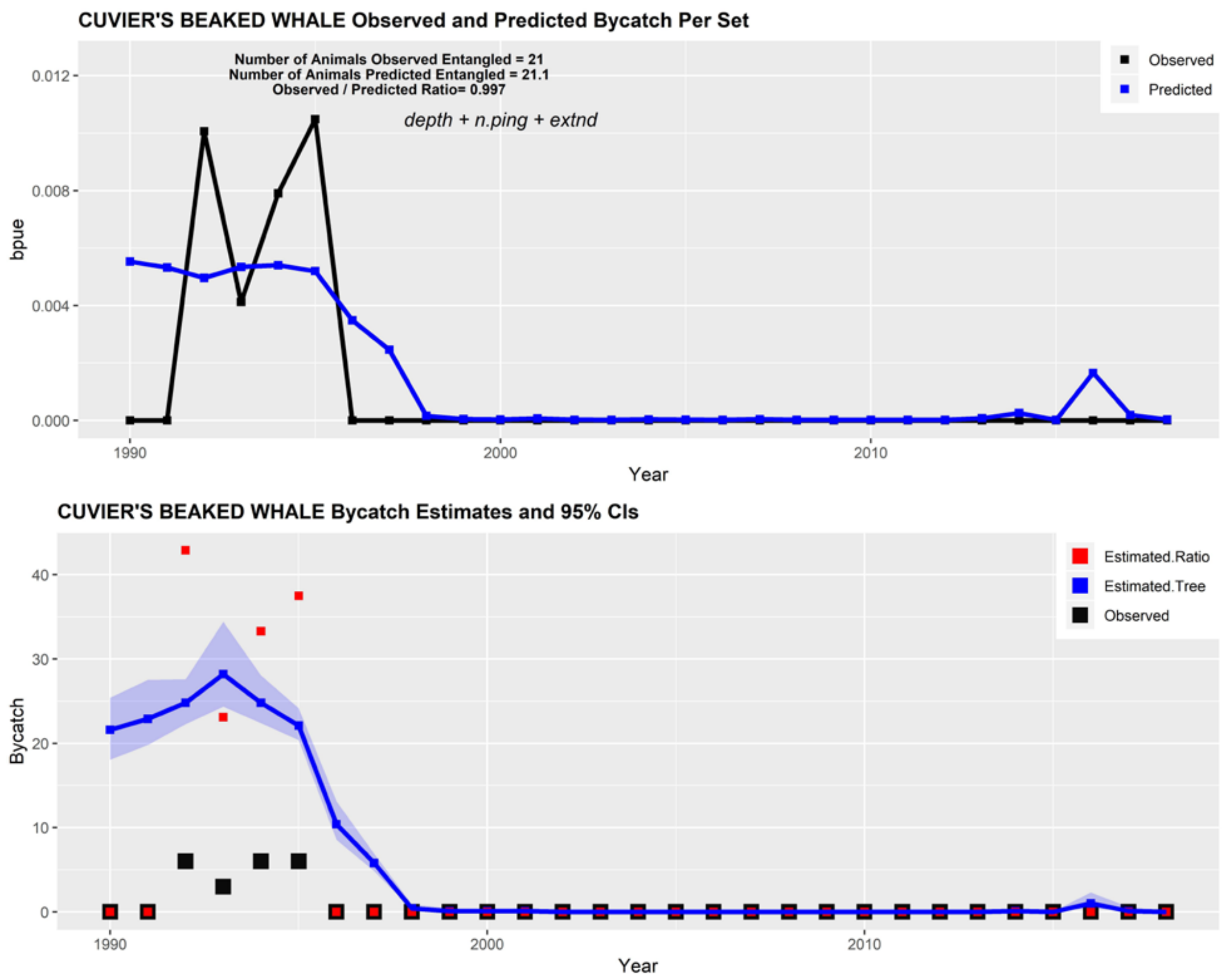

Figure 3-11. Observed and estimated bycatch of long-beaked common dolphin (*Delphinus delphis bairdii*). The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel 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. Variables used in each bycatch model are shown in the top panel.

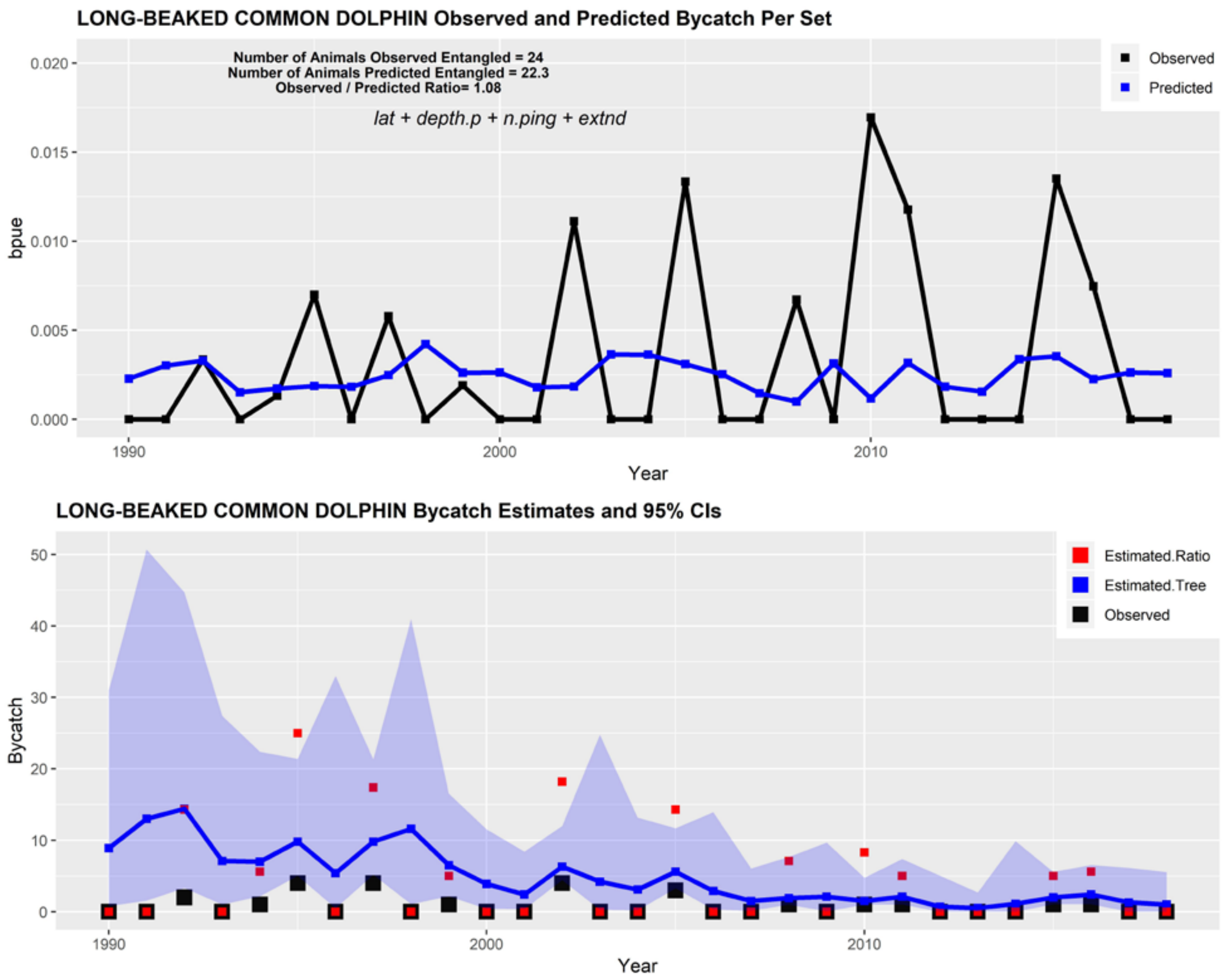

Figure 3-12. Observed and estimated bycatch of loggerhead sea turtles. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

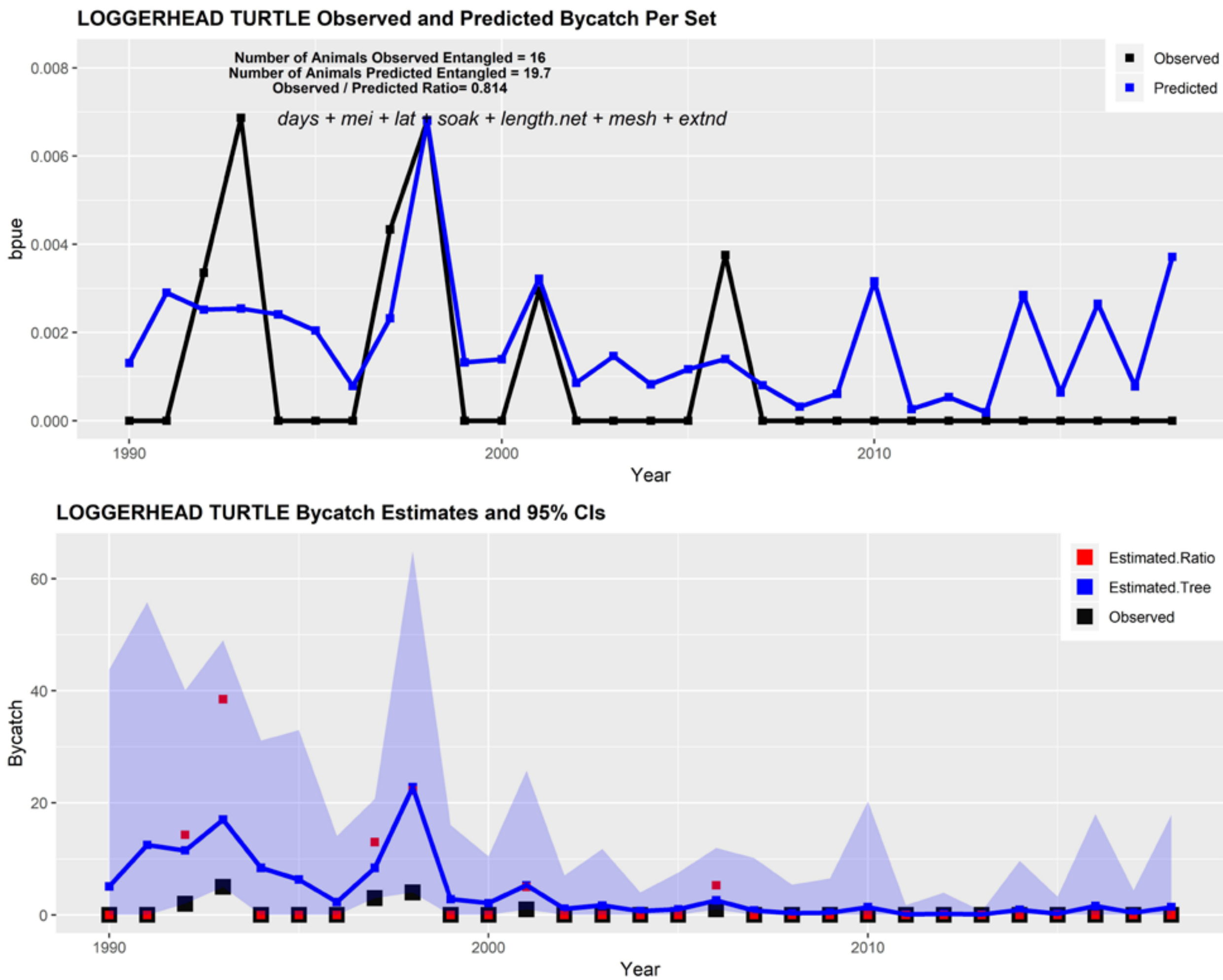

Figure 3-13. Observed and estimated bycatch of short-finned pilot whale. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch 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. Variables used in each bycatch model are shown in the top panel.

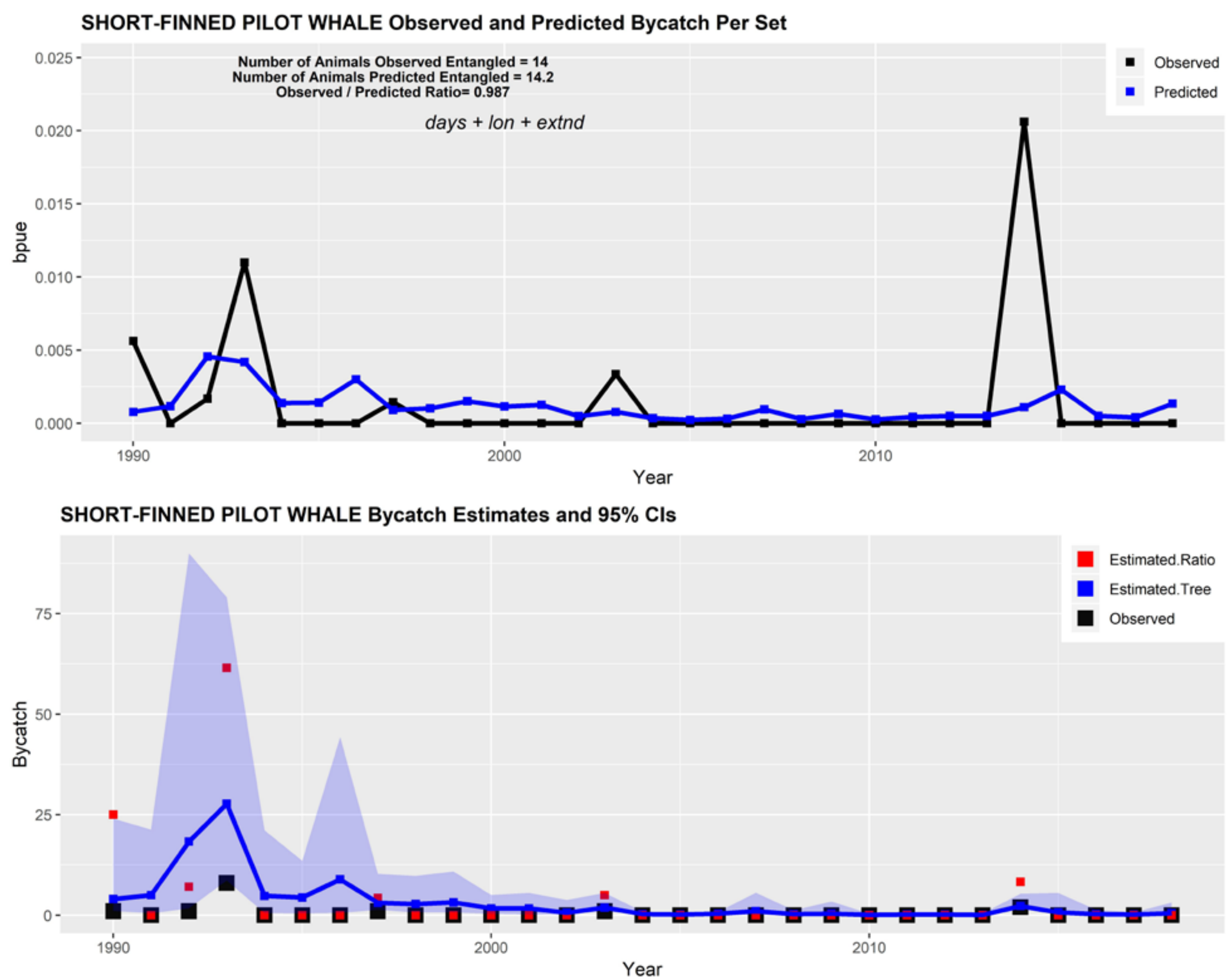

Figure 3-14. Observed and estimated bycatch of sperm whale. The top panel shows annual observed and predicted bycatch per fishing set. The ratio of observed to predicted bycatch is also shown for the cross-validated dataset of 9,085 fishing sets. Bottom panel shows observed annual bycatch and estimated total bycatch from both random forest regression trees and ratio estimates. Blue shading represents 95% confidence intervals for the random forest bycatch estimates. Variables used in each bycatch model are shown in the top panel.

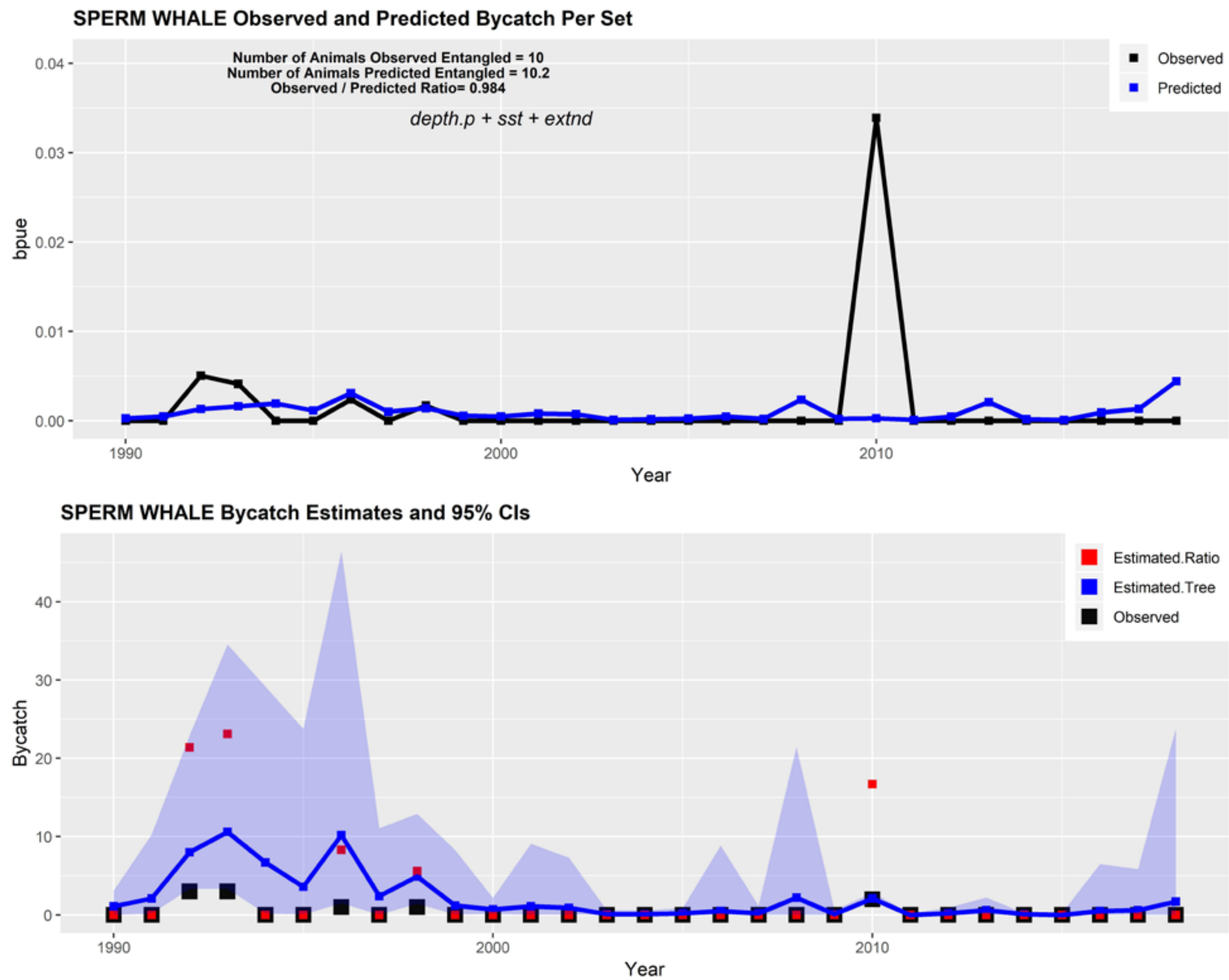

Figure 4. Observed drift gillnet fishing sets in 2018 (n=129).

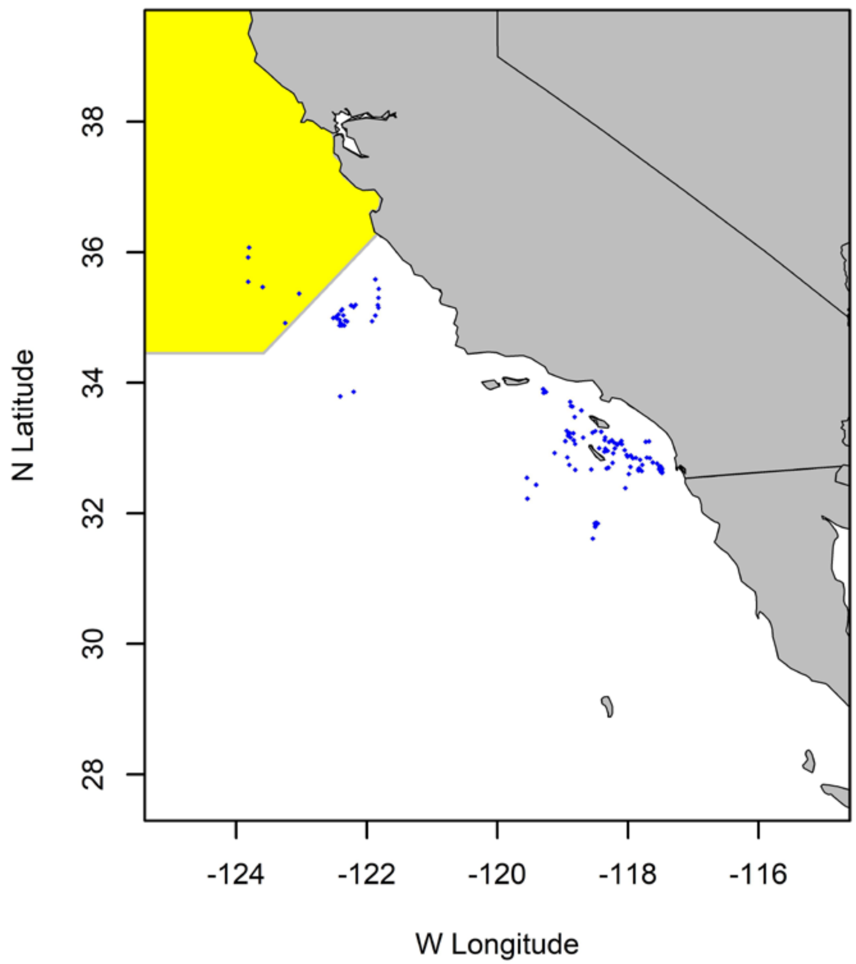

Figure 5. Violin plots of selected RF variables (*depth.p, sst, lat, days*) by year. Variables are shown to demonstrate variability of some of the commonly-used variables through the time series, but do not contribute to all species models. Median (●), mean (●), 25th and 75th percentiles are shown.

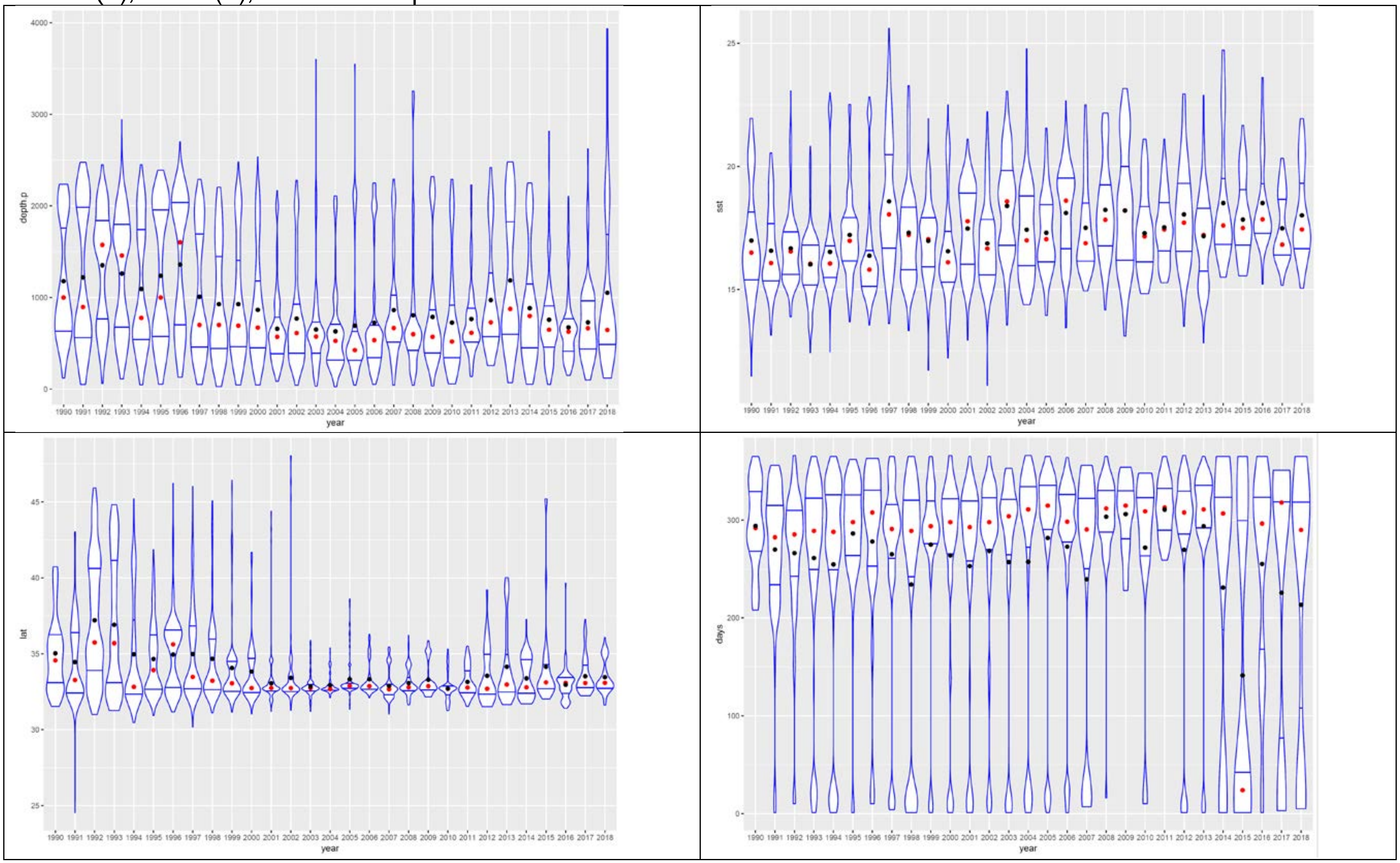

Table 1. Variables tested in random forest classification tree bycatch presence / absence models. A total of 500 random forest (RF) models were constructed, each consisting of 500 trees and each had a different set of variables (from n=2 to all 10 variables) selected for tree construction. The bootstrap 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)	0 - 3936
Extnd	top of net depth below surface in (feet)	3 - 99
height.net	Number of meshes from top to bottom of net	14 - 300
Lat	Latitude	24.5 - 48
length.net	Length of net (meters)	50 – 2000
Lon	Longitude	117 - 129
mei	Multivariate El Niño index (sum of anomalies for Aug - Jan)	-13.2 to +12.6
mesh	mesh size in inches	14 - 28
n.ping	Number of acoustic pingers	0 - 76
soak	Soak time of net in hours	1 - 62
SST	Sea surface temperature (C)	11.1 – 25.6

Table 2. Variable selection and model performance from bycatch presence / absence RF classification tree models constructed with equal sample sizes of fishing sets with and without bycatch. Variables identified in the classification tree step were then used to estimate bycatch with regression tree models. Variable selection was based on the variable suite associated with maximizing the correct prediction of bycatch presence (='specificity') through generation of 1,000 RF presence / absence models. Measures of overall model performance are given by the True Skill Statistic (TSS). The TSS ranges from +1 (perfect prediction) to -1 (always inaccurate), where scores less than zero indicating a prediction accuracy no better than random chance (Allouche *et al*. 2006). The TSS specificity score is equal to the number of entanglement events correctly classified for bycatch presence (last column), divided by the total number of entanglement events observed (first column).

Species	Entanglement Events	Number of Animals	Var1	Var2	Var3	Var4	Var5	Var6	Var7	Specificity	Sensitivity	Accuracy	TSS	Events Correctly Classified
ALL DELPHINOIDS	492	646	n.ping	length.net	height.net	-	-	-	-	0.640	0.526	0.533	0.167	315
Delphinus delphis delphis, SHORT-BEAKED COMMON DOLPHIN	340	428	lat	n.ping	length.net	-	-	-	-	0.659	0.581	0.584	0.240	224
Zalophus californianus, CALIFORNIA SEA LION	179	220	depth.p	n.ping	extnd	-	-	-	-	0.615	0.686	0.685	0.301	110
Mirounga angustirostris, NORTHERN ELEPHANT SEAL	114	118	mei	n.ping	height.net	-	-	-	-	0.816	0.560	0.563	0.376	93
Lissodelphis borealis, NORTHERN RIGHT WHALE DOLPHIN	58	80	lon	length.net	extnd	-	-	-	-	0.776	0.669	0.670	0.445	45
ALL BEAKED WHALES	33	33	days	mei	n.ping	-	-	-	-	0.970	0.720	0.721	0.690	32
Grampus griseus, RISSO'S DOLPHIN	27	35	days	mei	length.net	-	-	-	-	0.741	0.865	0.864	0.606	20
Lagenorhynchus obliquidens, PACIFIC WHITE-SIDED DOLPHIN	27	36	soak	n.ping	extnd	-	-	-	-	0.667	0.605	0.605	0.272	18
Dermochelys coriacea, LEATHERBACK SEA TURTLE	25	25	lon	sst	extnd	-	-	-	-	0.800	0.749	0.749	0.549	20
Phocoenoides dalli, DALL'S PORPOISE	21	23	n.ping	height.net	extnd	-	-	-	-	0.905	0.625	0.625	0.529	19
Ziphius cavirostris, CUVIER'S BEAKED WHALE	21	21	depth.p	n.ping	extnd	-	-	-	-	1.000	0.650	0.651	0.650	21
Fulmarus glacialis, NORTHERN FULMAR	20	36	days	mei	n.ping	length.net	-	-	-	0.950	0.867	0.868	0.817	19
Delphinus delphis bairdii, LONG-BEAKED COMMON DOLPHIN	18	24	lat	depth.p	n.ping	extnd	-	-	-	0.833	0.795	0.795	0.629	15
Caretta caretta, LOGGERHEAD SEA TURTLE	14	16	days	mei	lat	soak	length.net	mesh	extnd	0.929	0.842	0.842	0.771	13
Globicephala macrorhynchus, SHORT-FINNED PILOT WHALE	10	14	days	lon	extnd	-	-	-	-	0.800	0.763	0.763	0.563	8
Physeter macrocephalus, SPERM WHALE	6	10	depth.p	sst	extnd	-	-	-	-	0.833	0.790	0.790	0.623	5
Eschrichtius robustus, GRAY WHALE	5	5	soak	n.ping	extnd	-	-	-	-	0.800	0.849	0.849	0.649	4
Mesoplodon hubbsi, HUBB'S BEAKED WHALE	5	5	mei	depth.p	n.ping	-	-	-	-	1.000	0.724	0.724	0.724	5
UNID. BIRD	5	5	soak	height.net	extnd	-	-	-	-	0.600	0.732	0.732	0.332	3
Balaenoptera acutorostrata, MINKE WHALE	4	4	lat	soak	height.net	-	-	-	-	0.750	0.849	0.849	0.599	3

Table 3. MINKE WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.5) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	1.9	1.9	2.5	0	−	1	2.8
1991	470	0.1	0	3	3	0.95	0	−	1.5	1.2
1992	596	0.14	0	1.8	1.8	1	0	−	0.9	1.2
1993	728	0.13	0	2.8	2.8	0.95	0	−	1.4	1.1
1994	759	0.18	1	1.6	2.6	1.1	5.6	0.99	1.8	0.58
1995	572	0.16	0	2.7	2.7	1	0	−	1.3	1.3
1996	421	0.12	1	1.2	2.2	1.2	8.3	1	1.5	0.61
1997	692	0.23	0	0.3	0.3	1.1	0	−	0.1	1.2
1998	587	0.18	0	0.3	0.3	0.87	0	−	0.2	0.94
1999	526	0.2	1	0.4	1.4	0.31	5	1	0.2	1
2000	444	0.23	0	0.5	0.5	1.7	0	−	0.3	1.8
2001	339	0.2	0	0.5	0.5	1.7	0	−	0.3	2.2
2002	360	0.22	0	0.7	0.7	1.7	0	−	0.4	2.1
2003	298	0.2	0	0.2	0.2	2.7	0	−	0.1	4
2004	223	0.21	0	0.1	0.1	0.92	0	−	0	−
2005	225	0.21	0	0.1	0.1	0.92	0	−	0	−
2006	266	0.19	0	0.2	0.2	3.1	0	−	0.1	3.7
2007	204	0.16	0	1.5	1.5	1.5	0	−	0.8	1.7
2008	149	0.14	0	0.2	0.2	3.2	0	−	0.1	2.9
2009	101	0.13	0	0.2	0.2	4	0	−	0.1	4
2010	59	0.12	0	0.1	0.1	2.7	0	−	0	−
2011	85	0.2	1	0	1	0.055	5	0.99	0	−
2012	83	0.19	0	0.1	0.1	3.4	0	−	0	−
2013	175	0.37	0	0.1	0.1	0.87	0	−	0	−
2014	97	0.24	0	0.2	0.2	2.9	0	−	0.1	3.7
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.6	0.6	1.5	0	−	0.3	1.8
2017	111	0.19	0	0.2	0.2	2.5	0	−	0.1	3.1
2018	129	0.25	0	0.1	0.1	1.3	0	−	0	−
1990−2000	5973	0.15	3	14.8	17.8	0.41	20	0.59	9	0.51
2001−2018	3112	0.2	1	4.7	5.7	0.63	5	1	2.3	0.84
2014−2018	545	0.21	0	1	1	1.1	0	−	0.5	1.3

Table 4. FIN WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3.6	0	−	0.1	3.6
1991	470	0.1	0	0	0	−	0	−	0	−
1992	596	0.14	0	0.1	0.1	5.8	0	−	0.1	5.8
1993	728	0.13	0	0	0	−	0	−	0	−
1994	759	0.18	0	1.5	1.5	1.3	0	−	1.5	1.3
1995	572	0.16	0	0.1	0.1	3.3	0	−	0.1	3.3
1996	421	0.12	0	0.1	0.1	7.2	0	−	0.1	7.2
1997	692	0.23	0	0.8	0.8	1.7	0	−	0.8	1.7
1998	587	0.18	0	0.1	0.1	3.5	0	−	0.1	3.5
1999	526	0.2	1	0.3	1.3	0.76	5	1	1.3	0.76
2000	444	0.23	0	0.3	0.3	2.5	0	−	0.3	2.5
2001	339	0.2	0	0.1	0.1	2.3	0	−	0.1	2.3
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	3.6	0	−	0.1	3.6
2007	204	0.16	0	0.1	0.1	4.1	0	−	0.1	4.1
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	2.6	0	−	0.3	2.6
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0.1	0.1	2.7	0	−	0.1	2.7
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	4.6	5.6	0.82	6.7	1	5.6	0.82
2001−2018	3112	0.2	0	0.9	0.9	1.3	0	−	0.9	1.3
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 5. GRAY WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.3	0.3	2.4	0	−	0.3	2.4
1991	470	0.1	0	0.3	0.3	0.47	0	−	0.3	0.47
1992	596	0.14	0	0.2	0.2	0.43	0	−	0.2	0.43
1993	728	0.13	0	0.4	0.4	0.87	0	−	0.4	0.87
1994	759	0.18	0	0.3	0.3	0.53	0	−	0.3	0.53
1995	572	0.16	0	0.2	0.2	0.69	0	−	0.2	0.69
1996	421	0.12	0	1	1	0.83	0	−	1	0.83
1997	692	0.23	0	1	1	0.49	0	−	1	0.49
1998	587	0.18	1	3.2	4.2	0.79	5.6	1	4.2	0.79
1999	526	0.2	1	2	3	0.32	5	0.97	3	0.32
2000	444	0.23	0	1.6	1.6	0.36	0	−	1.6	0.36
2001	339	0.2	0	0.9	0.9	0.28	0	−	0.9	0.28
2002	360	0.22	0	1.4	1.4	0.5	0	−	1.4	0.5
2003	298	0.2	0	1	1	0.32	0	−	1	0.32
2004	223	0.21	0	0.6	0.6	0.38	0	−	0.6	0.38
2005	225	0.21	1	0.8	1.8	0.18	4.8	1	1.8	0.18
2006	266	0.19	0	0.9	0.9	0.3	0	−	0.9	0.3
2007	204	0.16	0	1	1	0.36	0	−	1	0.36
2008	149	0.14	0	1.1	1.1	0.63	0	−	1.1	0.63
2009	101	0.13	0	0.4	0.4	0.46	0	−	0.4	0.46
2010	59	0.12	0	0.2	0.2	0.54	0	−	0.2	0.54
2011	85	0.2	0	0.2	0.2	0.49	0	−	0.2	0.49
2012	83	0.19	0	0.2	0.2	0.4	0	−	0.2	0.4
2013	175	0.37	1	0.3	1.3	0.15	2.7	0.99	1.3	0.15
2014	97	0.24	0	0.3	0.3	0.62	0	−	0.3	0.62
2015	74	0.2	0	0.3	0.3	0.35	0	−	0.3	0.35
2016	134	0.18	0	0.2	0.2	0.65	0	−	0.2	0.65
2017	111	0.19	0	0.5	0.5	1.1	0	−	0.5	1.1
2018	129	0.25	1	0.3	1.3	0.16	4	1	1.3	0.16
1990−2000	5973	0.15	2	13.6	15.6	0.26	13.3	0.71	15.6	0.26
2001−2018	3112	0.2	3	10.7	13.7	0.13	15	0.58	13.7	0.13
2014−2018	545	0.21	1	1.6	2.6	0.37	4.8	0.99	2.6	0.37

Table 6. HUMPBACK WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.25) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	5.4	0	−	0	−
1991	470	0.1	0	1.4	1.4	2.1	0	−	0.3	3.2
1992	596	0.14	0	1.1	1.1	2.1	0	−	0.3	3.4
1993	728	0.13	0	0.4	0.4	2.7	0	−	0.1	3.9
1994	759	0.18	1	1.7	2.7	1.1	5.6	1	0.4	1.7
1995	572	0.16	0	0.3	0.3	2.4	0	−	0.1	3.2
1996	421	0.12	0	0.2	0.2	3.7	0	−	0	−
1997	692	0.23	0	0.1	0.1	3.6	0	−	0	−
1998	587	0.18	0	2.1	2.1	1.2	0	−	0.5	2
1999	526	0.2	1	0.4	1.4	0.94	5	1	0.1	4.6
2000	444	0.23	0	0.2	0.2	2.7	0	−	0.1	3.7
2001	339	0.2	0	0.9	0.9	1.7	0	−	0.2	2.2
2002	360	0.22	0	0.7	0.7	1.8	0	−	0.2	3.1
2003	298	0.2	0	0.6	0.6	2	0	−	0.1	3.1
2004	223	0.21	1	0.1	1.1	0.34	4.8	0.99	0	−
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.1	0.1	2.4	0	−	0	−
2007	204	0.16	0	0.5	0.5	2.3	0	−	0.1	4.2
2008	149	0.14	0	0.2	0.2	4.2	0	−	0.1	4.8
2009	101	0.13	0	0.1	0.1	7.6	0	−	0	−
2010	59	0.12	0	0.5	0.5	3.4	0	−	0.1	5.5
2011	85	0.2	0	0.4	0.4	2.8	0	−	0.1	3.8
2012	83	0.19	0	0.1	0.1	4.7	0	−	0	−
2013	175	0.37	0	0.2	0.2	2.6	0	−	0.1	2.7
2014	97	0.24	0	0.2	0.2	2.9	0	−	0.1	3.6
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	6	0	−	0	−
2017	111	0.19	0	0.2	0.2	4	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	8.7	10.7	0.62	13.3	0.71	2.1	1.3
2001−2018	3112	0.2	1	4.9	5.9	0.73	5	1	1.2	1.4
2014−2018	545	0.21	0	0.5	0.5	2.2	0	−	0.1	3

Table 7. SHORT−BEAKED COMMON DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	267.9	275.9	0.2	200	0.47	275.9	0.2
1991	470	0.1	44	267.9	311.9	0.091	440	0.2	311.9	0.091
1992	596	0.14	45	204.9	249.9	0.084	321.4	0.18	249.9	0.084
1993	728	0.13	28	220.2	248.2	0.12	215.4	0.28	248.2	0.12
1994	759	0.18	26	215.6	241.6	0.071	144.4	0.21	241.6	0.071
1995	572	0.16	38	207.6	245.6	0.081	237.5	0.23	245.6	0.081
1996	421	0.12	28	161.3	189.3	0.14	233.3	0.21	189.3	0.14
1997	692	0.23	22	111.3	133.3	0.14	95.7	0.23	133.3	0.14
1998	587	0.18	9	109.9	118.9	0.2	50	0.33	118.9	0.2
1999	526	0.2	36	86.1	122.1	0.21	180	0.24	122.1	0.21
2000	444	0.23	25	54.7	79.7	0.25	108.7	0.24	79.7	0.25
2001	339	0.2	7	42.2	49.2	0.32	35	0.43	49.2	0.32
2002	360	0.22	7	48.7	55.7	0.31	31.8	0.42	55.7	0.31
2003	298	0.2	17	54.5	71.5	0.28	85	0.31	71.5	0.28
2004	223	0.21	7	43.6	50.6	0.46	33.3	0.42	50.6	0.46
2005	225	0.21	12	29	41	0.33	57.1	0.28	41	0.33
2006	266	0.19	7	39.8	46.8	0.35	36.8	0.47	46.8	0.35
2007	204	0.16	9	64.3	73.3	0.46	56.2	0.36	73.3	0.46
2008	149	0.14	8	34.6	42.6	0.43	57.1	0.45	42.6	0.43
2009	101	0.13	1	19.5	20.5	0.69	7.7	0.99	20.5	0.69
2010	59	0.12	3	21.4	24.4	0.8	25	0.74	24.4	0.8
2011	85	0.2	2	12.5	14.5	0.53	10	0.69	14.5	0.53
2012	83	0.19	5	18.1	23.1	0.49	26.3	0.59	23.1	0.49
2013	175	0.37	6	10.9	16.9	0.44	16.2	0.4	16.9	0.44
2014	97	0.24	6	8.8	14.8	0.61	25	0.47	14.8	0.61
2015	74	0.2	0	9.4	9.4	0.7	0	−	9.4	0.7
2016	134	0.18	4	15.8	19.8	0.51	22.2	0.5	19.8	0.51
2017	111	0.19	16	26.7	42.7	0.46	84.2	0.36	42.7	0.46
2018	129	0.25	2	14.9	16.9	0.55	8	0.71	16.9	0.55
1990−2000	5973	0.15	309	1813.6	2122.6	0.04	2060	0.07	2122.6	0.04
2001−2018	3112	0.2	119	509.9	628.9	0.1	595	0.11	628.9	0.1
2014−2018	545	0.21	28	75.2	103.2	0.25	133.3	0.25	103.2	0.25

Table 8. LONG−BEAKED COMMON DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	8.9	8.9	0.91	0	−	8.9	0.91
1991	470	0.1	0	13	13	0.98	0	−	13	0.98
1992	596	0.14	2	12.4	14.4	0.86	14.3	0.7	14.4	0.86
1993	728	0.13	0	7.1	7.1	0.86	0	−	7.1	0.86
1994	759	0.18	1	6	7	0.79	5.6	1	7	0.79
1995	572	0.16	4	5.8	9.8	0.71	25	0.99	9.8	0.71
1996	421	0.12	0	5.4	5.4	1.5	0	−	5.4	1.5
1997	692	0.23	4	5.8	9.8	0.68	17.4	0.61	9.8	0.68
1998	587	0.18	0	11.6	11.6	0.9	0	−	11.6	0.9
1999	526	0.2	1	5.5	6.5	0.65	5	1	6.5	0.65
2000	444	0.23	0	3.9	3.9	0.71	0	−	3.9	0.71
2001	339	0.2	0	2.4	2.4	0.85	0	−	2.4	0.85
2002	360	0.22	4	2.3	6.3	0.4	18.2	0.78	6.3	0.4
2003	298	0.2	0	4.2	4.2	1.4	0	−	4.2	1.4
2004	223	0.21	0	3.1	3.1	1.2	0	−	3.1	1.2
2005	225	0.21	3	2.6	5.6	0.5	14.3	0.58	5.6	0.5
2006	266	0.19	0	2.9	2.9	1.1	0	−	2.9	1.1
2007	204	0.16	0	1.5	1.5	1.3	0	−	1.5	1.3
2008	149	0.14	1	0.9	1.9	1.4	7.1	0.99	1.9	1.4
2009	101	0.13	0	2.1	2.1	1.4	0	−	2.1	1.4
2010	59	0.12	1	0.5	1.5	0.7	8.3	0.99	1.5	0.7
2011	85	0.2	1	1.1	2.1	1.9	5	0.99	2.1	1.9
2012	83	0.19	0	0.7	0.7	2	0	−	0.7	2
2013	175	0.37	0	0.5	0.5	1.6	0	−	0.5	1.6
2014	97	0.24	0	1.1	1.1	2.3	0	−	1.1	2.3
2015	74	0.2	1	1	2	2.3	5	1	2	2.3
2016	134	0.18	1	1.4	2.4	1.1	5.6	1	2.4	1.1
2017	111	0.19	0	1.3	1.3	1.4	0	−	1.3	1.4
2018	129	0.25	0	1	1	1.4	0	−	1	1.4
1990−2000	5973	0.15	12	86.4	98.4	0.28	80	0.42	98.4	0.28
2001−2018	3112	0.2	12	31.1	43.1	0.34	60	0.36	43.1	0.34
2014−2018	545	0.21	2	5.8	7.8	0.75	9.5	0.7	7.8	0.75

Table 9. RISSO'S DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	4.1	4.1	1.5	0	−	4.1	1.5
1991	470	0.1	5	29.1	34.1	0.35	50	0.44	34.1	0.35
1992	596	0.14	5	32.4	37.4	0.33	35.7	0.44	37.4	0.33
1993	728	0.13	7	35.1	42.1	0.22	53.8	0.43	42.1	0.22
1994	759	0.18	1	9.6	10.6	0.63	5.6	1	10.6	0.63
1995	572	0.16	6	26.2	32.2	0.28	37.5	0.62	32.2	0.28
1996	421	0.12	0	5.2	5.2	1.3	0	−	5.2	1.3
1997	692	0.23	3	5.7	8.7	0.91	13	0.75	8.7	0.91
1998	587	0.18	0	7.6	7.6	0.52	0	−	7.6	0.52
1999	526	0.2	0	2.9	2.9	0.75	0	−	2.9	0.75
2000	444	0.23	2	6.8	8.8	0.79	8.7	0.71	8.8	0.79
2001	339	0.2	0	1.7	1.7	1.3	0	−	1.7	1.3
2002	360	0.22	0	1	1	2.2	0	−	1	2.2
2003	298	0.2	4	13.1	17.1	0.65	20	1	17.1	0.65
2004	223	0.21	0	3.1	3.1	0.87	0	−	3.1	0.87
2005	225	0.21	0	1	1	1.1	0	−	1	1.1
2006	266	0.19	0	2.7	2.7	1.7	0	−	2.7	1.7
2007	204	0.16	0	1.9	1.9	1.6	0	−	1.9	1.6
2008	149	0.14	1	2.6	3.6	1.2	7.1	0.99	3.6	1.2
2009	101	0.13	0	1.7	1.7	1.1	0	−	1.7	1.1
2010	59	0.12	0	0.8	0.8	2.3	0	−	0.8	2.3
2011	85	0.2	1	4.8	5.8	1.2	5	0.99	5.8	1.2
2012	83	0.19	0	0.2	0.2	1.9	0	−	0.2	1.9
2013	175	0.37	0	0.3	0.3	1.7	0	−	0.3	1.7
2014	97	0.24	0	0.1	0.1	2.1	0	−	0.1	2.1
2015	74	0.2	0	1.4	1.4	1	0	−	1.4	1
2016	134	0.18	0	1.1	1.1	2.3	0	−	1.1	2.3
2017	111	0.19	0	0.7	0.7	2.1	0	−	0.7	2.1
2018	129	0.25	0	0.3	0.3	2.5	0	−	0.3	2.5
1990−2000	5973	0.15	29	161.7	190.7	0.13	193.3	0.22	190.7	0.13
2001−2018	3112	0.2	6	37.6	43.6	0.35	30	0.69	43.6	0.35
2014−2018	545	0.21	0	3.4	3.4	0.88	0	−	3.4	0.88

Table 10. SHORT−FINNED PILOT WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3	4	1.8	25	1	4	1.8
1991	470	0.1	0	5	5	1.2	0	−	5	1.2
1992	596	0.14	1	17.3	18.3	1.3	7.1	1	18.3	1.3
1993	728	0.13	8	19.7	27.7	1.1	61.5	0.57	27.7	1.1
1994	759	0.18	0	4.8	4.8	1	0	−	4.8	1
1995	572	0.16	0	4.4	4.4	0.79	0	−	4.4	0.79
1996	421	0.12	0	8.9	8.9	1.3	0	−	8.9	1.3
1997	692	0.23	1	2.1	3.1	1.1	4.3	0.99	3.1	1.1
1998	587	0.18	0	2.8	2.8	0.85	0	−	2.8	0.85
1999	526	0.2	0	3.2	3.2	0.85	0	−	3.2	0.85
2000	444	0.23	0	1.7	1.7	0.89	0	−	1.7	0.89
2001	339	0.2	0	1.7	1.7	1.1	0	−	1.7	1.1
2002	360	0.22	0	0.6	0.6	1.2	0	−	0.6	1.2
2003	298	0.2	1	0.9	1.9	0.68	5	1	1.9	0.68
2004	223	0.21	0	0.3	0.3	0.77	0	−	0.3	0.77
2005	225	0.21	0	0.2	0.2	0.71	0	−	0.2	0.71
2006	266	0.19	0	0.4	0.4	0.55	0	−	0.4	0.55
2007	204	0.16	0	1	1	1.4	0	−	1	1.4
2008	149	0.14	0	0.3	0.3	1.9	0	−	0.3	1.9
2009	101	0.13	0	0.4	0.4	2.3	0	−	0.4	2.3
2010	59	0.12	0	0.1	0.1	1.3	0	−	0.1	1.3
2011	85	0.2	0	0.2	0.2	1.3	0	−	0.2	1.3
2012	83	0.19	0	0.2	0.2	0.99	0	−	0.2	0.99
2013	175	0.37	0	0.1	0.1	1.4	0	−	0.1	1.4
2014	97	0.24	2	0.3	2.3	0.4	8.3	0.71	2.3	0.4
2015	74	0.2	0	0.7	0.7	2	0	−	0.7	2
2016	134	0.18	0	0.3	0.3	1.6	0	−	0.3	1.6
2017	111	0.19	0	0.2	0.2	2.4	0	−	0.2	2.4
2018	129	0.25	0	0.5	0.5	1.8	0	−	0.5	1.8
1990−2000	5973	0.15	11	70.8	81.8	0.44	73.3	0.46	81.8	0.44
2001−2018	3112	0.2	3	8.6	11.6	0.41	15	0.58	11.6	0.41
2014−2018	545	0.21	2	2.1	4.1	0.95	9.5	0.7	4.1	0.95

Table 11. PAC. WHITE−SIDED DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	22.8	25.8	0.19	75	0.57	25.8	0.19
1991	470	0.1	5	23.1	28.1	0.3	50	0.66	28.1	0.3
1992	596	0.14	3	23.2	26.2	0.2	21.4	0.75	26.2	0.2
1993	728	0.13	2	20	22	0.1	15.4	0.71	22	0.1
1994	759	0.18	3	14	17	0.1	16.7	0.74	17	0.1
1995	572	0.16	1	14.9	15.9	0.098	6.2	1	15.9	0.098
1996	421	0.12	3	13.1	16.1	0.37	25	0.75	16.1	0.37
1997	692	0.23	3	9.3	12.3	0.36	13	0.57	12.3	0.36
1998	587	0.18	0	7.7	7.7	0.32	0	−	7.7	0.32
1999	526	0.2	0	6.1	6.1	0.35	0	−	6.1	0.35
2000	444	0.23	2	4.3	6.3	0.58	8.7	0.71	6.3	0.58
2001	339	0.2	2	3.3	5.3	0.31	10	0.7	5.3	0.31
2002	360	0.22	1	3.2	4.2	0.52	4.5	0.99	4.2	0.52
2003	298	0.2	0	2.6	2.6	0.28	0	−	2.6	0.28
2004	223	0.21	0	1.8	1.8	0.27	0	−	1.8	0.27
2005	225	0.21	0	1.6	1.6	0.31	0	−	1.6	0.31
2006	266	0.19	0	3.4	3.4	0.93	0	−	3.4	0.93
2007	204	0.16	1	2	3	0.36	6.2	1	3	0.36
2008	149	0.14	5	2.4	7.4	0.23	35.7	0.71	7.4	0.23
2009	101	0.13	2	0.9	2.9	0.12	15.4	0.99	2.9	0.12
2010	59	0.12	0	0.8	0.8	0.54	0	−	0.8	0.54
2011	85	0.2	0	0.8	0.8	0.56	0	−	0.8	0.56
2012	83	0.19	0	1.1	1.1	1.6	0	−	1.1	1.6
2013	175	0.37	0	0.6	0.6	0.55	0	−	0.6	0.55
2014	97	0.24	0	0.7	0.7	1.5	0	−	0.7	1.5
2015	74	0.2	0	0.5	0.5	1.1	0	−	0.5	1.1
2016	134	0.18	0	1.9	1.9	0.5	0	−	1.9	0.5
2017	111	0.19	0	1	1	0.44	0	−	1	0.44
2018	129	0.25	0	3.9	3.9	1	0	−	3.9	1
1990−2000	5973	0.15	25	147.4	172.4	0.08	166.7	0.24	172.4	0.08
2001−2018	3112	0.2	11	33.6	44.6	0.22	55	0.42	44.6	0.22
2014−2018	545	0.21	0	8.8	8.8	0.61	0	−	8.8	0.61

Table 12. N. RIGHT WHALE DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	69	69	0.86	0	−	69	0.86
1991	470	0.1	7	40.4	47.4	0.39	70	0.43	47.4	0.39
1992	596	0.14	2	44.3	46.3	0.36	14.3	0.72	46.3	0.36
1993	728	0.13	7	48	55	0.41	53.8	0.43	55	0.41
1994	759	0.18	7	28.9	35.9	0.34	38.9	0.43	35.9	0.34
1995	572	0.16	9	24.7	33.7	0.41	56.2	0.65	33.7	0.41
1996	421	0.12	5	23.4	28.4	0.43	41.7	0.66	28.4	0.43
1997	692	0.23	5	16.1	21.1	0.41	21.7	0.44	21.1	0.41
1998	587	0.18	0	25.6	25.6	0.43	0	−	25.6	0.43
1999	526	0.2	3	22.8	25.8	0.71	15	0.58	25.8	0.71
2000	444	0.23	11	9.9	20.9	0.24	47.8	0.49	20.9	0.24
2001	339	0.2	5	11.7	16.7	0.56	25	0.53	16.7	0.56
2002	360	0.22	2	9.3	11.3	0.48	9.1	0.71	11.3	0.48
2003	298	0.2	1	12.9	13.9	0.98	5	1	13.9	0.98
2004	223	0.21	1	3.9	4.9	0.71	4.8	0.99	4.9	0.71
2005	225	0.21	0	1.9	1.9	0.83	0	−	1.9	0.83
2006	266	0.19	0	4.9	4.9	0.46	0	−	4.9	0.46
2007	204	0.16	1	7.1	8.1	0.5	6.2	1	8.1	0.5
2008	149	0.14	1	7.3	8.3	1.4	7.1	1	8.3	1.4
2009	101	0.13	0	4.5	4.5	0.94	0	−	4.5	0.94
2010	59	0.12	1	2.3	3.3	0.72	8.3	1	3.3	0.72
2011	85	0.2	1	7.8	8.8	0.82	5	1	8.8	0.82
2012	83	0.19	1	2.9	3.9	0.85	5.3	1	3.9	0.85
2013	175	0.37	2	2.2	4.2	0.52	5.4	1	4.2	0.52
2014	97	0.24	1	2.3	3.3	0.53	4.2	1	3.3	0.53
2015	74	0.2	0	3	3	0.47	0	−	3	0.47
2016	134	0.18	5	3.1	8.1	0.47	27.8	0.72	8.1	0.47
2017	111	0.19	2	6	8	0.73	10.5	0.69	8	0.73
2018	129	0.25	0	4.2	4.2	0.86	0	−	4.2	0.86
1990−2000	5973	0.15	56	321.5	377.5	0.15	373.3	0.19	377.5	0.15
2001−2018	3112	0.2	24	98.3	122.3	0.2	120	0.25	122.3	0.2
2014−2018	545	0.21	8	18.8	26.8	0.36	38.1	0.5	26.8	0.36

Table 13. KILLER WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	6.4	0	−	0.2	6.4
1991	470	0.1	0	0.7	0.7	2.6	0	−	0.7	2.6
1992	596	0.14	0	0.6	0.6	2.6	0	−	0.6	2.6
1993	728	0.13	0	0.8	0.8	2	0	−	0.8	2
1994	759	0.18	0	0	0	−	0	−	0	−
1995	572	0.16	1	0	1	0.3	6.2	1	1	0.3
1996	421	0.12	0	1.8	1.8	1.8	0	−	1.8	1.8
1997	692	0.23	0	0.9	0.9	1.4	0	−	0.9	1.4
1998	587	0.18	0	0.4	0.4	2.9	0	−	0.4	2.9
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	0.3	0.3	4.1	0	−	0.3	4.1
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0	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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5.5	6.5	0.83	6.7	1.01	6.5	0.83
2001−2018	3112	0.2	0	0.4	0.4	2.2	0	−	0.4	2.2
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 14. DALL'S PORPOISE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	22.4	23.4	0.65	25	1	23.4	0.65
1991	470	0.1	2	19.7	21.7	0.39	20	0.69	21.7	0.39
1992	596	0.14	1	30	31	0.38	7.1	1	31	0.38
1993	728	0.13	9	18.3	27.3	0.14	69.2	0.37	27.3	0.14
1994	759	0.18	2	16.1	18.1	0.27	11.1	0.7	18.1	0.27
1995	572	0.16	1	14.1	15.1	0.28	6.2	1	15.1	0.28
1996	421	0.12	2	13.7	15.7	0.62	16.7	0.7	15.7	0.62
1997	692	0.23	4	6.9	10.9	0.42	17.4	0.61	10.9	0.42
1998	587	0.18	0	1.2	1.2	1.4	0	−	1.2	1.4
1999	526	0.2	0	1	1	0.82	0	−	1	0.82
2000	444	0.23	0	0.5	0.5	0.68	0	−	0.5	0.68
2001	339	0.2	0	0.6	0.6	0.63	0	−	0.6	0.63
2002	360	0.22	0	0.5	0.5	2.2	0	−	0.5	2.2
2003	298	0.2	0	0.2	0.2	1.3	0	−	0.2	1.3
2004	223	0.21	0	0.4	0.4	1.3	0	−	0.4	1.3
2005	225	0.21	0	0.8	0.8	1.7	0	−	0.8	1.7
2006	266	0.19	0	2	2	2	0	−	2	2
2007	204	0.16	0	0.1	0.1	0.97	0	−	0.1	0.97
2008	149	0.14	0	0.1	0.1	1.6	0	−	0.1	1.6
2009	101	0.13	0	0.4	0.4	1.1	0	−	0.4	1.1
2010	59	0.12	0	0	0	−	0	−	0	−
2011	85	0.2	0	0.1	0.1	2.2	0	−	0.1	2.2
2012	83	0.19	0	0.2	0.2	2.7	0	−	0.2	2.7
2013	175	0.37	0	0.2	0.2	1.5	0	−	0.2	1.5
2014	97	0.24	1	1	2	1.5	4.2	0.99	2	1.5
2015	74	0.2	0	0.3	0.3	1.2	0	−	0.3	1.2
2016	134	0.18	0	0.9	0.9	0.73	0	−	0.9	0.73
2017	111	0.19	0	0.2	0.2	1.1	0	−	0.2	1.1
2018	129	0.25	0	0.2	0.2	1.6	0	−	0.2	1.6
1990−2000	5973	0.15	22	125.7	147.7	0.13	146.7	0.23	147.7	0.13
2001−2018	3112	0.2	1	8.4	9.4	0.55	5	1.01	9.4	0.55
2014−2018	545	0.21	1	2.6	3.6	0.63	4.8	1.01	3.6	0.63

Table 15. STRIPED DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.3	0.3	1.6	0	−	0.3	1.6
1993	728	0.13	0	2.8	2.8	7.4	0	−	2.8	7.4
1994	759	0.18	1	1.1	2.1	7.4	5.6	0.98	2.1	7.4
1995	572	0.16	0	0.1	0.1	7.4	0	−	0.1	7.4
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	3.7	0	−	0.1	3.7
1999	526	0.2	0	0.2	0.2	3.7	0	−	0.2	3.7
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	4.9	5.9	0.85	6.7	0.99	5.9	0.85
2001−2018	3112	0.2	0	0	0	−	0	−	0	−
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 16. BOTTLENOSE DOLPHIN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.55	0	−	1.2	0.55
1991	470	0.1	0	1.1	1.1	1.1	0	−	1.1	1.1
1992	596	0.14	3	5.5	8.5	2	21.4	1	8.5	2
1993	728	0.13	0	5	5	1.5	0	−	5	1.5
1994	759	0.18	0	0.8	0.8	1.5	0	−	0.8	1.5
1995	572	0.16	0	1	1	2.2	0	−	1	2.2
1996	421	0.12	0	0.9	0.9	0.49	0	−	0.9	0.49
1997	692	0.23	0	0.5	0.5	0.69	0	−	0.5	0.69
1998	587	0.18	0	1	1	0.53	0	−	1	0.53
1999	526	0.2	0	0.8	0.8	0.36	0	−	0.8	0.36
2000	444	0.23	0	0.4	0.4	0.47	0	−	0.4	0.47
2001	339	0.2	0	0.3	0.3	0.46	0	−	0.3	0.46
2002	360	0.22	0	0.4	0.4	0.49	0	−	0.4	0.49
2003	298	0.2	0	0.2	0.2	0.57	0	−	0.2	0.57
2004	223	0.21	0	0.3	0.3	0.62	0	−	0.3	0.62
2005	225	0.21	0	0.2	0.2	0.76	0	−	0.2	0.76
2006	266	0.19	0	0.4	0.4	0.76	0	−	0.4	0.76
2007	204	0.16	0	0.5	0.5	1.1	0	−	0.5	1.1
2008	149	0.14	0	0.2	0.2	1.1	0	−	0.2	1.1
2009	101	0.13	0	0.1	0.1	1.1	0	−	0.1	1.1
2010	59	0.12	1	0.1	1.1	0.089	8.3	0.99	1.1	0.089
2011	85	0.2	0	0.2	0.2	0.99	0	−	0.2	0.99
2012	83	0.19	0	0.2	0.2	0.92	0	−	0.2	0.92
2013	175	0.37	0	0.3	0.3	0.81	0	−	0.3	0.81
2014	97	0.24	0	0.3	0.3	1.1	0	−	0.3	1.1
2015	74	0.2	0	0.1	0.1	0.81	0	−	0.1	0.81
2016	134	0.18	0	0.3	0.3	0.64	0	−	0.3	0.64
2017	111	0.19	0	0.1	0.1	0.85	0	−	0.1	0.85
2018	129	0.25	0	0.1	0.1	0.75	0	−	0.1	0.75
1990−2000	5973	0.15	3	17.4	20.4	0.73	20	1.01	20.4	0.73
2001−2018	3112	0.2	1	4.7	5.7	0.22	5	0.99	5.7	0.22
2014−2018	545	0.21	0	1	1	0.5	0	−	1	0.5

Table 17. PYGMY SPERM WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	4.2	4.2	0.46	0	−	4.1	0.48
1991	470	0.1	0	2.8	2.8	0.31	0	−	2.8	0.31
1992	596	0.14	1	2.8	3.8	0.51	7.1	1	3.8	0.51
1993	728	0.13	1	2.2	3.2	0.36	7.7	1	3.2	0.36
1994	759	0.18	0	1	1	0.21	0	−	1	0.21
1995	572	0.16	0	1.3	1.3	0.23	0	−	1.3	0.23
1996	421	0.12	0	0.6	0.6	0.34	0	−	0.6	0.34
1997	692	0.23	0	0.3	0.3	0.57	0	−	0.3	0.57
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	11.3	13.3	0.16	13.3	0.71	13	0.17
2001−2018	3112	0.2	0	0	0	−	0	−	0	−
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 18. BAIRD'S BEAKED WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.3	0	−	0.9	0.3
1991	470	0.1	0	1.3	1.3	0.23	0	−	1.3	0.23
1992	596	0.14	0	1.1	1.1	0.28	0	−	1.1	0.28
1993	728	0.13	0	1.4	1.4	0.26	0	−	1.3	0.32
1994	759	0.18	1	0.8	1.8	0.11	5.6	1	1.8	0.11
1995	572	0.16	0	0.9	0.9	0.24	0	−	0.9	0.24
1996	421	0.12	0	0.4	0.4	0.35	0	−	0.4	0.35
1997	692	0.23	0	0.2	0.2	0.35	0	−	0.2	0.35
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5.9	6.9	0.1	6.7	1.01	6.8	0.15
2001−2018	3112	0.2	0	0	0	−	0	−	0	−
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 19. HUBB'S BEAKED WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	4.1	4.1	0.23	0	−	3.9	0.25
1991	470	0.1	0	5.8	5.8	0.16	0	−	5.6	0.17
1992	596	0.14	3	3.5	6.5	0.15	21.4	0.57	6.4	0.09
1993	728	0.13	0	5.9	5.9	0.15	0	−	5.7	0.16
1994	759	0.18	2	4.8	6.8	0.16	11.1	0.71	6.7	0.12
1995	572	0.16	0	4.2	4.2	0.13	0	−	4.1	0.15
1996	421	0.12	0	2.2	2.2	0.21	0	−	2.1	0.22
1997	692	0.23	0	1.4	1.4	0.25	0	−	1.3	0.26
1998	587	0.18	0	0.1	0.1	1.2	0	−	0.1	1.2
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0	0	−	0	−	0	−
2001	339	0.2	0	0.1	0.1	2.7	0	−	0.1	2.7
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	0.69	0	−	0.1	0.69
2017	111	0.19	0	0	0	−	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	5	28.4	33.4	0.06	33.3	0.45	32.6	0.08
2001−2018	3112	0.2	0	0.2	0.2	1.2	0	−	0.2	1.2
2014−2018	545	0.21	0	0.1	0.1	0.59	0	−	0.1	0.59

Table 20. STEJNEGER'S BEAKED WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.3	0.3	1	0	−	0.3	1
1991	470	0.1	0	1.8	1.8	1.2	0	−	1.8	1.2
1992	596	0.14	0	0.9	0.9	0.87	0	−	0.8	0.91
1993	728	0.13	0	3	3	0.85	0	−	3	0.85
1994	759	0.18	1	0.8	1.8	0.4	5.6	1	1.8	0.4
1995	572	0.16	0	0.4	0.4	0.28	0	−	0.4	0.28
1996	421	0.12	0	0.2	0.2	0.37	0	−	0.2	0.37
1997	692	0.23	0	0.1	0.1	0.41	0	−	0.1	0.41
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	0.2	0.2	3.6	0	−	0.1	3.8
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	6.6	7.6	0.48	6.7	1	7.5	0.44
2001−2018	3112	0.2	0	0.2	0.2	2.7	0	−	0.2	2.7
2014−2018	545	0.21	0	0.1	0.1	3.4	0	−	0.1	3.4

Table 21. SPERM WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.7) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3.8	0	−	0.8	3.3
1991	470	0.1	0	2.1	2.1	1.8	0	−	1.4	1.9
1992	596	0.14	3	5	8	1.2	21.4	0.99	4.5	0.92
1993	728	0.13	3	7.6	10.6	1.1	23.1	0.75	7.4	0.79
1994	759	0.18	0	6.7	6.7	1.2	0	−	4.7	1.2
1995	572	0.16	0	3.6	3.6	1.7	0	−	2.5	1.8
1996	421	0.12	1	9.2	10.2	1.3	8.3	1	7.4	1.2
1997	692	0.23	0	2.4	2.4	1.2	0	−	1.6	1.2
1998	587	0.18	1	3.9	4.9	0.78	5.6	0.98	3.7	0.61
1999	526	0.2	0	1.2	1.2	1.4	0	−	0.8	1.5
2000	444	0.23	0	0.7	0.7	1.6	0	−	0.5	1.6
2001	339	0.2	0	1.1	1.1	2.4	0	−	0.7	2.5
2002	360	0.22	0	0.9	0.9	1.5	0	−	0.7	1.5
2003	298	0.2	0	0.1	0.1	1.2	0	−	0.1	1.2
2004	223	0.21	0	0.1	0.1	1	0	−	0.1	1
2005	225	0.21	0	0.2	0.2	2.3	0	−	0.2	2.3
2006	266	0.19	0	0.5	0.5	2.8	0	−	0.3	3.2
2007	204	0.16	0	0.2	0.2	1.4	0	−	0.2	1.4
2008	149	0.14	0	2.2	2.2	2.9	0	−	1.6	3.1
2009	101	0.13	0	0.1	0.1	1.1	0	−	0.1	1.1
2010	59	0.12	2	0.1	2.1	0.13	16.7	0.99	2.1	0.13
2011	85	0.2	0	0	0	−	0	−	0	−
2012	83	0.19	0	0.2	0.2	1.6	0	−	0.1	1.7
2013	175	0.37	0	0.6	0.6	0.97	0	−	0.4	1
2014	97	0.24	0	0.1	0.1	6	0	−	0	−
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.5	0.5	2.9	0	−	0.4	2.7
2017	111	0.19	0	0.6	0.6	3.4	0	−	0.5	3.5
2018	129	0.25	0	1.7	1.7	2.7	0	−	1.1	2.8
1990−2000	5973	0.15	8	44.9	52.9	0.44	53.3	0.5	36.9	0.41
2001−2018	3112	0.2	2	10.3	12.3	0.89	10	1	9.2	0.74
2014−2018	545	0.21	0	3.3	3.3	1.9	0	−	2.3	2

Table 22. CUVIER'S BEAKED WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	21.6	21.6	0.085	0	−	20.9	0.091
1991	470	0.1	0	22.9	22.9	0.079	0	−	22.3	0.087
1992	596	0.14	6	18.8	24.8	0.066	42.9	0.41	24.2	0.057
1993	728	0.13	3	25.2	28.2	0.095	23.1	0.58	27.4	0.091
1994	759	0.18	6	18.8	24.8	0.069	33.3	0.4	24.3	0.057
1995	572	0.16	6	16.1	22.1	0.053	37.5	0.4	20.6	0.048
1996	421	0.12	0	10.4	10.4	0.11	0	−	10	0.11
1997	692	0.23	0	5.8	5.8	0.085	0	−	5.6	0.091
1998	587	0.18	0	0.4	0.4	0.35	0	−	0.4	0.35
1999	526	0.2	0	0.1	0.1	0.88	0	−	0.1	0.88
2000	444	0.23	0	0.1	0.1	0.8	0	−	0	−
2001	339	0.2	0	0.1	0.1	2.2	0	−	0.1	2.2
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	0.1	0.1	0.36	0	−	0.1	0.36
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	1	1	0.46	0	−	1	0.46
2017	111	0.19	0	0.1	0.1	2.7	0	−	0.1	2.7
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	21	121.3	142.3	0.03	140	0.22	137.6	0.04
2001−2018	3112	0.2	0	1.5	1.5	0.38	0	−	1.4	0.38
2014−2018	545	0.21	0	1	1	0.43	0	−	1	0.43

Table 23. UNID. ZIPHIID. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3	3	0.17	0	−	2.9	0.19
1991	470	0.1	0	3.1	3.1	0.17	0	−	3	0.2
1992	596	0.14	2	2.7	4.7	0.16	14.3	0.71	4.7	0.16
1993	728	0.13	0	4.1	4.1	0.15	0	−	4	0.17
1994	759	0.18	1	3	4	0.17	5.6	1	3.9	0.15
1995	572	0.16	0	2.1	2.1	0.15	0	−	2.1	0.15
1996	421	0.12	0	1.2	1.2	0.18	0	−	1.2	0.18
1997	692	0.23	0	0.6	0.6	0.2	0	−	0.6	0.2
1998	587	0.18	0	0.1	0.1	0.96	0	−	0.1	0.96
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	0.49	0	−	0.1	0.49
2017	111	0.19	0	0	0	−	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	3	17.3	20.3	0.07	20	0.58	19.9	0.1
2001−2018	3112	0.2	0	0.2	0.2	0.39	0	−	0.2	0.39
2014−2018	545	0.21	0	0.1	0.1	0.64	0	−	0.1	0.64

Table 24. UNID. MESOPLODON. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	1.2	2.2	0.21	25	1	2.2	0.21
1991	470	0.1	0	1.6	1.6	0.25	0	−	1.6	0.25
1992	596	0.14	1	1.5	2.5	0.2	7.1	0.99	2.4	0.13
1993	728	0.13	0	1.7	1.7	0.14	0	−	1.7	0.14
1994	759	0.18	0	1.4	1.4	0.13	0	−	1.3	0.17
1995	572	0.16	0	1.1	1.1	0.14	0	−	1.1	0.14
1996	421	0.12	0	1.7	1.7	0.95	0	−	1.6	0.97
1997	692	0.23	0	1.1	1.1	0.84	0	−	1	0.85
1998	587	0.18	0	0.1	0.1	0.35	0	−	0.1	0.35
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0.1	0.1	2.1	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	0.1	0.1	2.8	0	−	0.1	2.8
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	0.1	0.1	3.1	0	−	0.1	3.1
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	0.1	0.1	1.3	0	−	0.1	1.3
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	0.1	0.1	0.59	0	−	0.1	0.59
2017	111	0.19	0	0	0	−	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	10.6	12.6	0.2	13.3	0.71	12.4	0.19
2001−2018	3112	0.2	0	0.7	0.7	0.61	0	−	0.7	0.61
2014−2018	545	0.21	0	0.3	0.3	0.86	0	−	0.3	0.86

Table 25. CA SEA LION. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.98) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	58.2	60.2	0.37	50	1	59.1	0.36
1991	470	0.1	4	73.4	77.4	0.18	40	0.49	76	0.17
1992	596	0.14	9	53.6	62.6	0.42	64.3	0.33	61.7	0.36
1993	728	0.13	12	75.1	87.1	0.27	92.3	0.33	85.7	0.23
1994	759	0.18	5	60.4	65.4	0.2	27.8	0.45	63.3	0.19
1995	572	0.16	5	51.5	56.5	0.29	31.2	0.45	54.6	0.27
1996	421	0.12	4	44.6	48.6	0.24	33.3	0.5	47.8	0.22
1997	692	0.23	39	60.1	99.1	0.2	169.6	0.29	97	0.12
1998	587	0.18	23	73.3	96.3	0.18	127.8	0.24	95	0.14
1999	526	0.2	6	59.4	65.4	0.17	30	0.41	65.3	0.15
2000	444	0.23	13	51.7	64.7	0.18	56.5	0.33	62.8	0.15
2001	339	0.2	2	39.2	41.2	0.2	10	0.7	40.5	0.19
2002	360	0.22	18	41.5	59.5	0.25	81.8	0.24	58.7	0.17
2003	298	0.2	4	34.2	38.2	0.18	20	0.5	37.6	0.16
2004	223	0.21	7	30.8	37.8	0.22	33.3	0.37	36.2	0.18
2005	225	0.21	1	33	34	0.21	4.8	0.99	33.4	0.2
2006	266	0.19	12	39.2	51.2	0.2	63.2	0.37	50.5	0.15
2007	204	0.16	8	39.5	47.5	0.28	50	0.39	46.7	0.23
2008	149	0.14	7	28.3	35.3	0.3	50	0.42	34.8	0.24
2009	101	0.13	5	25.9	30.9	0.31	38.5	0.43	30.4	0.26
2010	59	0.12	0	14.9	14.9	0.43	0	−	14.6	0.43
2011	85	0.2	18	13.9	31.9	0.26	90	0.51	31.6	0.21
2012	83	0.19	6	9.9	15.9	0.38	31.6	0.39	15.8	0.24
2013	175	0.37	3	5.5	8.5	0.39	8.1	0.57	8.4	0.25
2014	97	0.24	3	11.1	14.1	0.6	12.5	0.99	13.9	0.47
2015	74	0.2	0	6.3	6.3	0.44	0	−	6.2	0.44
2016	134	0.18	0	15.8	15.8	0.38	0	−	15.5	0.38
2017	111	0.19	2	15.4	17.4	0.52	10.5	0.7	17.1	0.46
2018	129	0.25	2	8	10	0.41	8	0.71	7.9	0.41
1990−2000	5973	0.15	122	721.2	843.2	0.07	813.3	0.13	827.2	0.06
2001−2018	3112	0.2	98	403.7	501.7	0.07	490	0.14	491.2	0.06
2014−2018	545	0.21	7	56.3	63.3	0.22	33.3	0.51	60.3	0.2

Table 26. STELLER'S SEA LION. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.42	0	−	1.1	0.42
1991	470	0.1	0	3.4	3.4	0.99	0	−	3.4	0.99
1992	596	0.14	1	1.5	2.5	0.59	7.1	0.99	2.5	0.59
1993	728	0.13	0	1.6	1.6	0.37	0	−	1.6	0.37
1994	759	0.18	1	1.2	2.2	0.56	5.6	1	2.2	0.56
1995	572	0.16	0	1.3	1.3	0.71	0	−	1.3	0.71
1996	421	0.12	0	0.8	0.8	0.65	0	−	0.8	0.65
1997	692	0.23	0	0.5	0.5	0.84	0	−	0.5	0.84
1998	587	0.18	0	0.1	0.1	1.1	0	−	0.1	1.1
1999	526	0.2	0	0	0	−	0	−	0	−
2000	444	0.23	0	0.1	0.1	2.4	0	−	0.1	2.4
2001	339	0.2	0	0.1	0.1	2.9	0	−	0.1	2.9
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	0.1	0.1	3	0	−	0.1	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	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	0.2	0.2	1.7	0	−	0.2	1.7
2017	111	0.19	0	0	0	−	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	10.3	12.3	0.28	13.3	0.72	12.3	0.28
2001−2018	3112	0.2	0	0.4	0.4	0.88	0	−	0.4	0.88
2014−2018	545	0.21	0	0.2	0.2	1.4	0	−	0.2	1.4

Table 27. UNID. PINNIPED. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.1	0.1	7.4	0	−	0.1	7.4
1992	596	0.14	0	0	0	−	0	−	0	−
1993	728	0.13	0	0	0	−	0	−	0	−
1994	759	0.18	0	0.1	0.1	5.3	0	−	0.1	5.3
1995	572	0.16	0	0	0	−	0	−	0	−
1996	421	0.12	0	0.4	0.4	3.1	0	−	0.4	3.1
1997	692	0.23	0	0.2	0.2	0.59	0	−	0.2	0.59
1998	587	0.18	2	6.7	8.7	2.1	11.1	0.71	8.7	2.1
1999	526	0.2	0	0.5	0.5	2.1	0	−	0.5	2.1
2000	444	0.23	0	0	0	−	0	−	0	−
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0.2	0.2	3.3	0	−	0.2	3.3
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	0.2	0.2	3.4	0	−	0.2	3.4
2007	204	0.16	0	0	0	−	0	−	0	−
2008	149	0.14	0	0.1	0.1	4.2	0	−	0.1	4.2
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	0.2	0.2	4	0	−	0.2	4
2017	111	0.19	0	0	0	−	0	−	0	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	10.1	12.1	0.55	13.3	0.71	12.1	0.55
2001−2018	3112	0.2	0	0.8	0.8	1.7	0	−	0.8	1.7
2014−2018	545	0.21	0	0.2	0.2	3.9	0	−	0.2	3.9

Table 28. N ELEPHANT SEAL. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	92.5	97.5	0.12	125	0.44	97.5	0.12
1991	470	0.1	13	103.4	116.4	0.087	130	0.27	116.4	0.087
1992	596	0.14	15	96.1	111.1	0.066	107.1	0.26	111.1	0.066
1993	728	0.13	14	105.8	119.8	0.066	107.7	0.29	119.8	0.066
1994	759	0.18	22	91.5	113.5	0.08	122.2	0.24	113.5	0.08
1995	572	0.16	14	75	89	0.064	87.5	0.28	89	0.064
1996	421	0.12	5	39.1	44.1	0.17	41.7	0.45	44.1	0.17
1997	692	0.23	9	31.5	40.5	0.17	39.1	0.33	40.5	0.17
1998	587	0.18	4	19	23	0.4	22.2	0.5	23	0.4
1999	526	0.2	2	10.2	12.2	0.25	10	0.7	12.2	0.25
2000	444	0.23	6	16.1	22.1	0.31	26.1	0.41	22.1	0.31
2001	339	0.2	1	2.6	3.6	0.62	5	1	3.6	0.62
2002	360	0.22	1	1.5	2.5	1.4	4.5	1	2.5	1.4
2003	298	0.2	1	3.4	4.4	0.71	5	0.99	4.4	0.71
2004	223	0.21	0	1.7	1.7	0.79	0	−	1.7	0.79
2005	225	0.21	1	2	3	1.1	4.8	1	3	1.1
2006	266	0.19	0	0.9	0.9	1.2	0	−	0.9	1.2
2007	204	0.16	1	4.3	5.3	0.94	6.2	0.99	5.3	0.94
2008	149	0.14	0	1.4	1.4	1.4	0	−	1.4	1.4
2009	101	0.13	0	2.8	2.8	1.9	0	−	2.8	1.9
2010	59	0.12	0	1.9	1.9	1.5	0	−	1.9	1.5
2011	85	0.2	0	1.2	1.2	0.78	0	−	1.2	0.78
2012	83	0.19	0	1.3	1.3	0.92	0	−	1.3	0.92
2013	175	0.37	0	0.5	0.5	0.82	0	−	0.5	0.82
2014	97	0.24	1	2.3	3.3	0.95	4.2	0.98	3.3	0.95
2015	74	0.2	0	0.7	0.7	1.6	0	−	0.7	1.6
2016	134	0.18	0	4.3	4.3	0.7	0	−	4.3	0.7
2017	111	0.19	3	10	13	0.54	15.8	0.57	13	0.54
2018	129	0.25	0	0.7	0.7	0.85	0	−	0.7	0.85
1990−2000	5973	0.15	109	626.1	735.1	0.04	726.7	0.1	735.1	0.04
2001−2018	3112	0.2	9	41.9	50.9	0.23	45	0.33	50.9	0.23
2014−2018	545	0.21	4	16.6	20.6	0.36	19	0.5	20.6	0.36

Table 29. LOGGERHEAD TURTLE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.25) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	5.1	5.1	2.1	0	−	1.2	2.5
1991	470	0.1	0	12.5	12.5	1.1	0	−	3	1.4
1992	596	0.14	2	9.5	11.5	1.1	14.3	0.71	3.5	0.85
1993	728	0.13	5	12	17	0.94	38.5	0.44	3	1.1
1994	759	0.18	0	8.4	8.4	0.94	0	−	2.1	1
1995	572	0.16	0	6.3	6.3	1.4	0	−	1.5	1.7
1996	421	0.12	0	2.3	2.3	1.6	0	−	0.6	1.9
1997	692	0.23	3	5.4	8.4	0.88	13	0.57	2.4	0.57
1998	587	0.18	4	18.8	22.8	0.79	22.2	0.8	6.9	0.64
1999	526	0.2	0	2.8	2.8	1.4	0	−	0.7	1.8
2000	444	0.23	0	2.1	2.1	1.4	0	−	0.5	1.7
2001	339	0.2	1	4.3	5.3	1.4	5	0.98	1	1.6
2002	360	0.22	0	1.1	1.1	1.7	0	−	0.3	1.8
2003	298	0.2	0	1.7	1.7	1.8	0	−	0.4	2
2004	223	0.21	0	0.7	0.7	2.1	0	−	0.2	2.4
2005	225	0.21	0	1	1	2.2	0	−	0.2	2.7
2006	266	0.19	1	1.6	2.6	1.7	5.3	1	0.4	1.9
2007	204	0.16	0	0.8	0.8	2.7	0	−	0.2	3.3
2008	149	0.14	0	0.3	0.3	4.3	0	−	0.1	3.9
2009	101	0.13	0	0.4	0.4	4.5	0	−	0.1	3.6
2010	59	0.12	0	1.4	1.4	3.6	0	−	0.3	3.9
2011	85	0.2	0	0.1	0.1	4.8	0	−	0	−
2012	83	0.19	0	0.2	0.2	5.3	0	−	0.1	6
2013	175	0.37	0	0.1	0.1	6.8	0	−	0	−
2014	97	0.24	0	0.9	0.9	2.7	0	−	0.2	3.1
2015	74	0.2	0	0.2	0.2	4.1	0	−	0	−
2016	134	0.18	0	1.6	1.6	2.7	0	−	0.4	2.6
2017	111	0.19	0	0.4	0.4	3	0	−	0.1	3.1
2018	129	0.25	0	1.4	1.4	2.8	0	−	0.3	3.3
1990−2000	5973	0.15	14	89	103	0.35	93.3	0.32	26.1	0.45
2001−2018	3112	0.2	2	18.4	20.4	0.65	10	0.71	4.5	0.78
2014−2018	545	0.21	0	4.7	4.7	1.4	0	−	1.2	1.6

Table 30. GREEN TURTLE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.4	0.4	12	0	−	0.4	12
1991	470	0.1	0	0.7	0.7	3.4	0	−	0.7	3.4
1992	596	0.14	0	0.1	0.1	1.9	0	−	0.1	1.9
1993	728	0.13	0	0.2	0.2	2.1	0	−	0.2	2.1
1994	759	0.18	0	0	0	−	0	−	0	−
1995	572	0.16	0	0.1	0.1	2	0	−	0.1	2
1996	421	0.12	0	0.3	0.3	1.9	0	−	0.3	1.9
1997	692	0.23	0	0.1	0.1	2.9	0	−	0.1	2.9
1998	587	0.18	0	0.1	0.1	3.1	0	−	0.1	3.1
1999	526	0.2	1	2.6	3.6	1.3	5	1	3.6	1.3
2000	444	0.23	0	0.2	0.2	3.6	0	−	0.2	3.6
2001	339	0.2	0	0.2	0.2	4.4	0	−	0.2	4.4
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	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	0.5	0.5	2.9	0	−	0.5	2.9
2012	83	0.19	0	0	0	−	0	−	0	−
2013	175	0.37	0	0	0	−	0	−	0	−
2014	97	0.24	0	0	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	0.1	0.1	4.6	0	−	0.1	4.6
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5.5	6.5	0.99	6.7	1	6.5	0.99
2001−2018	3112	0.2	0	1	1	1.9	0	−	1	1.9
2014−2018	545	0.21	0	0.2	0.2	4.1	0	−	0.2	4.1

Table 31. LEATHERBACK TURTLE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.68) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	18.5	19.5	0.87	25	1	13.5	0.81
1991	470	0.1	1	16.6	17.6	0.68	10	1	11.3	0.7
1992	596	0.14	4	16.8	20.8	0.57	28.6	0.5	13.3	0.5
1993	728	0.13	3	21.4	24.4	0.54	23.1	0.58	17.5	0.47
1994	759	0.18	1	13.6	14.6	0.52	5.6	0.98	9.3	0.54
1995	572	0.16	5	9	14	0.65	31.2	0.45	10.1	0.4
1996	421	0.12	2	10.6	12.6	0.66	16.7	0.7	9.1	0.52
1997	692	0.23	4	13.2	17.2	0.46	17.4	0.5	10.9	0.39
1998	587	0.18	0	6	6	0.61	0	−	4.1	0.63
1999	526	0.2	2	3.5	5.5	0.73	10	0.71	2.3	0.75
2000	444	0.23	0	1.5	1.5	0.92	0	−	1	0.95
2001	339	0.2	0	0.6	0.6	1.6	0	−	0.4	1.7
2002	360	0.22	0	0.6	0.6	1.3	0	−	0.4	1.3
2003	298	0.2	0	0.3	0.3	2.5	0	−	0.2	2.4
2004	223	0.21	0	0.3	0.3	1.4	0	−	0.2	1.3
2005	225	0.21	0	1.3	1.3	1.2	0	−	0.9	1.2
2006	266	0.19	0	2.5	2.5	0.89	0	−	1.7	0.89
2007	204	0.16	0	0.4	0.4	1.6	0	−	0.3	1.5
2008	149	0.14	0	0.3	0.3	3.4	0	−	0.2	3.6
2009	101	0.13	1	0.3	1.3	0.63	7.7	0.99	0.2	2.7
2010	59	0.12	0	0.1	0.1	1.2	0	−	0	−
2011	85	0.2	0	0.3	0.3	1.8	0	−	0.2	1.8
2012	83	0.19	1	0.6	1.6	0.84	5.3	0.99	0.4	1.7
2013	175	0.37	0	0.8	0.8	1.1	0	−	0.5	1.1
2014	97	0.24	0	0.3	0.3	1.6	0	−	0.2	1.6
2015	74	0.2	0	0.7	0.7	1.9	0	−	0.5	1.9
2016	134	0.18	0	0.3	0.3	2.1	0	−	0.2	2.1
2017	111	0.19	0	0.1	0.1	2.8	0	−	0.1	2.8
2018	129	0.25	0	0.4	0.4	1.6	0	−	0.3	1.6
1990−2000	5973	0.15	23	123.9	146.9	0.19	153.3	0.21	98.6	0.19
2001−2018	3112	0.2	2	11.3	13.3	0.39	10	0.72	7.7	0.41
2014−2018	545	0.21	0	1.8	1.8	0.92	0	−	1.2	0.92

Table 32. OLIVE RIDLEY TURTLE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3.2	0	−	0	−
1991	470	0.1	0	0.2	0.2	2.6	0	−	0	−
1992	596	0.14	0	0	0	−	0	−	0	−
1993	728	0.13	0	0.3	0.3	3	0	−	0	−
1994	759	0.18	0	0.1	0.1	2.9	0	−	0	−
1995	572	0.16	0	0.1	0.1	2.4	0	−	0	−
1996	421	0.12	0	0.1	0.1	2.8	0	−	0	−
1997	692	0.23	0	0	0	−	0	−	0	−
1998	587	0.18	0	0.1	0.1	4.2	0	−	0	−
1999	526	0.2	1	2.8	3.8	1.5	5	1	0	−
2000	444	0.23	0	0.1	0.1	3.1	0	−	0	−
2001	339	0.2	0	0.1	0.1	3.4	0	−	0	−
2002	360	0.22	0	0.1	0.1	3.2	0	−	0	−
2003	298	0.2	0	0.1	0.1	5.8	0	−	0	−
2004	223	0.21	0	0	0	−	0	−	0	−
2005	225	0.21	0	0.1	0.1	4.3	0	−	0	−
2006	266	0.19	0	0.1	0.1	4.4	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	0.2	0.2	5.3	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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	1	5.4	6.4	1.2	6.7	1	0	−
2001−2018	3112	0.2	0	0.8	0.8	1.7	0	−	0	−
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 33. UNID. TURTLE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.33) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	3	3	1.3	0	−	1.1	1.4
1991	470	0.1	0	3.3	3.3	0.94	0	−	1.1	1.3
1992	596	0.14	0	3.1	3.1	0.78	0	−	1	1.3
1993	728	0.13	3	1	4	0.45	23.1	0.59	1.4	0.54
1994	759	0.18	0	4.3	4.3	0.94	0	−	1.2	1.4
1995	572	0.16	0	2.2	2.2	1.1	0	−	0.7	1.7
1996	421	0.12	0	0.6	0.6	1.8	0	−	0.2	1.8
1997	692	0.23	0	0.2	0.2	1.9	0	−	0.1	2.2
1998	587	0.18	0	0.2	0.2	1.9	0	−	0.1	2
1999	526	0.2	0	0.2	0.2	2.6	0	−	0.1	4.1
2000	444	0.23	0	0.2	0.2	2	0	−	0.1	2.6
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0.2	0.2	2.3	0	−	0.1	3.9
2003	298	0.2	0	0.1	0.1	4.2	0	−	0	−
2004	223	0.21	0	0.2	0.2	2.4	0	−	0.1	2.4
2005	225	0.21	0	0.1	0.1	3.2	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	0.1	0.1	4.2	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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	3	16.2	19.2	0.43	20	0.58	5.8	0.78
2001−2018	3112	0.2	0	1	1	1.1	0	−	0.4	1.7
2014−2018	545	0.21	0	0.2	0.2	3	0	−	0.1	4.3

Table 34. UNID. BIRD. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.85	25	0.99	2.3	0.85
1991	470	0.1	0	2.4	2.4	0.52	0	−	2.4	0.52
1992	596	0.14	1	1.7	2.7	0.46	7.1	0.98	2.7	0.46
1993	728	0.13	0	2.9	2.9	0.41	0	−	2.9	0.41
1994	759	0.18	1	5	6	0.7	5.6	1	6	0.7
1995	572	0.16	0	2.5	2.5	0.35	0	−	2.5	0.35
1996	421	0.12	0	1.9	1.9	0.46	0	−	1.9	0.46
1997	692	0.23	1	1.6	2.6	0.54	4.3	1	2.6	0.54
1998	587	0.18	0	1	1	0.34	0	−	1	0.34
1999	526	0.2	0	0.7	0.7	0.39	0	−	0.7	0.39
2000	444	0.23	0	0.9	0.9	0.68	0	−	0.9	0.68
2001	339	0.2	0	0.6	0.6	0.39	0	−	0.6	0.39
2002	360	0.22	1	0.6	1.6	0.23	4.5	1	1.6	0.23
2003	298	0.2	0	0.5	0.5	0.28	0	−	0.5	0.28
2004	223	0.21	0	0.3	0.3	0.62	0	−	0.3	0.62
2005	225	0.21	0	0.2	0.2	0.58	0	−	0.2	0.58
2006	266	0.19	0	0.4	0.4	0.4	0	−	0.4	0.4
2007	204	0.16	0	0.4	0.4	0.36	0	−	0.4	0.36
2008	149	0.14	0	0.3	0.3	0.79	0	−	0.3	0.79
2009	101	0.13	0	0.3	0.3	0.78	0	−	0.3	0.78
2010	59	0.12	0	0.2	0.2	1.2	0	−	0.2	1.2
2011	85	0.2	0	0.1	0.1	0.8	0	−	0.1	0.8
2012	83	0.19	0	0.1	0.1	0.91	0	−	0.1	0.91
2013	175	0.37	0	0.2	0.2	0.56	0	−	0.2	0.56
2014	97	0.24	0	0.2	0.2	0.78	0	−	0.2	0.78
2015	74	0.2	0	0.1	0.1	0.88	0	−	0.1	0.88
2016	134	0.18	0	0.4	0.4	0.92	0	−	0.4	0.92
2017	111	0.19	0	0.1	0.1	0.86	0	−	0.1	0.86
2018	129	0.25	0	0.2	0.2	0.61	0	−	0.2	0.61
1990−2000	5973	0.15	4	23.4	27.4	0.22	26.7	0.49	27.4	0.22
2001−2018	3112	0.2	1	5.2	6.2	0.15	5	0.99	6.2	0.15
2014−2018	545	0.21	0	1	1	0.39	0	−	1	0.39

Table 35. UNID. CORMORANT. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	9.7	0	−	0.1	9.7
1991	470	0.1	0	0.4	0.4	2.9	0	−	0.4	2.9
1992	596	0.14	0	0.6	0.6	2.9	0	−	0.6	2.9
1993	728	0.13	0	0.3	0.3	4.7	0	−	0.3	4.7
1994	759	0.18	0	0.4	0.4	4.6	0	−	0.4	4.6
1995	572	0.16	0	0.2	0.2	3.1	0	−	0.2	3.1
1996	421	0.12	0	0	0	−	0	−	0	−
1997	692	0.23	0	0	0	−	0	−	0	−
1998	587	0.18	0	0	0	−	0	−	0	−
1999	526	0.2	0	0.5	0.5	2.4	0	−	0.5	2.4
2000	444	0.23	0	0.1	0.1	5.1	0	−	0.1	5.1
2001	339	0.2	0	0	0	−	0	−	0	−
2002	360	0.22	0	0.1	0.1	5.4	0	−	0.1	5.4
2003	298	0.2	1	0	1	0.029	5	1	1	0.029
2004	223	0.21	0	0.5	0.5	2.4	0	−	0.5	2.4
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0.1	0.1	3.4	0	−	0.1	3.4
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	3.3	0	−	0.4	3.3
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	0.2	0.2	2.9	0	−	0.2	2.9
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	0	2.9	2.9	1.4	0	−	2.9	1.4
2001−2018	3112	0.2	1	1.3	2.3	1.3	5	0.99	2.3	1.3
2014−2018	545	0.21	0	0.3	0.3	2.8	0	−	0.3	2.8

Table 36. NORTHERN FULMAR. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.14) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	2.1	0	−	0.1	2.4
1991	470	0.1	0	0.7	0.7	2.6	0	−	0.1	3.8
1992	596	0.14	0	2.9	2.9	2.2	0	−	0.4	2.5
1993	728	0.13	0	1.1	1.1	1.4	0	−	0.1	1.6
1994	759	0.18	0	0.8	0.8	2.3	0	−	0.1	3.1
1995	572	0.16	0	1.1	1.1	1.9	0	−	0.1	1.9
1996	421	0.12	0	1.4	1.4	1.1	0	−	0.2	1.2
1997	692	0.23	0	2.8	2.8	1.7	0	−	0.4	1.5
1998	587	0.18	0	20.8	20.8	0.94	0	−	3	1.1
1999	526	0.2	0	16.7	16.7	0.95	0	−	2.4	1.1
2000	444	0.23	16	38.5	54.5	0.37	69.6	0.37	8.4	0.36
2001	339	0.2	0	2	2	1.1	0	−	0.3	1.2
2002	360	0.22	1	4.1	5.1	1.2	4.5	1	0.6	1.3
2003	298	0.2	14	23.4	37.4	0.74	70	0.41	5.2	0.59
2004	223	0.21	0	2.2	2.2	1.7	0	−	0.3	1.9
2005	225	0.21	5	5.8	10.8	1.4	23.8	0.82	0.8	1.5
2006	266	0.19	0	2.8	2.8	2.8	0	−	0.4	2.6
2007	204	0.16	0	6.2	6.2	1.9	0	−	0.8	2.4
2008	149	0.14	0	2.4	2.4	1.8	0	−	0.3	2
2009	101	0.13	0	0.9	0.9	2.3	0	−	0.1	2.2
2010	59	0.12	0	4.1	4.1	2.1	0	−	0.5	2.1
2011	85	0.2	0	1.2	1.2	2.6	0	−	0.2	2.8
2012	83	0.19	0	1.1	1.1	2.2	0	−	0.1	2.3
2013	175	0.37	0	1	1	1.5	0	−	0.1	1.4
2014	97	0.24	0	0.4	0.4	2.5	0	−	0.1	3.2
2015	74	0.2	0	0.4	0.4	2.2	0	−	0.1	2.5
2016	134	0.18	0	1.5	1.5	2	0	−	0.2	2.2
2017	111	0.19	0	0.6	0.6	1.9	0	−	0.1	1.8
2018	129	0.25	0	0.4	0.4	3.5	0	−	0	−
1990−2000	5973	0.15	16	129.9	145.9	0.33	106.7	0.36	20.2	0.44
2001−2018	3112	0.2	20	60	80	0.42	100	0.36	10.2	0.48
2014−2018	545	0.21	0	3.2	3.2	1.1	0	−	0.5	1.2

Table 37. UNID. WHALE. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.5) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	2.3	2.3	2.4	0	−	1.2	3.1
1991	470	0.1	0	0.2	0.2	0.48	0	−	0.1	0.83
1992	596	0.14	0	0.2	0.2	0.4	0	−	0.1	0.81
1993	728	0.13	1	0.4	1.4	0.23	7.7	1	1.2	0.16
1994	759	0.18	0	1.3	1.3	1.3	0	−	0.6	2
1995	572	0.16	0	1.1	1.1	1.5	0	−	0.5	1.9
1996	421	0.12	0	0.9	0.9	2.5	0	−	0.4	2.9
1997	692	0.23	0	0.2	0.2	0.37	0	−	0.1	0.74
1998	587	0.18	0	0.5	0.5	0.79	0	−	0.2	1.1
1999	526	0.2	0	0.7	0.7	1.2	0	−	0.3	1.8
2000	444	0.23	0	0.3	0.3	0.26	0	−	0.2	0.67
2001	339	0.2	0	0.3	0.3	0.32	0	−	0.2	0.8
2002	360	0.22	0	0.4	0.4	0.26	0	−	0.2	0.69
2003	298	0.2	1	0.4	1.4	0.092	5	1	0.2	0.76
2004	223	0.21	0	0.2	0.2	0.34	0	−	0.1	0.91
2005	225	0.21	0	0.2	0.2	0.33	0	−	0.1	0.78
2006	266	0.19	0	0.4	0.4	0.84	0	−	0.2	1.2
2007	204	0.16	0	0.4	0.4	0.37	0	−	0.2	0.79
2008	149	0.14	0	0.3	0.3	0.37	0	−	0.2	0.82
2009	101	0.13	0	0.3	0.3	1.4	0	−	0.1	2.1
2010	59	0.12	0	0.1	0.1	0.8	0	−	0	−
2011	85	0.2	0	0.1	0.1	0.45	0	−	0.1	0.45
2012	83	0.19	0	0.2	0.2	0.52	0	−	0.1	0.93
2013	175	0.37	0	0.1	0.1	0.45	0	−	0	−
2014	97	0.24	0	0.1	0.1	0.6	0	−	0	−
2015	74	0.2	0	0.1	0.1	0.62	0	−	0.1	0.62
2016	134	0.18	0	0.1	0.1	0.45	0	−	0.1	0.45
2017	111	0.19	0	0.1	0.1	0.77	0	−	0.1	0.77
2018	129	0.25	0	0.1	0.1	0.49	0	−	0	−
1990−2000	5973	0.15	1	7.2	8.2	0.58	6.7	0.99	4.5	0.71
2001−2018	3112	0.2	1	3.9	4.9	0.14	5	1.01	2	0.65
2014−2018	545	0.21	0	0.5	0.5	0.27	0	−	0.2	0.72

Table 38. UNID. CETACEAN. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	0.7	0.7	0.37	0	−	0.7	0.37
1991	470	0.1	1	3.4	4.4	1.6	10	0.99	4.4	1.6
1992	596	0.14	1	2.1	3.1	1.1	7.1	1	3.1	1.1
1993	728	0.13	0	2.7	2.7	1	0	−	2.7	1
1994	759	0.18	0	1.3	1.3	0.9	0	−	1.3	0.9
1995	572	0.16	0	2.1	2.1	1.2	0	−	2.1	1.2
1996	421	0.12	0	0.4	0.4	0.35	0	−	0.4	0.35
1997	692	0.23	0	0.2	0.2	1.4	0	−	0.2	1.4
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	0.3	0.3	2.6	0	−	0.3	2.6
2003	298	0.2	0	0.2	0.2	4	0	−	0.2	4
2004	223	0.21	0	0.1	0.1	4	0	−	0.1	4
2005	225	0.21	0	0.3	0.3	2.8	0	−	0.3	2.8
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	−
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	2	11.4	13.4	0.51	13.3	0.71	13.4	0.51
2001−2018	3112	0.2	0	1	1	1.5	0	−	1	1.5
2014−2018	545	0.21	0	0	0	−	0	−	0	−

Table 39. ALL BEAKED WHALES. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (0.97) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	31.5	32.5	0.076	25	0.99	31.5	0.078
1991	470	0.1	0	36.2	36.2	0.089	0	−	35.1	0.093
1992	596	0.14	12	28.8	40.8	0.06	85.7	0.29	39.8	0.045
1993	728	0.13	3	40.8	43.8	0.084	23.1	0.58	42.6	0.084
1994	759	0.18	11	29.9	40.9	0.058	61.1	0.3	40	0.048
1995	572	0.16	6	25.2	31.2	0.049	37.5	0.41	29.4	0.048
1996	421	0.12	0	16.4	16.4	0.12	0	−	16	0.12
1997	692	0.23	0	9.2	9.2	0.11	0	−	8.9	0.11
1998	587	0.18	0	0.6	0.6	0.25	0	−	0.5	0.25
1999	526	0.2	0	0.1	0.1	0.61	0	−	0.1	0.61
2000	444	0.23	0	0.1	0.1	0.83	0	−	0.1	0.83
2001	339	0.2	0	0.1	0.1	2.2	0	−	0.1	2.2
2002	360	0.22	0	0.1	0.1	1.5	0	−	0	−
2003	298	0.2	0	0	0	−	0	−	0	−
2004	223	0.21	0	0.1	0.1	2.7	0	−	0.1	2.7
2005	225	0.21	0	0	0	−	0	−	0	−
2006	266	0.19	0	0	0	−	0	−	0	−
2007	204	0.16	0	0.1	0.1	0.57	0	−	0.1	0.57
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	0.2	0.2	0.77	0	−	0.2	0.77
2015	74	0.2	0	0	0	−	0	−	0	−
2016	134	0.18	0	1.4	1.4	0.36	0	−	1.3	0.37
2017	111	0.19	0	0.2	0.2	3.7	0	−	0.2	3.7
2018	129	0.25	0	0	0	−	0	−	0	−
1990−2000	5973	0.15	33	190.7	223.7	0.03	220	0.17	217	0.03
2001−2018	3112	0.2	0	2.3	2.3	0.41	0	−	2.2	0.42
2014−2018	545	0.21	0	1.6	1.6	0.52	0	−	1.5	0.52

Table 40. ALL DELPHINOIDS. Observed Sets, observer coverage, observed and estimated bycatch from 1990−2018. Unobserved bycatch estimated with regression trees ('Tree.Est') and total bycatch ('Bycatch.Tot') are shown. Ratio estimates ('Ratio.Est') of bycatch are shown for comparison. Total mortality and serious injury (MSI) is based on prorating Bycatch.Tot by the fraction of observations (1) resulting in death or serious injury. Precision for all estimates are given as coefficients of variation (CV).

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	338.1	351.1	0.14	325	0.33	351.1	0.14
1991	470	0.1	63	412.1	475.1	0.056	630	0.17	475.1	0.056
1992	596	0.14	62	374	436	0.064	442.9	0.16	436	0.064
1993	728	0.13	61	431.2	492.2	0.056	469.2	0.18	492.2	0.056
1994	759	0.18	41	315.4	356.4	0.043	227.8	0.17	356.4	0.043
1995	572	0.16	60	294.2	354.2	0.052	375	0.2	354.2	0.052
1996	421	0.12	38	227.7	265.7	0.094	316.7	0.19	265.7	0.094
1997	692	0.23	42	150.8	192.8	0.096	182.6	0.17	192.8	0.096
1998	587	0.18	9	159.4	168.4	0.19	50	0.33	168.4	0.19
1999	526	0.2	40	103.1	143.1	0.2	200	0.23	143.1	0.2
2000	444	0.23	40	76.2	116.2	0.2	173.9	0.21	116.2	0.2
2001	339	0.2	14	69.2	83.2	0.24	70	0.3	83.2	0.24
2002	360	0.22	14	64.1	78.1	0.21	63.6	0.33	78.1	0.21
2003	298	0.2	23	59.4	82.4	0.34	115	0.29	82.4	0.34
2004	223	0.21	8	49	57	0.31	38.1	0.39	57	0.31
2005	225	0.21	15	51.9	66.9	0.26	71.4	0.27	66.9	0.26
2006	266	0.19	7	71.6	78.6	0.32	36.8	0.48	78.6	0.32
2007	204	0.16	11	98.1	109.1	0.34	68.8	0.32	109.1	0.34
2008	149	0.14	16	66.8	82.8	0.33	114.3	0.37	82.8	0.33
2009	101	0.13	3	28.2	31.2	0.36	23.1	0.73	31.2	0.36
2010	59	0.12	6	18.1	24.1	0.59	50	0.45	24.1	0.59
2011	85	0.2	5	18.2	23.2	0.34	25	0.42	23.2	0.34
2012	83	0.19	6	25.3	31.3	0.61	31.6	0.51	31.3	0.61
2013	175	0.37	8	15.5	23.5	0.28	21.6	0.39	23.5	0.28
2014	97	0.24	10	21	31	0.3	41.7	0.33	31	0.3
2015	74	0.2	1	17.1	18.1	0.42	5	0.98	18.1	0.42
2016	134	0.18	10	27.6	37.6	0.43	55.6	0.42	37.6	0.43
2017	111	0.19	18	37.2	55.2	0.34	94.7	0.33	55.2	0.34
2018	129	0.25	2	30.7	32.7	0.36	8	0.71	32.7	0.36
1990−2000	5973	0.15	469	2739.3	3208.3	0.03	3126.7	0.06	3208.3	0.03
2001−2018	3112	0.2	177	763.5	940.5	0.08	885	0.09	940.5	0.08
2014−2018	545	0.21	41	136.4	177.4	0.17	195.2	0.2	177.4	0.17