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Bycatch Estimates of Coastal Bottlenose Dolphin (*Tursiops truncatus*) in U.S. Mid-Atlantic Gillnet Fisheries for 1996 to 2000

by

Debra L. Palka and Marjorie C. Rossman

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Debra L. Palka and Marjorie C. Rossman
National Marine Fisheries Serv., 166 Water St., Woods Hole, MA 02543

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EXECUTIVE SUMMARY

To assess the status of coastal bottlenose dolphins *(Tursiops truncatus),* estimates of population size and human-caused mortalities are required. The purpose of this manuscript is to estimate human-caused mortalities of coastal bottlenose dolphins due to bycatch in mid-Atlantic gillnet fisheries operating during 1996 to 2000 in oceanic waters (outside of bays) adjacent to New Jersey to North Carolina.

During summer (May to October), three coastal bottlenose dolphin management units reside in these waters: the Northern migratory, Northern NC, and Southern NC management units, and during winter (November to April) there is one management unit: the mixed stock management unit. This management unit was divided into two sub-units, one off North Carolina and one off Virginia. This is because, during winter most coastal bottlenose dolphins are off North Carolina, however, a small percentage are off Virginia; thus, bycatch rates off these two states differ. The management units in waters north of Cape Hatteras extend12 km offshore, and those south of Cape Hatteras extend 27 km offshore.

Total bycatch was defined as the product of the bycatch rate, takes per unit effort, estimated from a sample of the fishery, and the total effort from the fishery. Due to practical reasons, bycatch rates were defined as the ratio of observed dead coastal bottlenose dolphins to observed metric tons of fish landed. Consequently, total effort was total commercial gillnet landings.

Bycatch rates were estimated from a sample of fishing trips observed by the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) fisheries sampling program. These rates were estimated using a generalized linear model (GLM) that quantified the relationship between the number of observed takes and several variables: observed landings, seasonal management unit, body of water (state or federal waters), and mesh size category (small ($\leq$ 5 inches), medium (> 5 to < 7 inches) or large ($\geq$7 inches)). These variables were chosen out of 14 variables using a stepwise selection method. The GLM model is essentially a way to, in one step, estimate separate bycatch rates within each seasonal management unit for sub-fisheries represented by their mesh size and where they fish. Two variables not included in the bycatch model for practical reasons were a finer definition of distance from shore, and the presence or absence of an anchor. These two variables did not significantly improve the model's fit.

Total commercial metric tons of fish landed by the mid-Atlantic gillnet fishing fleet were calculated using landings recorded in the NMFS Northeast Region (NER) dealer reported commercial landings database and the North Carolina Division of Marine Fisheries (NCDMF) trip ticket program. These two databases contain the amount of fish landed by species. To generate bycatch estimates, landings were needed for each level of the factors selected by the GLM. Because data from NER and NCDMF lacked information on haul locations, landings of specific fish species (to account for the GLM factor mesh size category) from either the NER vessel trip reports (VTR) or NEFSC fisheries sampling databases were used to prorate total landings from the NER and NCDMF databases to water bodies within seasonal management units (to account for the GLM factors seasonal management and water body). Ideally, VTR data would be the best to use for the prorations, because these data are suppose to be a census of the fishing fleet. However, the fisheries sampling observer data from North Carolina were more representative than the North Carolina VTR data with respect to species composition and relative quantities of fish landed. Thus, fishery sampling observer data were used to prorate landings from North Carolina, and VTR data were used for the other states.

A total of 12 coastal bottlenose dolphins were observed taken within the mid-Atlantic gillnet fisheries during 1996 to 2000. One was released alive during the summer of 1999 on a trip in the Southern NC management unit. This uninjured animal was not considered in this analysis. Seven animals were taken in winter, and ten were taken from state waters.

Bycatch rates in state waters were 4 - 11 times higher than rates in federal waters. Rates in large mesh fisheries were 10 - 30 times higher than small mesh fisheries, and 4 - 9 times higher than medium mesh fisheries. Highest rates were in the summer Northern NC (0.0801 takes per mt landed; CV = 61.2%) and summer Northern migratory (0.0211; CV = 48.1%) management units. The lowest rate was in the Southern NC management unit (0). CV's of the bycatch rates when stratified to seasonal management unit, body of water, and mesh size category were large, mostly over 60%. However, when averaged to seasonal management unit, CV's improved to 48 - 84%.

Observer coverage was fairly high (generally 3 - 6%) in federal waters. Because of this level of coverage and the large number of observed hauls, power analyses indicate more takes should have been observed if the true bycatch was large. In conclusion, bycatch in federal waters was probably low. Observer coverage in state waters, where most of the takes were, was generally low, often below 1%, generally below 2.5%. Even with this low observer coverage, because there were so many trips observed during winter in North Carolina, the area with the most takes, there was a very good chance of observing a take when there were truly more than 150 takes per season. A disadvantage of low observer coverage is sub-fisheries may be missed. This is probably not the case in North Carolina in winter because the number of observed fish species and the level of landings in the observer data resemble the general patterns from the entire fishery. However, low observer coverage was a problem in small fisheries, such as those in the summer Northern and Southern NC management units. Thus, it is likely bycatch estimates for the summer Northern and Southern NC management units are biased low.

Total estimated bycatch was highest in the winter mixed stock management unit (146 in 2000 to 211 in 1997 per year), with most off North Carolina and few from Virginia. Estimated takes in Virginia during winter increased annually, from 11 in 1996 to 53 in 2000, though the differences were not significant. The 2000 bycatch estimate in North Carolina in the winter (93) was about half that of the highest year in that time-area (187), though the difference was not significant.

Average summer takes (53) were about one-third average winter takes (180). Over all areas, the annual average was 233 (CV = 16%; 95% CI = 171-318) coastal bottlenose dolphins. Total annual bycatch estimates for 2000 were the lowest (202), though it was not significantly different than other years. Average annual bycatch estimates for 1996 to 2000 were 30 (CV = 21.9%) for the summer Northern migratory, 23 (CV = 28.7%) for the summer Northern NC, 0 for the summer Southern NC, and180 (CV = 20.9%) for the winter mixed stock management units.

INTRODUCTION

In accordance to the 1994 amendments to the Marine Mammal Protection Act (MMPA), the status of all marine mammal stocks within the US EEZ are assessed by comparing the population size, and resulting potential biological removal (PBR) level, to the annual human-caused mortalities levels. The purpose of this manuscript is to estimate for seasonal coastal bottlenose dolphin management units, the human-caused mortalities during 1996 to 2000 that were due to bycatch in mid-Atlantic gillnet fisheries. The mid-Atlantic gillnet fisheries being considered take place in oceanic waters adjacent to New Jersey to North Carolina.

The combined results of genetic, stable isotope, telemetric, and photo identification analyses were used to define the spatial ranges of mid-Atlantic bottlenose dolphin *(Tursiops truncatus)* seasonal management units (SEFSC, in review). These results revealed that the coastal form of bottlenose dolphins inhabit waters out to 12 kilometers from shore when off the coasts of New Jersey to Cape Hatteras, NC (35° 13.8' N), and out to 27 kilometers when in waters from Cape Hatteras, NC to Jacksonville, FL. These results also revealed the coastal bottlenose dolphins move between two seasonal habitats, where summer was defined as May to October and winter as November to April. Thus, the seasonal management units of the coastal bottlenose dolphin that will be considered here include (Figure 1):

During summer (May to October):

1) Northern Migratory Management Unit, located between New Jersey (40° 30' N) and the North Carolina/Virginia border (36° 31.8' N);
2) Northern NC Management Unit, located between the North Carolina/Virginia border (36° 31.8' N) and Cape Lookout, NC (34° 37.8' N);
3) Southern NC Management Unit, located between Cape Lookout, NC (34° 37.8' N) and Murrell's Inlet, SC (33° 31.2' N);

During winter (November to April):

4) Mixed Stock Management Unit, located mainly north of Murrell's Inlet, SC (33° 31.2' N) to the North Carolina/Virginia border (36° 31.8' N), however, few are within Virginia waters, thus there are two sub-units:
   a) NC Mixed Stock Sub-Management Unit, and
   b) VA Mixed Stock Sub-Management Unit.

Total bycatch of dolphins from these seasonal management units was defined as the product of the: 1) bycatch rate, takes per unit effort, estimated from a sample of the fishery, and 2) total effort from the entire fishery. Due to practical reasons, the bycatch rate was defined as the ratio of the observed number of dead coastal bottlenose dolphin takes to observed metric tons of fish landed. Consequently, total effort was defined as total commercial gillnet landings (in metric tons).

Bycatch rates were estimated from a sample of fishing trips observed by the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) fisheries sampling program. This program, initiated during mid-1994 in mid-Atlantic waters, was designed to monitor the incidental take of marine mammals in selected fisheries. The total commercial metric tons of fish landed by the mid-Atlantic gillnet fishing fleet were calculated using landings recorded in the NMFS Northeast Region (NER) dealer reported commercial landings database and the North Carolina Division of Marine Fisheries (NCDMF) trip ticket program. These two databases contain the amount of fish landed by species for different types of fishing gear.

In the past, the NEFSC used the ratio method (Cochran 1977) to estimate total bycatch of marine mammals in fisheries (e.g., Rossman and Merrick 1999). However, other analytical methods were necessary in this case because the 1996 to 2000 data set of observed coastal bottlenose dolphin bycatch was binomially distributed (contains either zero or one bottlenose dolphin per fishing haul) with a very large proportion of zeros (13 bottlenose dolphin takes in over 7000 observed hauls, Waring *et al.* 2000). Two methods that have been used to estimate bycatch from data sets with such properties include the delta method (for example for marine mammals and turtles bycaugth in the pelagic long line fishery; Johnson *et al.* 1999), and the generalized linear model (GLM) method (for example, for fish bycatch in US shrimp trawls; Ortiz *et al.* 2000).

After preliminary analysis and review of these three statistical methods, the GLM method was determined to be the most appropriate analytical method for the coastal bottlenose dolphin bycatch data. This is because (Table 1):

1) Half of the assumptions for the ratio method were violated,
2) All the assumptions for the GLM method were valid; and
3) Though the two primary assumptions from the delta-distribution method were not violated, conditions that indicated the presence of a positive bias and inefficiency could be demonstrated.

Thus, the GLM method will yield the most accurate and least biased bycatch rates and mortality estimates.

Section 1 of this manuscript describes the fishery sampling observer data and statistical methods used to estimate bycatch rates. The bycatch rates were estimated from a GLM that used gear characteristics and fishing practices to predict the number of coastal bottlenose dolphin takes that were observed in the fishery sampling observer program. Section 2 describes the landing databases and analytical methods used to estimate total commercial gillnet landings in oceanic waters (excluding bays and sounds) for the factors selected by the bycatch rate model. Section 3 reports observer coverage of each dolphin seasonal management unit. And finally, section 4 reports annual estimates of bycatch from the mid-Atlantic gillnet fisheries for each coastal bottlenose dolphin seasonal management unit for 1996 to 2000.

METHODS

1. Bycatch Rates

1.A. Data

Bottlenose dolphins were observed taken in mid-Atlantic gillnet fisheries in both the coastal bottlenose dolphin habitat (0 to 12 (or 27) km from shore - as defined above) and offshore bottlenose dolphin habitat (outside of the coastal bottlenose dolphin habitat). This paper focuses only on coastal bottlenose dolphin takes.

To estimate coastal bottlenose dolphin bycatch rates, the NMFS/NEFSC fisheries sampling observer data collected during 1996-2000 were used. The fishery observer program collects data on characteristics of the trip, haul, gear, economic factors, fish species caught, and incidental takes. Trip characteristics include the vessel name and number, date sailed, date landed, home port, port fish landed, steam time, and number of crew. Economic factors related to the trip include the tons of ice used, fuel used, damage costs, and price of water, food, oil, and bait. Characteristics of a haul include weather conditions, wind speed and direction, wave height, depth range, time string soaked for, direction string set, latitude and longitude of the set and haul locations, date of the set and haul, time set and time hauled, fish species captain targeted, presence and quantity of fish caught to be landed and to be discarded, presence of incidental takes of marine mammals, seals, turtles, or birds, and presence and number of active and passive deterrent devices. Gear characteristics include number of nets, length and height of a net, hanging ratio, vertical mesh count, mesh size range, twine size, number of strands in the net, net material, net color, use of a float line, length of float line, material of float line, number of floats, length of lead line, number and width of spaces between nets, presence of and length of tie downs, and weight of anchor, if used. When an incidental take occurs, the following are also recorded: species identification, number of each species, net animal caught in, condition of the body, body length, sex, tag number (if body returned to sea), types of samples taken (body parts or whole animal), and frame number of roll of film if pictures were taken.

The GLM of bycatch rates used data from those gillnet hauls observed within the oceanic portion of the coastal bottlenose dolphin habitat (excluded bays and sounds), and within the time period November 1995 to November 2000. This time period covers winter 1996 (November 1995 through April 1996) to summer 2000 (May through October 2000). The data include all types of gillnets; those that were anchored and not anchored, and those on the bottom, in the water column, and at the surface. Because it was not possible to distinguish between these different types, all types were included in this analysis. Only dead bottlenose dolphin were considered to in the bycatch estimate.

To investigate bycatch rates in the winter mixed stock management unit, only trips that landed in North Carolina and Virginia were used. This was done because field observations indicate that during winter, most coastal bottlenose dolphins are found in waters off North Carolina, with very few dolphins off Virginia, and even fewer, if any, north of Virginia (SEFSC in review). Thus, bycatch from the winter mixed stock management unit was the sum of the bycatch from the winter VA mixed stock sub-management unit and from the winter NC mixed stock sub-management unit. To investigate bycatch rates in the Northern migratory management unit during summer, trips that landed in New Jersey, Delaware, Maryland, and Virginia were used. For bycatch rates in the Southern NC management unit, only trips from North Carolina were used. Although this management unit extends into South Carolina, only very limited gillnetting is allowed in South Carolina, so it was assumed there was no bycatch in the waters of South Carolina.

1.B. Development of a GLM Bycatch Model

The aim of the GLM was to use the fishery observer program data to describe the relationship between bycatch rates of coastal bottlenose dolphins (number of bottlenose dolphin takes per metric tons of landings of fish) and important gear characteristics and fishing practices. A way to interpret a GLM like this is, in one step, estimate separate bycatch rates within each seasonal management unit for sub-fisheries that are represented by some combination of gear characteristics and fishing practices.

Examples of gear characteristics include twine size, string length, and soak duration. Examples of fishing practices include season, year, location, and management unit. All variables that were investigated were defined in Table 2. Assuming the observed trips were representative of the entire fishery, the GLM was then used to predict bycatch rates that explicitly account for differences in gear characteristics and fishing practices. This assumption is investigated in the proration section below.

The steps to develop the GLM between the bycatch rate of coastal bottlenose dolphins and potential explanatory variables (gear characteristics and fishing practices) were: 1) determine the general formula for the model, 2) determine most appropriate statistical distribution to model the relationship, 3) select a set of variables that best describes the relationship, 4) investigate if other variables should be included, and then 5) check the fit of the model.

Step 1: determine best general formula for the model
The bycatch rate of bottlenose dolphins is a ratio of two quantities: count of observed bottlenose dolphin takes, and metric tons of observed fish landings. A GLM of the bycatch rate is:

$$\log\left({takes}/{landings} \right) = b_0 + b_1 x_1 + b_2 x_2 + \ldots \qquad (1)$$

which can be re-written as:

$$\log(takes) = \log(landings) + b_0 + b_1 x_1 + b_2 x_2 + \ldots \quad (2)$$

where the b's are parameter coefficients and x's are the gear characteristic and fishing practice variables. In words, Equation 2 means the number of takes is modeled by a set of explanatory variables ($b_0 + b_1 x_1 + b_2 x_2 + \ldots$) and an offset variable (*log(landings)*). Equation 2 becomes the general formula for the GLM used in this analysis.

Step 2: determine most appropriate distribution to model the relationship
The question is: What type of distribution best models the relationship between the response variable (number of bottlenose dolphin takes) and potential explanatory variables (management unit, landings kept, gear characteristics and fishing practices)? In this case, the number of dolphin takes were counts that ranged from zero to one. The Poisson distribution is commonly used with count data. The Binomial distribution is used with binary data, that is, data represented by the presence or absence of a factor (zero or one take per haul). In the case of bottlenose dolphin takes both the Poisson and Binomial distributions are applicable because the dolphin takes are counts that range from zero to one. There is no *a prior* reason that the count of dolphins caught in a gillnet are limited to just zero and one (thus, leading to a Poisson distribution), however, in our sample, the counts have been limited to zero and one (thus, leading to a Binomial distribution). When the response variable is a binary response, and the other variables in the model are explanatory variables, using the Binomial distribution is equivalent to the Poisson distribution. McCullagh and Nelder (1991) recommends that when there is a single response variable that is binomially distributed, it is simpler and more natural to use the Binomial distribution, though the Poisson distribution is also appropriate.

Step 3: select a set of variables that best describes the relationship
The backward-forward stepwise selection method was used to determine the best fitting model. This method starts with a complex model and then, in steps, successively simplifies the model so that the fit improves at each step. In this analysis, the complex model contained variables that were essential for the purpose of estimating the total bycatch, as well as other potential explanatory variables. The two essential variables are landings kept and management unit. The latter is essential because the model must estimate the total bycatch rate for each management unit. So, for example, even if management unit was not one of the best fitting variables in the bycatch model, it was necessary to include it in the model. Potential explanatory variables included in the model have two requirements: 1) be related to the bycatch rate of coastal bottlenose dolphins, and 2) be structured such that both observed and total landings kept can be calculated for each level of the variable.

It was necessary to pool levels of some variables which have many levels, were continuous, or had to be redefined to calculate total landings for each level. This was necessary because commercial landings were known for specific fish species, but not known for other variables, such as mesh size, twine size, soak duration, etc. So, to determine the best way to pool like-levels and account for the fish species landed, the classification TREE method was used (Venables and Ripley, 1999). For example, to determine the best definition of categories of mesh sizes, the classification TREE method was used to divide mesh sizes into groups of mesh sizes that best predicted the mesh size used for each target species. The classification TREE model was fit using binary recursive partitioning whereby data were successively split along coordinate axes of the predictor variables so that at any node, the split maximally distinguished the response variable in the left and right branches. Splitting continued until nodes were pure or data were too sparse. The new definition of levels of the mesh size were then put into the GLM to determine how the new classification was related to the bycatch rate.

The final model selected was the combination of variables that best fit the data, i.e., had the smallest Akaike Information Criterion (*AIC*), which is defined as:

$$AIC = -2 \bullet (\log \; likelihood \; of \; model) + 2 \bullet (number \; of \; parameters) \quad (3)$$

The AIC is similar to an adjusted R^2 in regular regression in that it is a measure of the level of parsimony. A parsimonious model is a model that fits the data well and includes as few parameters as possible.

Step 4: investigate if other variables should be included

Because not all variables were included in the complex model used in the stepwise selection method, it was of interest to investigate if including other variables could improve the fit of the model. This was done by adding additional variables into the model that resulted from the stepwise selection method and evaluating the *AIC* statistic. If the *AIC* decreased, then the additional variable improved the fit of the model. A Chi-square test between the models with and without the new variable was used to determine if the improvement was significant. The additional variables also had to be evaluated to determine the practicality in calculating total landings for the fleet for each level.

Step 5: check the fit of the model

A model provides an accurate description and inference for a data set only if it fits that data set well. Tests of each parameter, summary goodness-of-fit statistics, and investigation of residuals were used to determine the adequacy of the model fit, where a residual is the difference between the observed value and the value predicted by the model. For a model that fits perfectly, each residual equals zero; that is, the observed value equals the predicted value.

To test the significance of each variable in the model, an analysis of deviance for the sequential addition of each variable was conducted. This test indicates the significance of a variable given the variables already in the model. If the p-value for the Chi-square test is less than 0.05 then that variable is important and adds new information, even after adjusting for the previous variables.

The purpose of goodness-of-fit tests are to test whether the chosen model fits the data. This was done by performing a Fisher Exact test and a linear regression on the predicted and actual number of takes within each management unit. Within each management unit, the sum of predicted takes, and sum of observed takes were computed. Using these sums, the following null hypothesis (H_0) was tested:

H_0: number of predicted takes = number of actual takes.

The Fisher Exact test is similar to the Pearson's Chi-square test, but the Fisher Exact test does not require large sample sizes within a cell, as the Chi-square test does. Thus, the Fisher Exact test is more appropriate in this case. If the p-value for this test is less than 0.05 then the null hypothesis is rejected, implying that the number of predicted takes does not equal the actual takes and so the model does not fit well.

A linear regression between the number of predicted takes and the number of observed takes visually displays how well the model fits, and the R^2 value of the regression indicates how well the model predicted the actual data. R^2 ranges from 0 to 1, where 0 indicates no association between the actual and predicted values (the model does not fit) and 1 indicates perfect association (the model fits perfectly).

Goodness-of-fit statistics broadly summarize how well the model fits the data. To obtain further insight into details of the fit of the model, the structure of the residuals (difference between observed and predicted values) were investigated. Examining a plot of residuals against predicted values can reveal unexplained structure in the residuals of, say, only a part of the data. In a model that fits well there is no structure in the residuals; the pattern appears as random noise. Two sets of diagnostic plots were investigated. The first set of diagnostic plots come from a diagnostic model that was between the predicted number of takes from the GLM model and the observed number of takes. The diagnostic plots included: 1) a plot of the residuals from the diagnostic model versus the predicted values from the GLM model, and 2) a plot of the observed number of takes versus the predicted number of takes from the diagnostic model. The second set of diagnostic plots were plots of the relative contribution of each level of each explanatory variable. In a model that fits well, residuals are spread evenly around the mean of each level, and standard errors (SE) are tight around the mean.

1.C. Bycatch Rate Estimates

Parameters estimates from the best fitting GLM were used to predict the average bycatch rate for each management unit, accounting for important gear characteristics and fishing practices selected by the model.

The coefficient of variation (CV) of a bycatch rate was estimated using bootstrap re-sampling techniques. The re-sampling unit was a haul and was sampled with replacement. One thousand bootstrap samples were drawn. The CV of the bycatch rate was defined as the standard error (SE) of the bycatch rates from the 1000 bootstrap samples divided by the bycatch rate estimated from the original data.

2. Commercial Gillnet Landings

2.A. Data

Two data sources used to compile total gillnet landings during the time period winter 1996 (November 1995 through April 1996) to summer 2000 (May to October 2000) were: 1) the NMFS NER dealer reported commercial landings database; and 2) the NCDMF trip ticket program database.

The NER dealer reported commercial landings database contains data on commercial landings of marine species harvested from both state (0 to 4.8km (0 to 3 nautical miles (nmi)) from shore) and federal waters (4.8 to 320km (3 to 200 nmi) from shore). Data from the states of Maine through North Carolina are contained in this database. Data on species harvested exclusively under state jurisdiction are reported to NMFS by the state of Virginia. In contrast, data on species harvested under both state and federal jurisdictions combined are reported by the states of Maryland, Delaware and New Jersey. Data from all states are collected from federally permitted seafood dealers and include species, market category, pounds landed, gear type, water body (when available), date, port, and county where species were landed. However, data on individual trip location or gear characteristics are not recorded in this database (Wigley *et al.* 1998).

The NCDMF data from the trip ticket program include commercial landings from North Carolina only. These data are collected by federally permitted seafood dealers and include species harvested from both state and federal waters. Similar to the NER dealer database, the NCDMF include data on species, pounds landed, gear type, water body, date, and county where species were landed, but no data on individual trip location or gear characteristics.

When we requested the NCDMF data from the state of North Carolina, the data from 2000 were considered by the state of North Carolina as preliminary. These data will have to be requested again and bycatch estimates will have to be re-calculated. Therefore, it is possible landings from North Carolina during 2000 will change, and so may the 2000 bycatch estimates for management units off North Carolina.

2.B. Prorating Commercial Gillnet Landings

To generate estimates of total bycatch, landings were needed for each level of the factors selected by the GLM (seasonal management unit, mesh size category, and water body). Because data in the NER and NCDMF databases lacked information on haul locations, data from the NEFSC fishery sampling observer data or NER vessel trip reports (VTR) data, which do include locations of fishing trips, were used to prorate the landings to water body. The VTR data have also been used to prorate NER landings to water body for bycatch estimates from the Northeast multispecies gillnet fisheries in the Gulf of Maine region (Rossman and Merrick 1999). The proration factor was the percentage of landings of specific fish species (to account for the GLM factor mesh size category) that were within each water body and seasonal management unit (to account for the GLM factors seasonal management and water body). There were landings from three water bodies included in the landing databases: 1) state waters within the coastal dolphin habitat; 2) federal waters within the coastal dolphin habitat; and 3) federal waters outside the coastal dolphin habitat (within the offshore dolphin habitat). Only the first two water bodies were needed to estimate bycatch of coastal bottlenose dolphins.

For NER landings data from several mid-Atlantic states, landings from state oceanic waters were explicitly defined, and so proration of landings within the state coastal habitat was not necessary. While for data from other states, landings from state oceanic waters were combined with federal oceanic waters and so proration was necessary to determine the landings within each water body. Because quality of location data in the VTR and fishery sampling observer databases varied by state, prorations of landings from a state were calculated from the database with the highest quality data for that state. Ideally, the VTR data is the best database to use for the prorations, because these data are suppose to be a census of the fishing industry. In contrast, the fishery sampling observer data was designed to be a sample of the fishery. However, in North Carolina, the VTR data were missing trips from most of the counties and many of the smaller sub-fisheries. Thus, landings from North Carolina were prorated using the fishery sampling observer data, while landings from the other states were prorated using the VTR data. Details of the proration methods for each management unit are described below.

2.B.1. Management Units adjacent to New Jersey through Virginia

VTR data were used to prorate commercial gillnet landings from the NER dealer landings database to the water bodies within the seasonal management units adjacent to Virginia, Maryland, Delaware, and New Jersey.

For each season, winter 1996 to summer 2000, total effort for a management unit and water body (H_{ysumw}) was defined as metric tons of fish landed (H) by year (y), season (s), management unit (u), mesh category (m), and water body (w). This was estimated by first, prorating the individual state's (t) total landings (H_{tysum}) by the percentage of fish landed within each water body, as reported in the VTR database (ρ_{tysumw}), then summing over the states (t):

$$H_{ysumw} = \sum_{t} H_{tysum} \bullet \rho_{tysumw} \tag{4}$$

where

$$\rho_{tysumw} = \frac{H_{tysumw}}{H_{tysum}} = \frac{\textit{water body landings}}{\textit{total landings}} \tag{5}$$

Gillnet landings from Virginia state waters were explicitly defined and so did not have to be prorated. Landings from Virginia federal waters were prorated to the federal coastal habitat and the federal offshore habitat water bodies. In contrast, gillnet landings from state waters of Maryland and New Jersey were not explicitly defined and so landings for these states were prorated to all three water bodies. Ocean gillnet landings from Delaware came entirely from within the state coastal habitat water body and hence did not have to be prorated.

2.B.2. North Carolina Management Units

To determine which data set contained the most representative sample of North Carolina's fisheries, landings from the VTR database were compared to landings from the fisheries sampling observer and the NCDMF databases. It was found that the VTR's were only available from Dare county. Therefore, fishery harvests south of Cape Hatteras were not reported in the VTR data. Although the number of VTR's submitted by North Carolina have consistently increased since 1996, the proportion of VTR's with missing or unknown locations has also increased. On the other hand, the NEFSC sampling fisheries observer database included information on trip's locations and contained samples of gillnet trips from all counties, and samples from trips that landed many species, even rare species (Appendix A). An interpretation of this is, in order to capture the rare species and also capture the same peaks as in the NCDMF landings data, the fishery sampling observer program must be tracking the spatial and temporal patterns of the different sub-fisheries fairly well. In conclusion, the fisheries sampling observer data from North Carolina are likely a more representative sample than the NC VTR data. Therefore, the NEFSC fisheries sampling observer data were used to prorate commercial landings from the NCDMF database to water bodies within the winter NC mixed stock, summer Northern NC, and summer Southern NC management units.

Total effort within the North Carolina seasonal management units, water bodies, and mesh categories were defined using Equations 4 and 5, where the state (t) was always North Carolina and the proration (ρ) was estimated from observer data.

Gillnet landings from North Carolina state waters were explicitly defined and so did not have to be prorated. Therefore, only landings from North Carolina federal waters were prorated to the federal coastal habitat and federal offshore habitat water bodies.

3. Observer Coverage

Observer coverage of the mid-Atlantic gillnet fisheries was defined as the percent of observed metric tons of fished landed from the fishery sampling observer data to the total metric tons of fish landed. Observer coverage was calculated for each year, seasonal management unit, and water body combination. Years included 1996 to 2000; seasons included summer (May to October) and winter (November to April); water bodies included state waters within the coastal dolphin habitat, federal waters within the coastal dolphin habitat, and federal waters outside the coastal dolphin habitat. The pro-rated metric tons of landings to water body were used as the measure of effort for each strata.

4. Total Bycatch

Total bycatch within a year for a seasonal management unit (C_{ysu}) was the sum of bycatch estimates from all water bodies and mesh size category combinations within that seasonal management unit and year combination. Each bycatch estimate was the product of the bycatch rate (R) as estimated by the GLM and landings (H):

$$C_{ysu} = \sum_{mw} R_{ysumw} \bullet H_{ysumw} \quad (6)$$

Total bycatch for the entire winter mixed stock management unit was the sum of bycatch from the winter NC mixed stock sub-management unit (covering waters off of North Carolina) and the winter VA mixed stock sub-management unit (coverings waters from Virginia).

The amount of commercial landings was assumed to be known and so its CV = 0. Thus, the CV of total bycatch was equal to the CV of the bycatch rate.

RESULTS

1. Bycatch Rates

1.A. Data

A total of 12 coastal bottlenose dolphins were observed taken within the mid-Atlantic gillnet fisheries during 1996 to 2000. Seven of the animals were taken in winter (November through April) and five were taken in summer (May through October). One of the 12 animals was caught and released alive from a gillnet fished during the summer of 1999 on a trip observed off of North Carolina in waters in the Southern NC management unit. Thus, this animal is not considered a lethal take, and was not included in the bycatch estimate. Of the 12 animals observed, 2, 0, 2, 5, and 3 were taken in 1996, 1997, 1998, 1999 and 2000, respectively (Table 3).

Of the observed coastal bottlenose dolphins, 83% (10 out of 12) were within the state coastal habitat, or within 4.8 km (3 nmi) from shore. The remaining 17% (2 out of 12) were within the federal coastal habitat, or between 4.8 and 27 km from shore (Table 3; Figure 2). The winter NC mixed stock sub-management unit had the highest observed number of takes of coastal bottlenose dolphins (n = 6; Table 4C), while the summer Northern migratory management unit had the second highest number (n = 3; Table 4B). The winter VA mixed stock sub-management unit (Table 4A), summer Northern NC, and Southern NC management units (Tables 4D-E) each had one observed coastal bottlenose dolphin take.

1.B. Development of a GLM Bycatch Model

Step 1: determine best general formula for the model

The general formula of the GLM was the number of takes modeled by a set of explanatory variables ($b_0 + b_1 x_1 + b_2 x_2 + ...$) and an offset variable (*log(landings)*), as expressed in Equation 2 and discussed in the Methods section.

Step 2: determine most appropriate distribution to model the relationship

The Binomial distribution was chosen (see Methods discussion).

Step 3: select a set of variables that best describes the relationship

The full model (a large, complex model) had the essential variables (management unit and the offset of landings) and many other potential explanatory variables:

$$\log(\text{num.bodo}) \sim \text{MU} + \text{offset}(\log(\text{land.kept.mton})) + \text{state.or.fed} + \text{year} + \text{target.species} + \text{soak.duration} + \text{km.hr} + \text{season} + \text{string.length} + \text{escape.panel.used} + \text{twine.size} + \text{mesh.size}. \tag{7}$$

All variables investigated, their definitions, and abbreviations are listed in Table 2., The full model was used to start the stepwise model selection.

Using the backward-forward stepwise model selection method, the model:

$$\log(\text{num.bodo}) \sim \text{MU} + \text{state.or.fed} + \text{mesh.size} + \text{offset}(\log(\text{land.kept.mton})) \tag{8}$$

was chosen because it fit the data the best (i.e., it had the lowest AIC; Table 5).

The variable mesh.size had values that range from 1.3 to 13 inches. To use Equation 8 to estimate total bycatch, the bycatch rate for each mesh size must be multiplied by the total landings for each mesh size. Due to the lack of mesh size data in the commercial landings databases, it was not possible to determine total landings for each mesh size directly. So a mesh size proxy was generated by creating three categories of mesh sizes (small, medium, and large), where each target species was assigned to a mesh size category.

The best definition of mesh size categories was defined using a classification TREE method that used mesh size, management unit, and year to predict the target species. Using this model, it was possible to correctly predict which target species the captain was fishing for 74% of the time. This TREE model indicated the appropriate cut points for the mesh size categories were 5.1 and 6.85 inches (Figure 3). This resulted in three mesh size categories: small: ≤5.0 inches, medium: > 5.0 to < 7.0 inches, and large: ≥7.0 inches. These categories represent different groups of target species quite well (Table 6). Using this definition of mesh size categories, the NEFSC fishery sampling observer data (Appendix B) and total commercial landings were divided into seasonal management units, water bodies, years, and mesh size categories.

Using mesh size categories (mesh.cats) in the GLM improved the AIC to174.3 from 175.38, which was for the model that used the exact mesh size (mesh.size). In other words, the model that used the mesh size categories fit the data slightly better. In conclusion, the best fitting model was:

$$\log(\text{num.bodo}) \sim \text{MU} + \text{state.or.fed} + \text{mesh.cats} + \text{offset}(\log(\text{land.kept.mton})) \tag{9}$$

Step 4: determine if other variables should be included

Because not all potential variables were included in the complex, full model, other variables were added to the model to determine if the fit could be improved. Eight additional variables were investigated, and it was found that they did not significantly improve the fit (Table 7). The *AIC* was lower (i.e., the model fit slightly, but not significantly, better) when two types of variables were added.

The first type of variable that improved the fit was finer resolution of the distance from shore (dist2shore and dist2shoreA). The model in Equation 9 included the variable state.or.fed, which indicated if the haul was in state or federal waters. But when an even finer resolution of distance from shore was included in the model, the new model fit slightly better. The new model indicated the bycatch rate was highest for observed hauls within 3 km of shore. A Chi-square test comparing the model with and without dist2shoreA indicated the model with dist2shoreA was not a significantly better model ($\chi 2$ test; p=1.0). In addition, for the purposes of estimating the total bycatch, the variable dist2shoreA was problematic in that it required a further very fine-scale proration of the landings data. That is, it would of been necessary to estimate total landings that used a specific mesh size category and that were caught between the shore and 3 km, between 3 and 4.8 km, and between 4.8 km and the outside of the coastal bottlenose dolphin habitat (12 or 27 km). Because of this complexity and lack of significance, this variable was not used in the bycatch model.

The second variable type that improved the fit of the model was the presence or absence of an anchor (anchor.used). As with the distance to shore variables, adding anchor.used did not significantly improve the model ($\chi 2$ test; p=0.81). In addition, it was not practical to use it to estimate total landings because it was not possible to predictable divide the fish species caught (a reliable variable in the landings databases) into those caught in strings with or without an anchor. For example, 54% of the observed hauls that targeted Atlantic croaker did not use an anchor, and 42% of the observed hauls that targeted spiny dogfish did not use an anchor.

Step 5: check the fit of the model
An analysis of deviance for the sequential addition of each variable was conducted to test the variable's significance. The results (Table 8) indicated that the variable management unit (MU) was not as important as the other variables variable. However, it was necessary to include it in the model to produce a bycatch rate for each management unit . The other two variables, state.or.fed and mesh.size.catagory, were significant and therefore, useful in modeling the bycatch rate. This analysis also indicated that the state.or.fed variable was more highly correlated with bycatch than the mesh.cat variable was.

The tests for goodness-of-fit investigate if the chosen model fits the data, i.e., the predicted number of takes equals the observed number of takes. Within a management unit, this hypothesis could not be rejected using the Fisher Exact test (Table 9); thus, indicating the model fits the data. The linear regression results indicated the same thing. Fits between observed number of takes and predicted number of takes for a management unit were quite good (R^2 greater than 0.5) for all management units, except the summer Northern Migratory management unit, where the R^2 was 0.34 (Table 9; Figures 4A and 4B). For this management unit, the model slightly under-estimated the number of takes.

Two sets of diagnostic plots displayed the structure of residuals of a model between the predicted and observed number of takes in a seasonal management unit. The first set of diagnostic plots indicated that there were no obvious outliers, but there still was some unexplained structure in the residuals (Figures 5A and 5B). In a model that fits perfectly, the residuals would be scattered about zero with no pattern. The R^2 for this model was 0.75 (CV=0.12) and the slope was 0.92. If there was a perfect fit, the R^2 and slope would both be 1.0. The second set of diagnostic plots (Figure 6) showed the SE bars were fairly tightly clustered around the mean, especially for levels of variables with many observed hauls, and the spread of the residuals were what is excepted when the number of takes are restricted to the values of zero and one. In a model that fits perfectly, the residuals would be spread evenly around the mean of each level of the explanatory variable, and the SE bars would be tight around the mean. Overall, the fit was good.

1.C. Bycatch Rate Estimates

The best fitting and practical model was Equation 9, where the AIC was 174.3. The variables in that model were water body, mesh size category, and seasonal management unit (Table 10). The coefficients for this model were:

Intercept	state or federal	small mesh	medium mesh	NC mix Winter sub-MU	VA mix Winter sub-MU	NNC Summer MU	Nmigratory Summer MU
-4.214	1.214	0.595	0.929	0.768	0.066	-0.508	-0.724

where MU is management unit. The coefficient for the last level of each variable (federal waters, large mesh size, and Southern NC management) is by definition zero because the base line level is defined as federal waters, large mesh size, and in Southern NC management unit, so, all other levels are relative to this base line level.

Within the coastal dolphin habitat, estimated bycatch rates for hauls in state waters were higher than rates in federal waters (Table 11A). Rates in large mesh fisheries were highest, and rates in small mesh fisheries were lowest. Rates in the summer Northern NC and summer Northern migratory management units were highest (Table 12), and rates in the Southern NC management unit were the lowest (no observed dead animals, though one animal was released alive and uninjuried). Even though there were no observed dead takes in the Southern NC management unit, the model predicted a very small bycatch rate.

The CV's of the bycatch rates when stratified to seasonal management unit, body of water, and mesh size are large, mostly over 60% (Table 11B). However, when averaged to seasonal management unit, the level we are most interested in, the CV's improved to 48 - 84% (Table 12).

2. Commercial Gillnet Landings

2.B. Prorating Commercial Gillnet Landings

2.B.1. Management Units adjacent to New Jersey through Virginia

Winter Virginia mixed stock Sub-Management Unit (Virginia only):
All water bodies: Most of the gillnet landings from ports that fished in the winter VA mixed stock sub-management unit were from federal waters (both inside and outside the coastal dolphin habitat), and were from the medium mesh category which was dominated by the dogfish fishery (Figure 7). The medium mesh category fisheries landings (dominated by dogfish and American shad) from state waters were significantly less than that from federal water. The majority of landings from the small mesh category originated from state waters and were dominated by croaker, weakfish, bluefish and Atlantic mackerel fisheries. Most of the landings from the large mesh category were attributed to the striped bass fishery within state waters, and to the monkfish (anglerfish) fishery in federal waters.

Coastal Habitat water bodies: The majority of gillnet landings from the coastal dolphin habitat originated from state waters (Table 13A). Most of the landings from federal waters in the coastal dolphin habitat were from the medium mesh category, while most landings from state coastal waters were from the small mesh category. As an aside, most of the landings from federal waters came from areas outside of the coastal dolphin habitat.

Winter Northern Migratory Management Unit (Maryland, Delaware, and New Jersey only):
Winter landings from Maryland (Table 13B), Delaware (Table 13C), and New Jersey (Table 13D) were prorated into the three water bodies. However, these landings were not used in the bycatch estimate because it was assumed that there were very few, if any, coastal bottlenose dolphins in these waters during the winter; thus, it was assumed the bycatch estimate for these waters was zero.

Summer Northern Migratory Management Unit:
Virginia
All water bodies: The largest landings within a year-mesh size category occurred in1999 in the federal offshore habitat waters within the large mesh monkfish category (Figure 8). Other than this exception, most gillnet landings from Virginia ports that fished in the summer Northern migratory management unit habitat originated from state waters within the small mesh category, and were dominated by the croaker and spot fisheries. Fisheries within the medium mesh category were primarily harvested from federal waters and were dominated by dogfish. Most landings from the large mesh category were for black drum within state waters, and for monkfish in federal waters.

Coastal Habitat water bodies: Most gillnet landings from the coastal dolphin habitat of the Virginia portion of the summer Northern migratory management unit were from state waters and the small mesh category (Table 13E). Again, most of the fish caught in federal waters were caught outside of the coastal dolphin habitat.

Maryland

All water bodies: Most gillnet landings from the ports in Maryland that were derived from the summer Northern migratory management unit habitat were from the large and medium mesh categories, dominated by monkfish and dogfish, respectively (Figure 9). The small mesh category was dominated by several species: croaker, spot, bluefish, weakfish and menhaden.

Coastal Habitat water bodies: Most of the landings within the coastal habitat came from federal waters (Table 13F). Landings from the federal coastal habitat came from the small mesh category, except in 1999 when medium mesh landings were at a high.

Delaware

All water bodies: Because there were no reported landings in federal waters for the Delaware portion of the summer Northern migratory management unit, landings were not prorated, and so all landings were attributed to the state coastal habitat (Figure 10). The majority of landings were from the small mesh category, which was dominated by the croaker, bluefish and weakfish fisheries. In 1996, less than 1 mt was landed within the medium mesh category, which was dominated by shad. There were no landings from the large mesh category.

Coastal Habitat water bodies: Within state waters, there were no landings reported from the large mesh category during any year, and from the medium mesh category during 1997 to 2000 (Table 13G). Nearly all landings were from the state coastal dolphin habitat small mesh category, where the landings were small, less than 6.5 mt per year.

New Jersey

All water bodies: Landings from New Jersey ports that fished within the summer Northern migratory management unit habitat were similar across all mesh categories (Figure 11). Bluefish and weakfish dominated the small mesh category landings, dogfish dominated the medium mesh category landings, and monkfish dominated the large mesh category landings.

Coastal Habitat water bodies: Coastal habitat landings from the small mesh category originated mainly from state waters, while the majority of landings from the medium and large mesh categories originated from federal coastal waters (Table 13H). Again, landings from federal waters outside of coastal dolphin habitat made up most of the New Jersey landings.

2.B.2. North Carolina Management Units

Winter North Carolina Mixed Stock Sub-Management Unit:

All water bodies: Reported landings from federal waters were highest for fish species in the medium mesh category (dominated by dogfish), second highest in the small mesh category (dominated by Atlantic croaker, bluefish and weakfish), and lowest in the large mesh category (dominated by monkfish; Figure 12). Within each mesh category, landings from state waters were nearly similar to landings from federal waters, in terms of species composition and quantities landed. The exception is in the large mesh category, where striped bass dominated landings in state waters, and monkfish dominated landings in federal waters.

Coastal Habitat water bodies:. Most of the gillnet landings within the winter NC mixed stock sub-management unit habitat came from small mesh fisheries with catches in state waters typically exceeding those from federal coastal waters (Table 13I). There appears to have been a significant shift in the pattern of landings in federal waters during 2000; prior to 2000 most of the small mesh catches came from federal coastal waters, but in 2000 most came from federal offshore waters, outside the coastal dolphin habitat.

<u>Summer Northern North Carolina Management Unit:</u>
All water bodies: Most gillnet landings from ports that fished during summer within the Northern NC management unit habitat originated in state waters (Figure 13). In particular, most were within the small mesh category (dominated by spanish mackerel, spot and bluefish). Landings from state waters in the medium mesh category were dominated by sharks, king mackerel and dogfish. The large mesh category had the least amount of landings from both state and federal waters. All landings from federal waters were from the small and medium mesh categories, with the exception of 1996, when there was fishing for monkfish.

Coastal Habitat water bodies:. The majority of gillnet landings within this management unit was from small mesh fisheries within state waters (Table 13J).

<u>Summer Southern North Carolina Management Unit:</u>
All water bodies: Nearly all gillnet landings from ports that fished during summer within the Southern NC management unit habitat originated from state waters within the small mesh category and was dominated by the spot fishery (Figure 14). Landings from state waters within the medium mesh category were dominated by sharks, fluke and king mackerel. All landings from federal waters were from the small mesh category, and was dominated by the spot fishery.

Coastal Habitat water bodies:. Nearly all the gillnet landings within the coastal dolphin habitat in this management unit were from the small mesh fisheries in state waters (Table 13K).

3. Observer Coverage

3.A. Management Units adjacent to New Jersey through Virginia

<u>Winter Virginia mixed sub-management unit (Virginia only):</u>
Annual number of trips observed and percent coverage of gillnet landings within this seasonal sub-management unit ranged from a low of 35 trips (7.50% coverage) in 1996 to a high of 92 trips (3.27% coverage) in 2000 (Table 4A). Although coverage of the gillnet fisheries was highest in the federal coastal and offshore habitats there was considerable variability, ranging from 8.20%-100% and 0.25%-57.51%, respectively. Landings reported in 1996 for federal water bodies were very low compared to other years. Coverage was lowest in the state coastal habitat, ranging from 0.50%-1.48%.

Summer Northern migratory management unit (Virginia through New Jersey):
Annual number of trips observed and percent coverage of gillnet landings within these seasonal management unit ranged from a low of 110 trips (1.50% coverage) in 1999 to a high of 162 trips (2.94% coverage) in 2000 (Table 4B). Coverage of gillnet fisheries was highest in the federal coastal and offshore habitats, ranging from 3.43%-16.60% and 1.24%-3.50%, respectively. Coverage was lowest in the state coastal habitat, ranging from 0.58%-2.98%.

3.B. North Carolina Management Units

In general, the NEFSC fisheries sampling observer data appear to be fairly representative of the North Carolina gillnet fishery, especially in the winter when most of the fishing occurs. In North Carolina, the diversity of fish species landed in the observed trips and the relative pattern of quantities of landings resemble that from the NCDMF landings (Appendix A).

Winter North Carolina mixed stock sub-management unit:
Annual number of trips observed and percent coverage of gillnet landings within this seasonal sub-management unit ranged from a low of 104 trips (1.69% coverage) in 1997 to a high of 173 trips (1.97% coverage) in 1999 (Table 4C). Coverage of the gillnet fisheries was highest in federal coastal and offshore habitats, ranging from 2.45%-4.51% and 2.76%-5.65%, respectively. Coverage was lowest in the state coastal habitat, ranging from 0.41%-1.49%.

Summer Northern North Carolina management unit (Dare and Hyde counties):
Annual number of trips observed and percent coverage of gillnet landings within this seasonal management unit ranged from a low of 1 trip (0.20% coverage) in 1997 to a high of 35 trips (3.28% coverage) in 2000 (Table 4D). Although coverage of gillnet fisheries was highest in the federal coastal and offshore habitats there was considerable variability, ranging from 0.00%-18.07% and 0.00%-24.18%, respectively. Coverage was lowest in the state coastal habitat, ranging from 0.00%-2.53%.

Summer Southern North Carolina management unit (Carteret, Onslow , Pender, New Hanover, Brunswick counties:
Annual number of trips observed and percent coverage of gillnet landings within this seasonal management unit ranged from a low of 0 trips (0.00% coverage) in 1996 and 1997, to a high of 44 trips (3.4% coverage) in 2000 (Table 4E). Beginning in 1998, coverage improved; in the federal coastal and federal offshore habitats coverage ranged from 3.12%-100% and 2.32%-100%, respectively, and coverage in the state coastal habitat ranged from 0.96%-2.70%.

4. Total Bycatch

Total estimated bycatch was highest in the winter mixed stock management unit (146 in 2000 to 211 in 1997), with most of the takes coming from waters off North Carolina and only a few from off Virginia (Tables 14 and 15). The annual differences in this management unit were not statistically different.

Estimated takes in Virginia during winter increased, from a low of 11 in 1996 to a high of 53 in 2000, though the differences were not significant (Table 15). The increase was due to increased landings in the large mesh fisheries in state waters (in particular striped bass), from 29 mt in 1996 to 248 mt in 2000 (Table 14A).

The 2000 bycatch estimate in North Carolina during winter (93) was about half that from the year with the highest bycatch in the same area and season (187 in 1997), though the difference was not significant (Table 15) . This difference was due to a decrease in landings from all mesh size fisheries in state waters and the small mesh fisheries in federal waters; however, the landings in the large mesh fisheries in federal waters inside the coastal dolphin habitat increased from 59 in 1999 to 283 in 2000 (Table 14C).

Average estimated summer takes (53) were about one-third of the average winter takes (180). In all waters between New Jersey and North Carolina, during 1996 to 2000, an average of 233 (CV = 16%; 95% CI = 171-318) coastal bottlenose dolphins were taken during a year (Table 15). Total annual bycatch estimates for 2000 were the lowest in the series (202), though the decrease was not significant.

The level of uncertainties (%CV) about the annual estimates were fairly high, ranging from 48% to 84% (Table 15). The uncertainties about the 5-year averages were lower (22% to 42%).

Five-year average annual bycatch estimates for the management units were 30 (CV = 21.9%) for summer Northern migratory, 23 (CV = 28.7%) for summer Northern NC, 0 for summer Southern NC, and180 (CV = 20.9%) for the winter mixed stock management units (Table 15).

DISCUSSION

1. Bycatch Rates

Two factors that had the highest correlation with the bycatch rate were distance from shore and mesh size. The bycatch rate was highest for hauls that were within state waters, particularly within 3 km of shore. This could be because there are more dolphins closer to the shore, as seen during aerial surveys conducted off New Jersey to North Carolina (Garrison and Yeung, in review). The GLM also detected bycatch rates were highest for hauls that used large mesh sizes ($\geq$7 inches), intermediate for medium mesh sizes (>5 to <7 inches), and lowest for hauls that used small mesh sizes ($\leq$5 inches). One interpretation of the mesh size categories is these categories represent different sub-fisheries within the mid-Atlantic that have different bycatch rates.

Two variables that were not included in the bycatch model for practical reasons, but could possibly be useful were a finer definition of distance from shore (dist2shoreA) and the presence or absence of an anchor (anchor.used). The effect of adding either of these two variables into the bycatch model was not significant; that is, they were not as important as the variables already in the model. The model already included a variable that was a measure of distance from shore (state.or.fed). So it is reasonable to believe that there may be a pattern in the bycatch rate of hauls within state waters. Especially because there appears to be a density gradient of coastal bottlenose dolphins relative to distance from shore, where there are more coastal bottlenose dolphins near the beach, and less offshore.

The other variable that slightly improved the bycatch model was anchor.used. However, the observation that strings with anchors had a higher bycatch rate than strings without anchors may only be a statistical artifact. That is, it is known that strings with large mesh sizes have a higher bycatch rate than strings with small mesh sizes. Of the observed strings that used large mesh sizes, 73% used an anchor, while only 46% that used small mesh sizes used an anchor. Thus, even if there was no true relationship between bycatch and the presence of an anchor, it is more likely that a take would be observed in a string with an anchor, because strings with anchors tend to use larger mesh sizes. In statistical terms, the variables mesh.cats and anchor.used are aliased, that is, they are correlated and so represent similar bycatch rates. Still another way to look at the data is 10 of the 11 dead bottlenose dolphins were taken in nets that had an anchor. Thus, it is possible that even within each mesh size category, nets with an anchor have a higher chance of taking a bottlenose dolphin. This could be investigated further.

The bycatch rate model was used to estimate the average bycatch rate within a seasonal management unit. It is important not to over-interpret these estimated bycatch rates. That is, the model is valid when estimating rates within the times and areas sampled, but they are not necessarily valid for the future or in areas not sampled. To make the inference to other times and areas, two assumptions must be made: 1) gear characteristics and fishing practices must somehow predict the probability of a bycatch; that is, there is a cause-and-effect relationship; and 2) fishing practices and combination of gear characteristics that were observed in the data will be the same as in other times and areas. Neither of these assumptions have been shown to be valid or invalid. Consequently, caution should be exercised when applying modeled results to times and areas other than that used to develop the model.

Most biological systems demonstrate inter-annual variability. Yet the stepwise selection method did not choose the variable year. This could be because there is little or no inter-annual variability, or there were insufficient data to accurately distinguish inter-annual variability in the bycatch rates within seasonal management unit, water body, and mesh size category. It is more likely that the latter is true. In the future, it is possible that fishery management actions or other events will cause fishing practices to alter sufficiently to change the bycatch rate. If this is thought to be happening or one wants to investigate inter-annual changes, then in the future when there are more data, the model can to be modified to explicitly account for effects of year, and yet still maintain the same bycatch rate estimates for 1996 to 2000.

Landings were used as the unit of effort in the bycatch rate because no other data were available for the measure of effort in the entire fishery. This unit of effort may not be the ideal measure because landings data from both the NER dealer and NCDMF databases may under-estimate fishing effort because, for example, not all landings are recorded into these databases, and some fishing effort may result in no landings. Thus, the total amount of fishing effort, the bycatch rate, and total bycatch is likely to be negatively biased. The magnitude of this bias is unknown. Other measures of effort should be explored and evaluated.

2. Commercial Gillnet Landings

Because the bycatch rate model accounted for sub-fisheries (mesh size categories and water body), some of the commercial landings had to be prorated using data that were collected from only a sample of the total landings (VTR and NEFSC fisheries sampling observer data). In the past, the amount of landings have been assumed to be known with certainty and so its CV equaled zero. However, when prorating the landings using data from a sample there is some uncertainty. Therefore, the CV should not equal zero. In the present analysis this component of the CV had not been estimated and so the presented CV's of the total bycatch estimates are biased low by some unknown amount. One reasonable way to obtain a CV of the prorated landings is by using bootstrap re-sampling techniques, because it is not possible to derive a theoretical CV. While the CV of landings when prorated using the VTR data is probably small because, for many states, the VTR data is a large sample of the total landings, the exact amount is presently unknown. This could be investigated further.

In the NCDMF database, when the number of vessels that report landings from a water body/county combination was equal to or less than three, their landings were considered confidential and so were not provided to us. This means that during summer when there were few vessels fishing from some North Carolina counties in some water bodies, these landings would be considered confidential. In these cases, the landings we reported were biased low and observer coverage biased high. Though, since there were only three or less vessels fishing, it was unlikely that the level of effort was not large, the bycatch estimate likely small, especially compared to the winter in NC, and so the level of bias also likely small.

Winter landings reported from 1996 for federal water bodies landed in Virginia were very low compared to other years. If these landings were erroneous, the reported levels of landings, bycatch estimate, as well as observer coverage would also be erroneous. This requires further investigation.

3. Observer Coverage

Observer coverage in federal waters, both inside and outside of the coastal bottlenose dolphin habitat, was generally 3 - 6%. In federal waters outside of coastal dolphin habitat no coastal dolphin takes were observed. Because of the relatively high level of coverage in federal waters outside of the coastal dolphin habitat and the large number of observed hauls, more observed takes should have been observed if the true bycatch was high. For example, assuming a binomial distribution of bycatch rates, for the total landings in federal waters outside the winter NC mixed stock sub-management unit during 1996 to 2000 (6238 mt) (annual estimates in Table 4C), and an average observer coverage of 4% (annual estimates in Table 4C), there was a 64% chance of observing one or more takes sometime during 1996 to 2000 if there were truly 25 dolphins taken in total during all five years, 87% chance if there were truly 50 dolphins taken, and a 98% chance if there were truly 100 takes during all five years. But a take was not observed. In conclusion, it is highly likely that the bycatch is very small in federal waters outside the coastal dolphin habitat, especially outside the winter NC mixed stock sub-management unit.

In federal waters inside the coastal bottlenose dolphin habitat, two bottlenose dolphins were observed taken (Table 2), and the observer coverage was generally between 2.5 and 6%, with some times and places higher (> 17% in winter VA mixed stock sub-management unit during 1996 to 1998), and other times and places lower (0% in the Southern NC management unit in the summers of 1996 to 1997). The only take observed in federal waters inside the coastal bottlenose dolphin habitat in the winter NC mixed stock sub-management unit was during 1998, the year with the highest observer coverage (4.51%). One interpretation of this is that the true bycatch in federal coastal waters was low because we needed a fairly high coverage of 4.5% to see one take. That is, assuming a binomial distribution of bycatch rates, for the 1,991 mt of landings in the federal coastal waters of the winter NC mixed stock sub-management unit (Table 4C), with an average observer coverage of 4.51%, there was a 90% chance of observing one or more takes if there were truly 50 dolphins taken in this time and area, and a 99% chance if there were truly 100 takes. In contrast to the year with the lowest coverage, 2.45% coverage in 2000, there was a 80% chance of observing one or more takes if there were truly 50 dolphins taken in this seasonal management unit, and a 91% chance if there were truly 100 takes. It was estimated that there were on average eight animals per year taken in this management unit (annual estimates in Table 14C). If it is true that the observer coverage (average of 2.9%) was too low in most years to have observed a take, then the estimated average bycatch of eight animals per season may be negatively biased perhaps up to 64% (2.9/4.5). If this level of bias were true, the estimated average bycatch for the federal coastal waters in the winter NC mixed stock sub-management unit would increase to only13 animals. In conclusion, the bycatch in federal waters inside the coastal dolphin habitat was probably low, though not as low as outside the dolphin habitat.

Observer coverage in state waters was generally low, often below 1%, generally below 2.5%. However, even though the observer coverage was low, there were nine observed takes in state waters, five of which were in the winter NC mixed stock sub-management unit. In this management unit, average observer coverage in state waters was 0.8% with an average of 3876 mt of landings in the winter season (annual estimates in Table 4C). Using these facts and assuming a binomially distributed bycatch rate, if there were 50, 100, 150, 200, or 250 animals that were truly taken in the winter season, then there was a 33%, 56%, 71%, 81% and 92% chance of observing one take in the winter season, respectively. The landings in these state waters have been declining, but the observer coverage has been increasing. So in the most recent year, using the facts from 2000 (2246 mt landed and a 1.49% observer coverage), there was a 90% chance of observing a take if there were truly 150 animals taken in the winter season. In other words, even with the low observer coverage, because there were so many trips observed (i.e., tons of landings observed), there was a good chance of observing a take in the winter NC waters when the true number of takes were 150 or more animals per season.

Low observer coverage was a problem in small fisheries (few mt landed), such as those in the summer Northern and Southern NC management units. In the Southern NC management unit, there was no coverage during 1996 and 1997, and a maximum of 2.7% observer coverage in 1999, when there were only 128 mt of landings from this seasonal management unit. The only observed take was during 1999, the year with the most coverage. Note, this animal was released alive from a net that soaked for a half hour, so it was not included in the bycatch estimate. Assuming takes were binomially distributed, there was a 72% chance of observing a take if the true number of takes were 45 animals per season, and a 91% chance if there were truly 70 animals taken. Thus, due to low coverage of a small fishery, it is likely the bycatch estimates for the summer Northern and Southern NC management units are biased low, by an unknown amount.

4. Total Bycatch

The CV's around the 5-year mean bycatch estimates ranged from 22 to 42% (Table 15). The most uncertainty was around the winter VA mixed stock sub-management unit, where the 95% confidence interval was16 to 74 animals per season. This may be due to low observer coverage (average of 1.1%) in state coastal habitat waters (annual estimates in Table 4A) or to the fact that coastal bottlenose dolphins may not always be present in waters off of Virginia during the winter.

In the NC winter mixed stock sub-management unit, the bycatch for 2000 (93) was about 40% lower than the average from the previous years (159 during1996 to1999). This change was due to a decline in landings in state waters, particularly that from the large mesh fisheries, and not due to a change in the bycatch rate. The reason for the decreased landings may be fishery management actions, natural variability in the distribution of dolphins and/or fishers, or something else. It does not appear that the change in landings during the winter 2000 season (November 1999 through April 2000) was due to the monkfish fishery management plan implemented on 1 May 2000, or a closure for turtles from 12 May to 12 June 2000. If these or other fishery management plans do influence future distributions and quantities of landings, then future bycatch estimates of coastal bottlenose dolphins will probably vary from that seen in this paper. In general it is expected that if landings decline so will the bycatch estimate.

Bycatch rates were highest for large mesh fisheries that target monkfish, striped bass, and black drum. So changes in these fisheries will have large influences on the bycatch estimate. The monkfish fishery was relatively small in coastal dolphin habitat and more intense in waters offshore the coastal dolphin habitat, while the striped bass and black drum fisheries were more intense in state waters. Striped bass landings have been increasing, while monkfish landings started decreasing in 2000 and is suppose to continue decreasing. If both of these patterns continue to hold true for the future, and the bycatch rates of monkfish and striped bass hauls continue to be similar to each other, then it is possible that bycatch of coastal bottlenose dolphins will not decrease, even though fishing for monkfish declines drastically.

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Table 1. Assumptions for three methods that can be used to estimate the bycatch rate of coastal bottlenose dolphins and if it was found to be valid.

	Assumption	Tested Valid
	Ratio Method	
1.	The relationship between the numerator (number of dolphins) and denominator (landings kept) of the ratio estimator is a straight line through the origin.	No
2.	The variance of the landings kept about the above line is proportional to the number of dolphin takes.	Yes
3.	The CV's of the numerator and denominator should be less than 10%.	No
4.	The sample size within a stratum exceeds 30.	Yes
	Delta-distribution Method	
1.	The data can be easily divided into events with a zero bycatch rate and a positive bycatch rate and the data are dominated by a large proportion of zeros.	Yes
2.	Positive bycatch rates follow a log-normal distribution.	Yes
3.	There are no small departures of the log-normal distribution, especially for small positive values.	No
4.	The sample size of positive events is greater than 15 within a stratum.	No
	Log-linear Regression Method	
1.	The bycatch rates follow a Poisson distribution, or	Yes
2.	The variance in the bycatch rate is constant over the range of the bycatch rate values.	Yes

Table 2. Gear characteristics and fishing practice variables investigated, in alphabetical order.

Variable Name	Description
anchor.used =	presence or absence of an anchor.
depth =	minimum depth string was set in (in fathoms)
dist2shore =	distance to shore (in km) binned into the following categories: (0-0.5], (0.5-1], (1-1.5], (1.5-2], (2-2.5], (2.5-3], (3-3.5], (3-4], (4-5], (5-6], and >6.
dist2shoreA =	distance to shore (in km) binned into the following categories: (0-3] and >3
escape.used =	presence or absence of an escape panel
km.hr =	product of length of string (in km) and soak duration (in hours)
land.kept.mton =	weight of landings of all fish species kept and not discarded (in metric tons)
mesh.size =	size of mesh (in inches)
mesh.cats =	target species that predominately use small (≤5.0 inches), medium (>5.0 to <7 inches), and large mesh sizes (≥7 inches)
month =	month
MU =	seasonal management units: All of NC in winter (NC mixed stock sub-management unit) VA mixed stock sub-management unit in winter Northern NC in summer Northern migratory in summer Southern NC in summer
net.height =	height of net
num.bodo =	number of dead bottlenose dolphins observed taken
season =	winter (November to April) summer (May to October)
set.dir =	direction net was set. Choices are: with depth, against depth, with a loran line, with the tide, with a compass direction, mixed reasons, other, unknown.
soak.duration =	length of time (hours) net was left in water
state.or.fed =	indicator if the haul was in state or federal waters
string.length =	length of string (in feet)
target.species =	primary fish species captain said they were fishing for
target.twine.cats =	target species that predominately were in nets with small (<0.57mm), medium (>= 0.57 to <=0.81 mm), and large twine sizes (> 0.81 mm)
tie.used =	presence or absence of tie downs
twine.size =	size of twine size (in mm)
year =	1996 = November 1995 to October 1996 1997 = November 1996 to October 1997 1998 = November 1997 to October 1998 1999 = November 1998 to October 1999 2000 = November 1999 to October 2000

Table 3. Coastal bottlenose dolphin takes observed by year, water body, and season.

Year	State Coastal Habitat		Federal Coastal Habitat		Seasonal Total		Annual Total
	Winter	Summer	Winter	Summer	Winter	Summer	
1996	1	1	0	0	1	1	2
1997	0	0	0	0	0	0	0
1998	0	1	1	0	1	1	2
1999	3	2[1]	0	0	3	2	5
2000	2	0	0	1	2	1	3
Sub-Total	6	4	1	1	7	5	12
Total (percent)	10 (83%)		2 (17%)		7 (58%)	5 (42%)	12 (100%)

[1] One animal was caught and released alive in a haul in the Southern NC management unit. All other animals caught were dead.

Table 4A. Number of observed gillnet trips and hauls, and percent observer coverage (defined as the ratio of gillnet landings (mt) observed to gillnet landings collected by the NER dealer reported landings program), by seasonal management unit, year and water body (state-coastal habitat, federal-coastal habitat, and federal-offshore habitat). Highlighted rows indicate when and where a coastal bottlenose dolphin take was observed.

Winter (Nov-Apr) - VA Mixed Stock Sub-Management Unit (Virginia only)

Year	water body	NER landings*	NEFSC observed landings	% Observer coverage	Observed number of trips	Observed number of hauls	Observed Takes
1996	state - coastal	428.15	5.23	1.22	9	21	0
	fed - coastal	6.95	6.95	100.00	11	43	0
	fed - offshore	39.89	22.94	57.51	15	62	0
	TOTAL	468.04	35.12	7.50	35	126	0
1997	state - coastal	791.04	5.97	0.75	9	34	0
	fed - coastal	109.38	18.82	17.21	18	96	0
	fed - offshore	1739.40	32.60	1.87	13	86	0
	TOTAL	2639.82	57.39	2.17	40	216	0
1998	state - coastal	984.52	4.94	0.50	11	31	0
	fed - coastal	29.71	10.65	35.85	21	73	0
	fed - offshore	1368.15	3.45	0.25	13	93	0
	TOTAL	2382.38	19.04	0.80	45	197	0
1999	state - coastal	838.33	12.45	1.48	28	89	1
	fed - coastal	206.03	16.90	8.20	44	164	0
	fed - offshore	1712.08	15.21	0.89	13	86	0
	TOTAL	2756.44	44.56	1.62	85	339	1
2000	state - coastal	750.47	11.13	1.48	43	170	0
	fed - coastal	172.68	14.48	8.38	34	133	0
	fed - offshore	353.23	16.13	4.57	15	73	0
	TOTAL	1276.38	41.74	3.27	92	376	0
	Total Observed Coastal Bottlenose Dolphins						1

[*] NER gillnet landings reported for federal waters were prorated to coastal and offshore habitats.

Table 4B. Number of observed gillnet trips and hauls, and percent observer coverage (defined as the ratio of gillnet landings (mt) observed to gillnet landings collected by the NER dealer reported landings program), by seasonal management unit, year and water body (state-coastal habitat, federal-coastal habitat, and federal-offshore habitat). Highlighted rows indicate when and where a coastal bottlenose dolphin take was observed.

Summer (May-Oct) - Northern Migratory Management Unit (Virginia, Maryland, Delaware, New Jersey)

Year	water body	NER landings*	NEFSC observed landings	% Observer coverage	Observed number of trips	Observed number of hauls	Observed Takes
1996	state - coastal	733.43	13.59	1.85	20	78	0
	fed - coastal	199.40	33.10	16.60	34	163	0
	fed - offshore	1999.70	57.47	2.87	59	342	0
	TOTAL	2932.53	104.16	3.55	113	583	0
1997	state - coastal	752.33	14.71	1.95	33	158	0
	fed - coastal	301.29	14.92	4.95	25	103	0
	fed - offshore	1473.95	51.53	3.50	62	269	0
	TOTAL	2527.57	81.16	3.21	120	530	0
1998	state - coastal	615.65	3.55	0.58	15	37	1
	fed - coastal	179.68	9.66	5.37	25	54	0
	fed - offshore	2348.14	81.74	3.48	93	451	0
	TOTAL	3143.47	94.95	3.02	133	542	1
1999	state - coastal	406.15	5.32	1.31	18	59	1
	fed - coastal	170.34	9.83	5.77	24	72	0
	fed - offshore	2504.12	31.15	1.24	68	274	0
	TOTAL	3080.61	46.30	1.50	110	405	1
2000	state - coastal	565.27	16.87	2.98	39	144	0
	fed - coastal	372.43	12.78	3.43	36	113	1
	fed - offshore	1224.46	33.96	2.77	87	296	0
	TOTAL	2162.16	63.61	2.94	162	553	1
	Total Observed Coastal Bottlenose Dolphins						3

* NER gillnet landings reported for state and federal waters from the states of New Jersey and Maryland were prorated to coastal and offshore habitats. Virginia's landings from only federal waters were prorated. Delaware landings were not prorated.

Table 4C. Number of observed gillnet trips and hauls, and percent observer coverage (defined as the ratio of gillnet landings (mt) observed to gillnet landings collected by the NCDMF trip ticket program), by seasonal management unit, year and water body (state-coastal habitat, federal-coastal habitat, and federal-offshore habitat). Highlighted rows indicate when and where a coastal bottlenose dolphin take was observed.

Winter (Nov-Apr) - North Carolina Mixed Stock Sub-Management Unit (all of North Carolina)

Year	Water Body	NCDMF landings*	NEFSC observed landings	% Observer coverage	Observed number of trips	Observed number of hauls	Observed Takes
1996	state - coastal	4501.01	18.57	0.41	30	136	1
	fed - coastal	2288.17	80.32	3.51	43	211	0
	fed - offshore	1877.06	92.76	4.94	35	148	0
	TOTAL	8666.24	191.65	2.21	108	495	1
1997	state - coastal	4667.75	23.70	0.51	38	162	0
	fed - coastal	2256.95	58.50	2.59	47	184	0
	fed - offshore	880.57	49.71	5.65	19	96	0
	TOTAL	7805.27	131.91	1.69	104	442	0
1998	state - coastal	4400.13	17.84	0.41	52	200	0
	fed - coastal	1990.61	89.80	4.51	76	319	1
	fed - offshore	1216.64	46.48	3.82	26	120	0
	TOTAL	7607.38	154.12	2.03	154	639	1
1999	state - coastal	3563.19	42.72	1.20	94	433	2
	fed - coastal	1839.38	58.32	3.17	67	263	0
	fed - offshore	710.41	19.58	2.76	12	61	0
	TOTAL	6112.98	120.62	1.97	173	757	2
2000	state - coastal	2246.43	33.46	1.49	84	309	2
	fed - coastal	1482.10	36.24	2.45	54	175	0
	fed - offshore	1553.55	43.37	2.79	29	161	0
	TOTAL	5282.08	113.07	2.14	167	645	2
Total Observed Coastal Bottlenose Dolphins							6

* NCDMF gillnet landings reported for federal waters were prorated to coastal and offshore habitats.

Table 4D. Number of observed gillnet trips and hauls, and percent observer coverage (defined as the ratio of gillnet landings (mt) observed to gillnet landings collected by the NCDMF trip ticket program), by seasonal management unit, year and water body (state-coastal habitat, federal-coastal habitat, and federal-offshore habitat). Highlighted rows indicate when and where a coastal bottlenose dolphin take was observed. Observed takes = '-' when there was no observer coverage.

Summer (May-Oct) - Northern North Carolina Management Unit (Dare and Hyde counties)

Year	water body	NCDMF landings*	NEFSC observed landings	% Observer coverage	Observed number of trips	Observed number of hauls	Observed Takes
1996	state - coastal	244.54	2.67	1.09	17	143	1
	fed - coastal	8.76	0.02	0.23	3	3	0
	fed - offshore	0.00	0.00	0.00	0	0	-
	TOTAL	253.30	2.69	1.06	20	146	1
1997	state - coastal	314.84	0.00	0.00	0	0	-
	fed - coastal	0.00	0.00	0.00	0	0	0
	fed - offshore	37.78	0.72	1.91	1	1	0
	TOTAL	352.62	0.72	0.20	1	1	0
1998	state - coastal	201.91	0.50	0.25	13	76	0
	fed - coastal	3.04	0.48	15.79	5	28	0
	fed - offshore	7.36	1.78	24.18	8	28	0
	TOTAL	212.31	2.76	1.30	26	132	0
1999	state - coastal	175.43	1.28	0.73	8	26	0
	fed - coastal	28.07	1.60	5.70	9	28	0
	fed - offshore	2.43	0.12	4.94	7	22	0
	TOTAL	205.93	3.00	1.46	24	76	0
2000	state - coastal	261.62	6.61	2.53	22	137	0
	fed - coastal	7.14	1.29	18.07	11	27	0
	fed - offshore	46.20	2.44	5.28	2	15	0
	TOTAL	314.96	10.34	3.28	35	179	0
	Total Observed Coastal Bottlenose Dolphins						1

* NCDMF gillnet landings reported for federal waters were prorated to coastal and offshore habitats.

Table 4E. Number of observed gillnet trips and hauls, and percent observer coverage (defined as the ratio of gillnet landings (mt) observed to gillnet landings collected by the NCDMF trip ticket program), by seasonal management unit, year and water body (state-coastal habitat, federal-coastal habitat, and federal-offshore habitat). Highlighted rows indicate when and where a coastal bottlenose dolphin take was observed. Observed takes = '-' when there was no observer coverage.

Summer (May-Oct) - Southern North Carolina Management Unit (Carteret, Onslow, Pender, New Hanover, and Brunswick counties)

Year	water body	NCDMF landings[1]	NEFSC observed landings	% Observer coverage	Observed number of trips	Observed number of hauls	Observed Takes
1996	state - coastal	179.21	0.00	0.00	0	0	-
	fed-coastal & fed-offshore	0.67	0.00	0.00	0	0	-
	TOTAL	179.88	0.00	0.00	0	0	-
1997	state - coastal	197.99	0.00	0.00	0	0	-
	fed-coastal & fed-offshore	0.00	0.00	0.00	0	0	-
	TOTAL	197.99	0.00	0.00	0	0	-
1998	state - coastal	177.98	1.71	0.96	14	44	0
	fed - coastal	0.69	0.69	100.00	6	15	0
	fed - offshore	0.27	0.27	100.00	2	2	0
	TOTAL	178.94	2.67	1.49	22	61	0
1999	state - coastal	127.97	3.46	2.70	13	33	1#
	fed - coastal	0.32	0.01	3.12	7	13	0
	fed - offshore	7.75	0.18	2.32	1	1	0
	TOTAL	136.04	3.65	2.68	21	47	1
2000	state - coastal	180.75	4.36	2.41	20	51	0
	fed - coastal	0.49	0.49	100.00	17	38	0
	fed - offshore	1.33	1.33	100.00	7	25	0
	TOTAL	181.57	6.18	3.40	44	114	0
	Total Observed Coastal Bottlenose Dolphins						1

[*] NCDMF gillnet landings reported for federal waters were prorated to coastal and offshore habitats.
Bottlenose dolphin taken in gillnet and released alive. Not included in bycatch estimate.

Table 5. Results from a stepwise selection of a model of bycatch rates of coastal bottlenose dolphins in mid-Atlantic gillnets using gear characteristics and fishing practices. The statistics provided for each model includes: degrees of freedom of the model (DF), deviance of the model (Deviance), residual degrees of freedom (Resid DF), residual deviance (Resid Dev), and the AIC. The smaller the AIC the better the model fits.

Model	DF	Deviance	Resid. DF	Resid. Dev	AIC
full[1]			4424	120.92	208.92
-twine size	15	18.13	4439	139.05	197.05
-target species	17	19.06	4456	158.11	182.11
-escape panel used	1	0.00	4457	158.12	180.12
-string length	1	0.12	4458	158.13	178.13
-year	1	0.26	4459	158.39	176.39
-km.hr	1	1.71	4460	160.09	176.09
-soak duration[2]	1	1.28	4461	161.38	175.38

[1] full model: log(num.bodo) ~ MU + offset(log(land.kept.mton)) + state.or.fed + year + target.species + soak.duration + km.hr + season + string.length + escape.panel.used + twine.size + mesh.size

[2] final model: log(num.bodo) ~ MU + state.or.fed + mesh.size + offset(log(land.kept.mton))

Table 6. Fish species assigned to each mesh size category, and the proportion of hauls from the NEFSC fishery sampling data that targeted a fish species using a net that had small mesh sizes (≤5.0 inches), medium mesh sizes (> 5.0 to < 7.0 inches), or large mesh sizes (≥7.0 inches).

Mesh size category	target species	Percent of hauls using mesh sizes of		
		small	medium	large
small mesh size	Atlantic croaker	99	1	0
	Atlantic mackerel	100	0	0
	Spanish mackerel	99	1	0
	Weakfish	96	4	0
	Bluefish	62	38	0
	Kingfish	100	0	0
	Menhaden	100	0	0
	Spot	100	0	0
	Butterfish	100	0	0
medium mesh size	King mackerel	14	86	0
	Shad	15	85	0
	Shark	30	60	10
	Smooth dogfish	0	97	3
	Spiny dogfish	2	98	0
	Flounder	0	100	0
large mesh size	Monkfish	0	0	100
	Striped bass	1	16	83
	Black drum	0	14	86

Table 7. *AIC* values for models that added one more variable into the best fitting model chosen from the stepwise selection method. The lower the *AIC* the better the fit.

* indicates the model fits better than the "best model"[1]

Model	AIC
"best model"[1]	174.33
"best model" + set.dir	181.55
"best model" + month	177.51
"best model" + depth	176.18
"best model" + tie.used	175.94
"best model" + net.height	174.38
"best model" + dist2shore	170.87*
"best model" + dist2shoreA	169.98*
"best model" + anchor.used	167.79*

[1] the "best model" is log(num.bodo) ~ MU + state.or.fed + mesh.cats + offset(log(land.kept.mton))

Table 8. Analysis of deviance for the sequential addition of each variable in the model. If Pr(Chi) is less than 0.05 then the last variable in the model is important and contributes new information even after adjusting for the previous variables already in the model. The other statistics provides are explained in Table 5.

Model	Df	Deviance	Resid. Df	Resid. Dev.	Pr(Chi)
offset only			4020	179.40	
offset + MU	4	2.51	4016	176.89	0.6423
offset + MU + state.or.fed	1	9.55	4015	167.34	0.0020
offset + MU + state.or.fed + mesh size category	2	9.01	4013	158.33	0.0111
offset only			4020	179.40	
offset + MU	4	2.51	4016	176.89	0.6423
offset + MU + mesh size category	2	6.23	4014	170.66	0.0444
offset + MU + mesh size category + state.or.fed	1	12.33	4013	158.33	0.0004

Table 9. Results of two goodness-of-fit tests, the Fisher Exact test and a linear regression between predicted and actual number of takes. The null hypothesis was H_0: number of predicted takes within a seasonal management unit = the number of actual takes in that seasonal management unit. When the p-value of the Fisher Exact test is greater than 0.05 then we are not able to reject the H_0. The larger the value of R^2 of the linear regression, the better the fit.

Seasonal Management Unit	Fisher's p-value	R^2
Northern NC - summer	0.20	0.87
Northern migratory - summer	1.00	0.34
Southern NC - summer	1.00	1.00
VA mixed stock sub-unit - winter	1.00	0.53
NC mixed stock sub-unit - winter	0.05	0.87

Table 10. Summary of variables selected by the GLM analysis to estimate bycatch rates of coastal bottlenose dolphins in mid-Atlantic gillnet fisheries from New Jersey to North Carolina.

<table>
<tr><th>Years</th><th>Seasons</th><th>Management Units</th><th>Water Bodies</th><th>Mesh Categories</th></tr>
<tr><td rowspan="2">1996-2000
(Nov 1995 - October 2000)</td><td>Winter (Nov-Apr)</td><td>NC mixed stock sub-unit
VA mixed stock sub-unit</td><td rowspan="2">State Coastal Habitat (SCH)

Federal Coastal Habitat (FCH)

Federal Offshore Habitat (FOH)</td><td rowspan="2">Small: ≤ 5 inches. Fisheries:Croaker, Bluefish, Weakfish, Kingfish, Menhaden, Atl. Mackerel, Spot, Butterfish, Spanish Mackerel

Medium: >5- <7 inches. Fisheries:Dogfish, Shad, King Mackerel, Sharks, Fluke

Large: ≥7 inches. Fisheries:Monk-fish,Striped Bass, Black Drum</td></tr>
<tr><td>Summer (May-Oct)</td><td>Northern NC (Dare and Hyde Counties)

Southern NC (Carteret, Onslow, Pender, New Hanover, Brunswick)

Northern Migratory (Virginia, Maryland, Delaware, New Jersey)</td></tr>
</table>

Table 11. Estimated bycatch rate (number of coastal bottlenose dolphin takes/metric tons of fish landed) and coefficient of variation (CV) for each seasonal management unit, mesh size category (small, medium, and large), and distance from shore (state waters, federal waters within the coastal bottlenose dolphin habitat).

A. Bycatch rate

Management Unit	Body of water	Bycatch rate		
		Small mesh (≤5.0 inches)	Medium mesh (> 5.0 to < 7.0)	Large mesh (≥7.0 inches)
NC mixed stock - winter	state	0.0159	0.0504	0.3222
	federal	0.0014	0.0047	0.0403
VA mixed stock - winter	state	0.0075	0.0243	0.1825
	federal	0.0007	0.0022	0.0193
N. Migratory - summer	state	0.0266	0.0824	0.4458
	federal	0.0024	0.0079	0.0663
N. NC - summer	state	0.0698	0.1979	0.6885
	federal	0.0066	0.0213	0.1632
S. NC - summer	state	0.0006	0.0020	0.0173
	federal	0.0001	0.0002	0.0016

B. Coefficient of variation (CV)

Management Unit	Body of water	%CV		
		Small mesh (≤5.0 inches)	Medium mesh (> 5.0 to < 7.0)	Large mesh (≥7.0 inches)
NC mixed stock - winter	state	87.9	46.5	64.8
	federal	114.7	89.3	92.7
VA mixed stock - winter	state	120.0	126.5	107.1
	federal	146.4	160.5	129.9
N. Migratory - summer	state	64.9	70.7	64.7
	federal	111.5	113.6	109.6
N. NC - summer	state	100.3	94.1	92.4
	federal	171.1	159.3	134.3
S. NC - summer	state	111.8	146.6	206.3
	federal	146.8	527.2	184.8

Table 12. By management unit, average bycatch rates of coastal bottlenose dolphins, weighted by the percent observed landings within a mesh size category and water body stratum.

Variable	Seasonal Management Unit				
	Winter (Nov - Apr)		Summer (May - Oct)		
	NC mixed	VA mixed	N migratory	N. NC	S. NC
Bycatch rate	0.0143	0.0107	0.0211	0.0801	0.0003
%CV	49.2	84.4	48.1	61.2	164.9

Table 13. NER and NCDMF dealer reported commercial landings (in mt) prorated to water body (state coastal habitat (SCH), federal coastal habitat (FCH), and federal offshore habitat (FOH)) and mesh size category (small, medium, and large) using either the VTR or fishery sampling observer data.

A. winter- Virginia mixed stock sub-management unit (Virginia only)
B. winter- Northern migratory management unit (Maryland only)
C. winter- Northern migratory management unit (Delaware only)
D. winter- Northern migratory management unit (New Jersey only)
E. summer - Northern migratory management unit (Virginia only)
F. summer - Northern migratory management unit (Maryland only)
G. summer - Northern migratory management unit (Delaware only)
H. summer - Northern migratory management unit (New Jersey only)
I. winter - North Carolina mixed stock sub-management unit (all of NC)
J. summer - Northern North Carolina management unit (Dare and Hyde counties)
K. summer - Southern North Carolina management unit (Carteret, Onslow, Pender, New Hanover, and Brunswick counties)

Table 13A.

Winter-Virginia/VA Mixed Stock Sub-Management Unit NER Dealer Reported Commercial Landings (MT) from Federal Waters Prorated to Coastal and Offshore Habitats															
Year	SMALL MESH					MEDIUM MESH					LARGE MESH				
	% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT		% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT		% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT	
	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH
1996	.	.	0.50	.	.	0.00	100.00	35.06	0.00	35.06	0.00	100.00	4.83	0.00	4.83
1997	18.46	81.54	1.70	0.31	1.39	5.94	94.06	1738.33	103.25	1635.08	5.35	94.65	108.75	5.82	102.93
1998	17.51	82.49	10.87	1.90	8.96	1.57	98.43	1378.05	21.67	1356.38	68.58	31.42	8.94	6.13	2.81
1999	46.11	53.89	33.98	15.67	18.31	8.05	91.95	1787.20	143.86	1643.34	47.97	52.03	96.93	46.50	50.43
2000	66.44	33.56	27.00	17.94	9.06	28.92	71.08	405.20	117.19	288.01	40.07	59.93	93.71	37.55	56.16

Winter-Virginia/VA Mixed Stock Sub-Management Unit NER Dealer Reported Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	255.91	143.00	29.24
1997	298.45	435.54	57.04
1998	451.40	426.34	106.77
1999	329.30	291.00	218.03
2000	313.13	188.89	248.46

Table 13B.

Winter-Maryland/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from Oceanic Waters Prorated to All Habitats																					
Year	SMALL							MEDIUM							LARGE						
	% VTR MT			NER Dealer Total MT Landed in Oceanic waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT		
	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH
1996	53.89	1.92	92.70	106.16	5.72	2.04	98.40	0.39	1.56	98.05	3480.29	13.70	54.21	3412.38	2.14	1.14	96.72	115.70	2.48	1.31	111.90
1997	10.07	19.38	70.56	48.19	4.85	9.34	34.00	0.01	7.73	92.26	2109.51	0.21	163.11	1946.19	0.01	3.16	96.83	166.59	0.01	5.27	161.31
1998	27.18	9.80	63.02	34.12	9.27	3.34	21.50	2.51	2.79	94.70	920.14	23.09	25.69	871.36	6.00	8.15	85.85	102.14	6.13	8.32	87.69
1999	36.68	9.84	53.48	91.82	33.68	9.03	49.10	33.21	0.56	96.12	1050.91	34.89	5.87	1010.14	9.46	0.93	89.61	95.68	9.05	0.89	85.74
2000	52.06	1.64	46.30	68.71	35.77	1.13	31.81	18.95	6.38	74.67	274.27	51.97	17.51	204.79	17.37	12.56	70.07	65.04	11.30	8.17	45.57

Table 13C.

Winter-Delaware/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	6.32	78.28	10.96
1997	15.61	25.72	6.76
1998	23.45	62.32	5.79
1999	24.28	70.76	8.72
2000	61.99	80.72	5.41

Table 13D.

Winter-New Jersey/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from Oceanic Waters Prorated to All Habitats																					
Year	SMALL							MEDIUM							LARGE						
	% VTR MT			NER Dealer Total MT Landed in Oceanic waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT		
	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH
1996	-	28.10	71.89	61.99	-	17.42	44.56	-	3.43	96.57	609.46	-	20.92	588.54	-	5.75	94.24	864.29	-	49.76	814.53
1997	15.65	0.44	83.91	197.38	30.88	0.87	165.63	0.12	0.01	99.86	1548.66	1.92	0.25	1546.49	0.02	1.07	98.91	1330.29	0.22	14.22	1315.85
1998	11.21	17.15	71.64	186.06	20.85	31.92	133.29	1.57	9.71	88.72	1311.92	20.59	127.43	1163.89	0.01	31.88	96.79	1407.96	0.20	44.88	1362.88
1999	18.95	22.08	58.97	243.02	46.04	53.65	143.32	2.42	8.55	89.03	1337.14	32.38	114.34	1190.42	0.14	2.60	97.25	1718.73	2.45	44.74	1671.54
2000	25.72	26.94	47.34	176.02	45.27	47.43	83.32	2.22	12.00	85.78	907.59	20.16	108.91	778.52	0.09	1.11	98.79	1406.09	1.39	16.17	1442.54

Table 13E.

Summer-Virginia/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from Federal Waters Prorated to Coastal and Offshore Habitats															
Year	SMALL					MEDIUM					LARGE				
	% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT		% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT		% VTR MT		NER Dealer Total MT Landed in federal waters	Prorated NER MT	
	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH
1996	100.00	0.00	0.26	0.26	0.00	87.19	12.81	173.70	151.45	22.25	0.83	99.17	26.33	0.22	26.11
1997	45.07	54.93	0.07	0.03	0.04	0.00	100.00	32.99	0.00	32.99	0.00	100.00	2.34	0.00	2.34
1998	12.26	87.74	0.54	0.07	0.47	20.47	79.53	17.58	3.60	13.98	0.36	99.64	234.79	0.85	233.94
1999	22.08	77.92	19.48	4.30	15.18	11.75	88.25	132.34	15.55	116.79	0.01	99.99	614.92	0.07	614.85
2000	14.57	85.43	81.60	11.98	69.71	8.05	91.95	86.10	6.93	19.17	0.23	99.76	112.25	0.26	111.99

Summer-Virginia/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	447.12	85.55	15.56
1997	501.05	36.29	5.66
1998	219.39	43.55	16.85
1999	109.28	58.92	4.95
2000	219.16	29.82	5.80

Table 13F.

Summer-Maryland/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from Oceanic Waters Prorated to All Habitats																					
Year	SMALL							MEDIUM							LARGE						
	% VTR MT			NER Dealer Total MT Landed in Oceanic waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT		
	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH
1996	83.19	5.78	11.03	7.38	6.14	0.43	0.81	0.00	30.80	69.20	106.09	0.00	32.68	73.41	0.00	0.00	100.0	138.01	0.00	0.00	138.01
1997	10.45	67.48	22.07	17.23	1.80	11.63	3.80	23.95	21.84	54.20	30.45	7.29	6.65	16.50	1.81	10.78	87.41	149.07	2.70	16.08	130.30
1998	4.18	52.20	43.62	20.16	0.84	10.53	8.79	47.26	16.25	36.50	38.92	18.39	6.32	14.20	0.13	0.00	99.87	159.00	0.21	0.00	158.79
1999	0.61	56.87	42.52	46.35	0.28	26.36	19.71	0.99	60.32	38.68	83.90	0.83	50.61	32.45	0.00	0.00	100.0	134.16	0.00	0.00	134.16
2000	2.95	28.29	68.77	26.10	0.77	7.38	17.95	0.00	73.03	26.97	11.59	0.00	8.46	3.13	0.00	0.25	99.75	42.08	0.00	0.11	41.98

Table 13G.

Summer-Delaware/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	6.46	0.31	0.00
1997	1.97	0.00	0.00
1998	1.25	0.00	0.00
1999	0.00	0.00	0.00
2000	1.24	0.00	0.00

Table 13H.

Summer-New Jersey/Northern Migratory Management Unit NER Dealer Reported Commercial Landings (MT) from Oceanic Waters Prorated to All Habitats																					
Year	SMALL							MEDIUM							LARGE						
	% VTR MT			NER Dealer Total MT Landed in Oceanic waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT			% VTR MT			NER Dealer Total MT Landed in federal waters	Prorated NER Dealer MT		
	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH	SCH	FCH	FOH		SCH	FCH	FOH
1996	24.24	5.98	75.16	695.21	168.52	4.16	522.53	0.38	1.01	98.61	614.99	2.35	6.22	606.43	0.23	0.65	99.12	615.56	1.42	3.99	610.15
1997	30.79	26.93	42.27	623.30	191.95	167.86	263.50	0.86	17.90	81.24	408.45	3.52	73.11	331.82	0.01	3.61	96.38	718.68	0.10	25.92	692.66
1998	35.31	14.48	50.22	665.80	235.07	96.39	334.34	6.83	5.35	87.18	817.06	55.83	43.74	717.48	0.59	2.04	97.37	889.59	5.21	18.19	866.19
1999	32.31	6.11	61.57	654.68	211.52	40.06	403.09	6.97	9.26	83.76	288.81	20.14	26.76	241.90	0.02	1.03	98.94	935.89	0.22	9.67	025.99
2000	32.09	18.59	49.32	931.42	298.86	173.16	459.40	2.79	24.83	72.89	222.67	5.07	55.30	162.30	1.16	27.76	71.08	392.37	4.55	108.92	278.89

Table 13I.

Winter-North Carolina Mixed Stock Sub-Management Unit NCDMF Commercial Landings (MT) from Federal Waters Prorated to Coastal and Offshore Habitats															
Year	SMALL MESH					MEDIUM MESH					LARGE MESH				
	% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT	
	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH
1996	91.80	8.20	1605.56	1473.85	131.70	33.78	66.23	2402.85	811.59	1591.26	1.74	98.26	156.83	2.73	154.10
1997	97.65	2.35	1341.57	1309.99	31.58	61.11	38.89	1547.77	945.68	601.80	0.52	99.48	248.48	1.29	247.19
1998	65.66	34.34	1867.72	1226.33	641.39	72.41	27.59	1052.83	762.36	290.48	0.67	99.33	286.69	1.92	284.76
1999	73.14	26.86	1657.41	1212.26	445.15	86.21	13.79	658.74	567.89	90.85	25.35	74.65	233.65	59.22	174.42
2000	30.02	69.98	1960.36	588.46	1371.90	77.09	22.91	792.77	611.12	181.65	100.00	0.00	282.51	282.51	0.00

Winter-North Carolina Mix Management Unit NCDMF Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	2514.31	1926.59	60.11
1997	1911.32	2714.94	41.49
1998	2813.81	1543.12	43.19
1999	2365.58	1047.66	149.94
2000	1271.44	942.02	32.97

Table 13J.

Summer-Northern North Carolina Management Unit (Dare and Hyde Counties) NCDMF Commercial Landings (MT) from Federal Waters Prorated to Coastal and Offshore Habitats																
Year	SMALL					MEDIUM					LARGE					
	% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT	
	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH
1996	100.00	0.00	1.63	1.63	0.00	100.00	0.00	0	0.00	0.00	100.00	0.00	7.13	7.13	0.00
1997	0.00	100.00	31.02	0.00	31.02	0.00	0.00	6.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	15.40	84.60	8.66	1.33	7.33	100.00	0.00	1.74	1.74	0.00	0.00	100.00	0.00	0.00	0.00
1999	94.31	5.69	27.51	25.94	1.57	74.12	25.88	2.99	2.22	0.77	0.00	100.00	0.00	0.00	0.00
2000	27.09	72.91	46.20	12.52	33.68	47.70	52.30	7.14	3.41	3.73	0.00	0.00	0.00	0.00	0.00

Summer-Northern North Carolina Management Unit (Dare and Hyde Counties) NCDMF Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	179.07	64.94	0.53
1997	236.43	76.83	1.58
1998	173.29	23.27	0.35
1999	169.11	6.30	0.02
2000	207.68	53.28	0.66

Table 13K.

Summer-Southern North Carolina Management Unit (Carteret, Onslow, Pender, New Hanover, Brunswick Counties) NCDMF Commercial Landings (MT) from Federal Waters Prorated to Coastal and Offshore Habitats															
Year	SMALL					MEDIUM					LARGE				
	% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT		% Observed MT		NCDMF Total MT Landed in federal waters	Prorated NCDMF MT	
	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH	FCH	FOH		FCH	FOH
1996	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	71.84	28.16	0.96	0.69	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	4.19	95.81	8.07	0.34	7.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	26.80	73.20	1.82	0.49	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Summer-Southern North Carolina Management Unit (Carteret, Onslow, Pender, New Hanover, Brunswick Counties) NCDMF Commercial Landings (MT) from State Coastal Habitat			
Year	Small SCH	Medium SCH	Large SCH
1996	178.42	0.69	0.10
1997	197.53	0.42	0.04
1998	177.91	0.06	0.01
1999	127.96	0.00	0.00
2000	180.74	0.01	0.00

Table 14A. Bycatch estimates of coastal bottlenose dolphins by seasonal management unit, year, water body, and mesh category. In addition, the bycatch rates (dead coastal bottlenose dolphins/ fish landings (mt)), and prorated effort (landed fish in mt) are included. These data are for only the coastal bottlenose dolphin habitat.

Winter (Nov-Apr) - VA Mixed Stock Sub-Management Unit (Virginia only)

Year	Water body in coastal habitat	Small mesh category (≤ 5 inches)			Medium mesh category (> 5 to < 7 inches)			Large mesh category (≥7 inches)			All mesh
		Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Estimate
1996	state	0.0075	255.91	1.92	0.0243	143	3.48	0.1825	29.24	5.34	10.74
	federal	0.0007	0	0.00	0.0022	0	0.00	0.0193	0	0.00	0.00
	TOTAL			1.92			3.48			5.34	10.74
1997	state	0.0075	298.45	2.24	0.0243	435.54	10.59	0.1825	57.04	10.41	23.24
	federal	0.0007	0.31	0.00	0.0022	103.25	0.23	0.0193	5.82	0.11	0.34
	TOTAL			2.24			10.81			10.52	23.58
1998	state	0.0075	451.40	3.39	0.0243	426.34	10.36	0.1825	106.77	19.49	33.25
	federal	0.0007	1.90	0.00	0.0022	21.67	0.05	0.0193	6.13	0.12	0.17
	TOTAL			3.40			10.41			19.61	33.41
1999	state	0.0075	329.3	2.48	0.0243	291	7.07	0.1825	218.03	39.79	49.34
	federal	0.0007	15.67	0.01	0.0022	143.86	0.32	0.0193	46.50	0.90	1.22
	TOTAL			2.49			7.39			40.69	50.57
2000	state	0.0075	313.13	2.35	0.0243	188.89	4.59	0.1825	248.46	45.35	52.29
	federal	0.0007	17.94	0.01	0.0022	117.19	0.26	0.0193	37.55	0.73	0.99
	TOTAL			2.37			4.85			46.07	53.29

Table 14B. Bycatch estimates of coastal bottlenose dolphins by seasonal management unit, year, water body, and mesh category. In addition, the bycatch rates (dead coastal bottlenose dolphins/ fish landings (mt)), and prorated effort (landed fish in mt) are included. These data are for only the coastal bottlenose dolphin habitat.

Summer (May-Oct) - Northern Migratory Management Unit (Virginia, Maryland, Delaware, New Jersey)

Year	Water body in coastal habitat	Small mesh category (≤ 5 inches)			Medium mesh category (> 5 to < 7 inches)			Large mesh category (≥7 inches)			All mesh
		Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Estimate
1996	state	0.0266	628.24	16.69	0.0824	88.21	7.27	0.4458	16.98	7.57	31.53
	federal	0.0024	4.84	0.01	0.0079	190.35	1.50	0.0663	4.21	0.28	1.79
	TOTAL			16.70			8.76			7.85	33.31
1997	state	0.0266	696.77	18.51	0.0824	47.10	3.88	0.4458	8.46	3.77	26.16
	federal	0.0024	179.52	0.43	0.0079	79.77	0.63	0.0663	42.00	2.78	3.84
	TOTAL			18.94			4.51			6.55	30.00
1998	state	0.0266	464.99	12.35	0.0824	122.47	10.09	0.4458	28.19	12.57	35.01
	federal	0.0024	106.99	0.26	0.0079	53.66	0.42	0.0663	19.04	1.26	1.94
	TOTAL			12.61			10.51			13.83	36.95
1999	state	0.0266	321.09	8.53	0.0824	79.89	6.58	0.4458	5.17	2.30	17.42
	federal	0.0024	67.72	0.16	0.0079	92.92	0.73	0.0663	9.74	0.65	1.54
	TOTAL			8.69			7.31			2.95	18.95
2000	state	0.0266	520.03	13.82	0.0824	34.89	2.87	0.4458	10.35	4.61	21.30
	federal	0.0024	192.52	0.46	0.0079	70.69	0.56	0.0663	109.29	7.24	8.26
	TOTAL			14.28			3.43			11.86	29.57

Table 14C. Bycatch estimates of coastal bottlenose dolphins by seasonal management unit, year, water body, and mesh category. In addition, the bycatch rates (dead coastal bottlenose dolphins/ fish landings (mt)), and prorated effort (landed fish in mt) are included. These data are for only the coastal bottlenose dolphin habitat.

Winter (Nov-Apr) - North Carolina Mixed Stock Sub-Management Unit (all of North Carolina)

Year	Water body in coastal habitat	Small mesh category (≤ 5 inches)			Medium mesh category (> 5 to < 7 inches)			Large mesh category (≥7 inches)			All mesh
		Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Estimate
1996	state	0.0159	2514.31	39.98	0.0504	1926.59	97.10	0.3222	60.11	19.37	156.45
	federal	0.0014	1473.85	2.06	0.0047	811.59	3.81	0.0403	2.73	0.11	5.99
	TOTAL			42.04			100.91			19.48	162.43
1997	state	0.0159	1911.32	30.39	0.0504	2714.94	136.83	0.3222	41.49	13.37	180.59
	federal	0.0014	1309.99	1.83	0.0047	945.68	4.44	0.0403	1.29	0.05	6.33
	TOTAL			32.22			141.28			13.42	186.92
1998	state	0.0159	2813.81	44.74	0.0504	1543.12	77.77	0.3222	43.19	13.92	136.43
	federal	0.0014	1226.33	1.72	0.0047	762.36	3.58	0.0403	1.92	0.08	5.38
	TOTAL			46.46			81.36			13.99	141.81
1999	state	0.0159	2365.58	37.61	0.0504	1047.66	52.80	0.3222	149.94	48.31	138.73
	federal	0.0014	1212.26	1.70	0.0047	567.89	2.67	0.0403	59.22	2.39	6.75
	TOTAL			39.31			55.47			50.70	145.48
2000	state	0.0159	1271.44	20.22	0.0504	942.02	47.48	0.3222	32.97	10.62	78.32
	federal	0.0014	588.46	0.82	0.0047	611.12	2.87	0.0403	282.51	11.39	15.08
	TOTAL			21.04			50.35			22.01	93.40

Table 14D. Bycatch estimates of coastal bottlenose dolphins by seasonal management unit, year, water body, and mesh category. In addition, the bycatch rates (dead coastal bottlenose dolphins/ fish landings (mt)), and prorated effort (landed fish in mt) are included. These data are for only the coastal bottlenose dolphin habitat.

Summer (May-Oct) - Northern North Carolina Management Unit (Dare and Hyde counties)

Year	Water body in coastal habitat	Small mesh category (≤ 5 inches)			Medium mesh category (> 5 to < 7 inches)			Large mesh category (≥7 inches)			All mesh
		Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Estimate
1996	state	0.0698	179.07	12.50	0.1979	64.94	12.85	0.6885	0.53	0.36	25.71
	federal	0.0066	1.63	0.01	0.0213	0.00	0.00	0.1632	7.13	1.16	1.17
	TOTAL			12.51			12.85			1.53	26.89
1997	state	0.0698	236.43	16.50	0.1979	76.83	15.20	0.6885	1.58	1.09	32.79
	federal	0.0066	31.02	0.20	0.0213	6.76	0.14	0.1632	0.00	0.00	0.35
	TOTAL			16.70			15.35			1.09	33.14
1998	state	0.0698	178.29	12.44	0.1979	23.27	4.61	0.6885	0.35	0.24	17.29
	federal	0.0066	1.33	0.01	0.0213	1.74	0.04	0.1632	0.00	0.00	0.05
	TOTAL			12.45			4.64			0.24	17.33
1999	state	0.0698	169.11	11.80	0.1979	6.30	1.25	0.6885	0.02	0.01	13.06
	federal	0.0066	25.94	0.17	0.0213	2.22	0.05	0.1632	0.00	0.00	0.22
	TOTAL			11.97			1.29			0.01	13.28
2000	state	0.0698	207.68	14.49	0.1979	53.28	10.54	0.6885	0.66	0.45	25.49
	federal	0.0066	12.51	0.08	0.0213	3.41	0.07	0.1632	0.00	0.00	0.15
	TOTAL			14.58			10.62			0.45	25.65

Table 14E. Bycatch estimates of coastal bottlenose dolphins by seasonal management unit, year, water body, and mesh category. In addition, the bycatch rates (dead coastal bottlenose dolphins/ fish landings (mt)), and prorated effort (landed fish in mt) are included. These data are for only the coastal bottlenose dolphin habitat.

Summer (May-Oct) - Southern North Carolina Management Unit (Carteret, Onslow, Pender, New Hanover, Brunswick counties)

Year	Water body in coastal habitat	Small mesh category (≤ 5 inches)			Medium mesh category (> 5 to < 7 inches)			Large mesh category (≥7 inches)			All mesh
		Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Rate	Prorated Effort	Bycatch Estimate	Bycatch Estimate
1996	state	0.0006	178.42	0.11	0.0020	0.69	0.00	0.0173	0.10	0.00	0.11
	federal	0.0001	0.67	0.00	0.0002	0	0.00	0.0016	0	0.00	0.00
	TOTAL			0.11			0.00			0.00	0.11
1997	state	0.0006	197.53	0.12	0.0020	0.42	0.00	0.0173	0.04	0.00	0.12
	federal	0.0001	0.00	0.00	0.0002	0	0.00	0.0016	0	0.00	0.00
	TOTAL			0.12			0.00			0.00	0.12
1998	state	0.0006	177.91	0.11	0.0020	0.06	0.00	0.0173	0.01	0.00	0.11
	federal	0.0001	0.69	0.00	0.0002	0	0.00	0.0016	0	0.00	0.00
	TOTAL			0.11			0.00			0.00	0.11
1999	state	0.0006	127.96	0.08	0.0020	0	0.00	0.0173	0	0.00	0.08
	federal	0.0001	0.34	0.00	0.0002	0	0.00	0.0016	0	0.00	0.00
	TOTAL			0.08			0.00			0.00	0.08
2000	state	0.0006	180.74	0.11	0.0020	0.01	0.00	0.0173	0	0.00	0.11
	federal	0.0001	0.49	0.00	0.0002	0	0.00	0.0016	0	0.00	0.00
	TOTAL			0.11			0.00			0.00	0.11

Table 15. Annual, and 5-year mean of bycatch estimates for the mid-Atlantic coastal bottlenose dolphin management units during the years 1996 to 2000. Means weighted by CV. Percent CV, upper and lower 95% confidence interval (CI) of 5-year mean are also included.

Year	Winter			Summer			Winter+Summer All management units	
	NC Mixed Stock	VA Mixed Stock	Sum of NC & VA mixed sub-units	Northern Migratory	Northern N.C.	Southern N.C.	Total bycatch estimate	%CV of total bycatch
1996	162	11	173	33	27	0	233	35.8
1997	187	24	211	30	33	0	274	35.6
1998	142	33	175	37	17	0	229	34.1
1999	145	51	196	19	13	0	228	36.9
2000	93	53	146	30	26	0	202	33.3
%CV of above annual estimates	49.2	84.4	46.4	48.1	61.2	--	--	--
Mean	146	34	180	30	23	0	233	15.9
%CV of Mean	22.5	41.6	20.9	21.9	28.7	--	--	–
Lower 95% CI of Mean	94	16	120	20	13	--	171	--
Upper 95% CI of Mean	226	74	270	46	40	–	318	--

Figure 1. The US mid-Atlantic stratified to spatial and temporal coastal bottlenose dolphin management units.

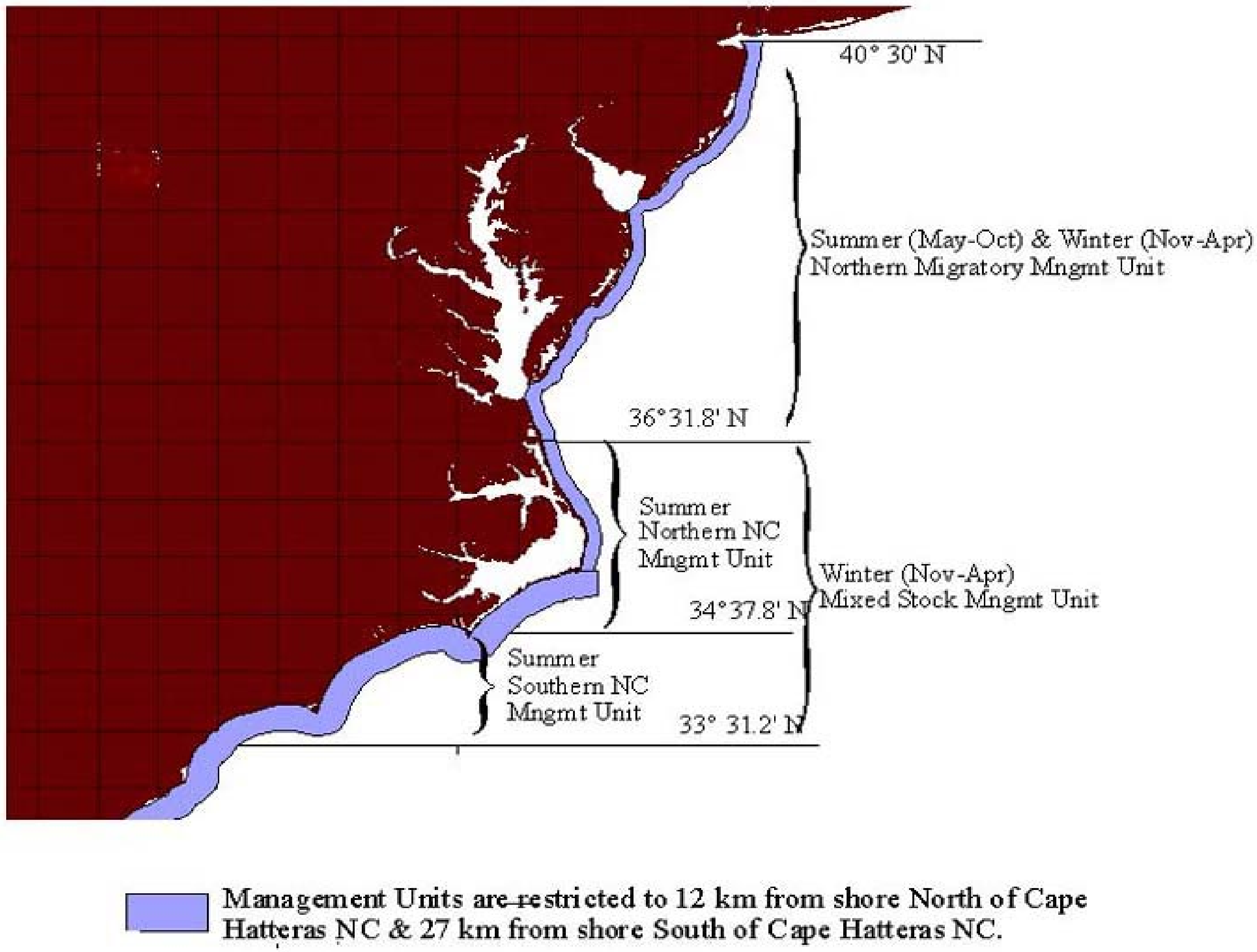


Figure 2. Coastal bottlenose dolphin bycatch observed in U.S. mid-Atlantic gillnet fisheries, by month during 1996-2000. This map does not include one coastal bottlenose dolphin caught and released alive in May in the Southern NC management unit.

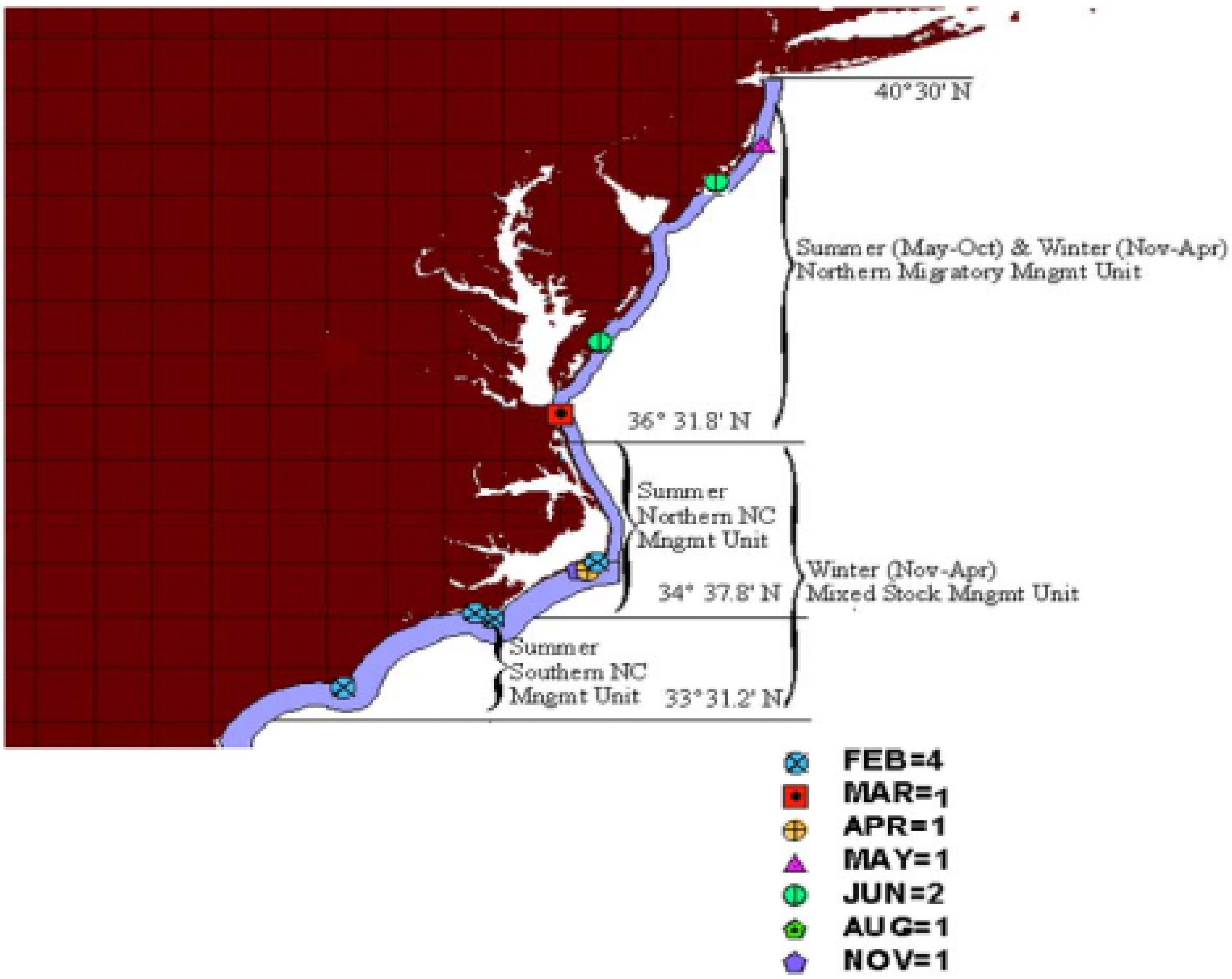


Figure 3. Division of target species into mesh sizes categories where the seasonal management unit was known, as determined from a TREE analysis.

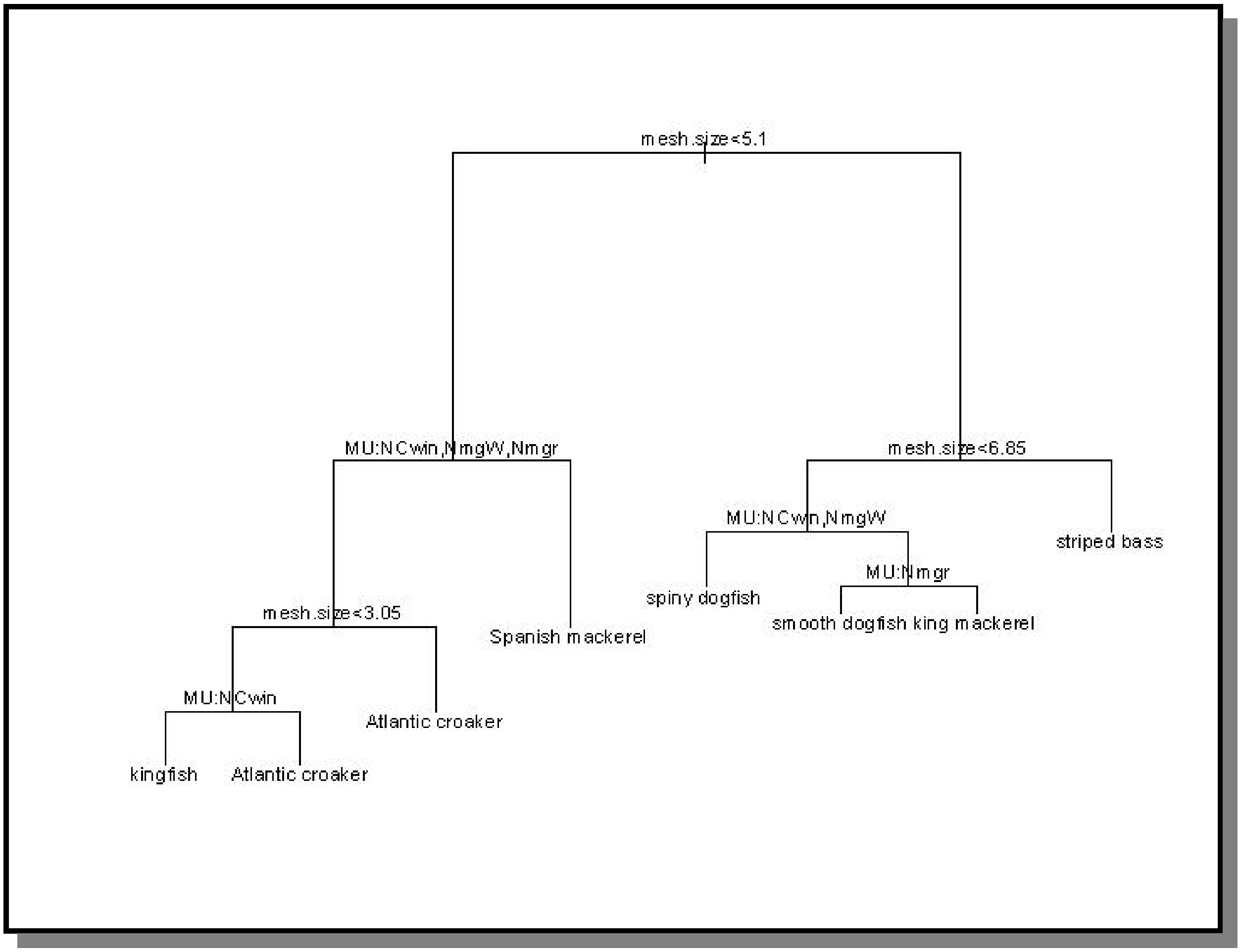
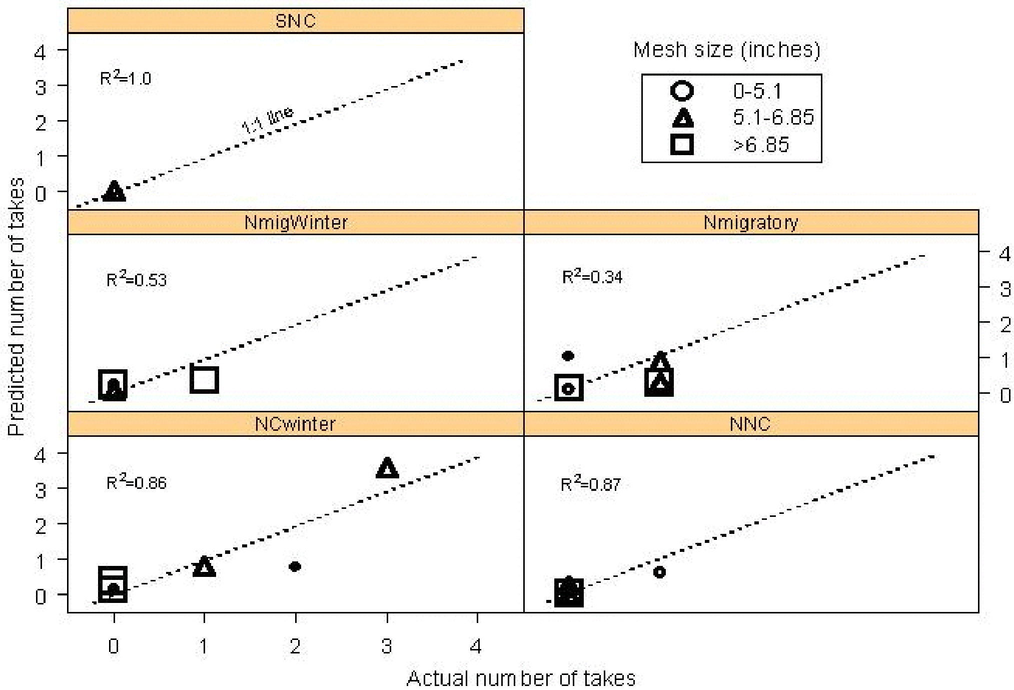


Figure 4. Plot of the predicted number of coastal bottlenose dolphin takes versus the observed number of takes for each seasonal management unit. A. Mesh size categories for each observation. B. Water body for each observation.

A.



B.

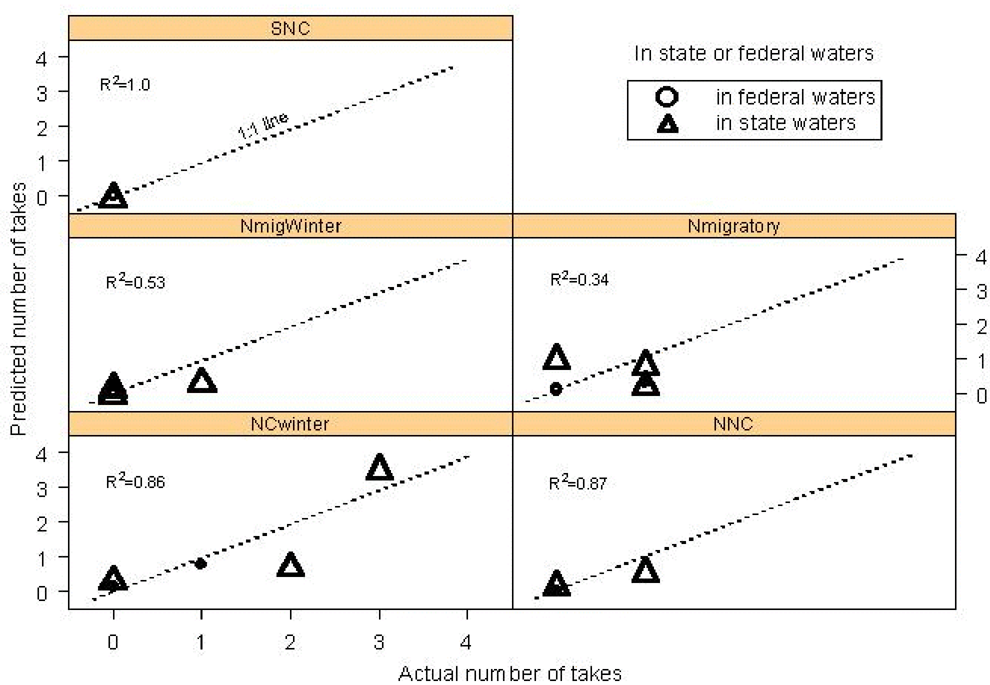
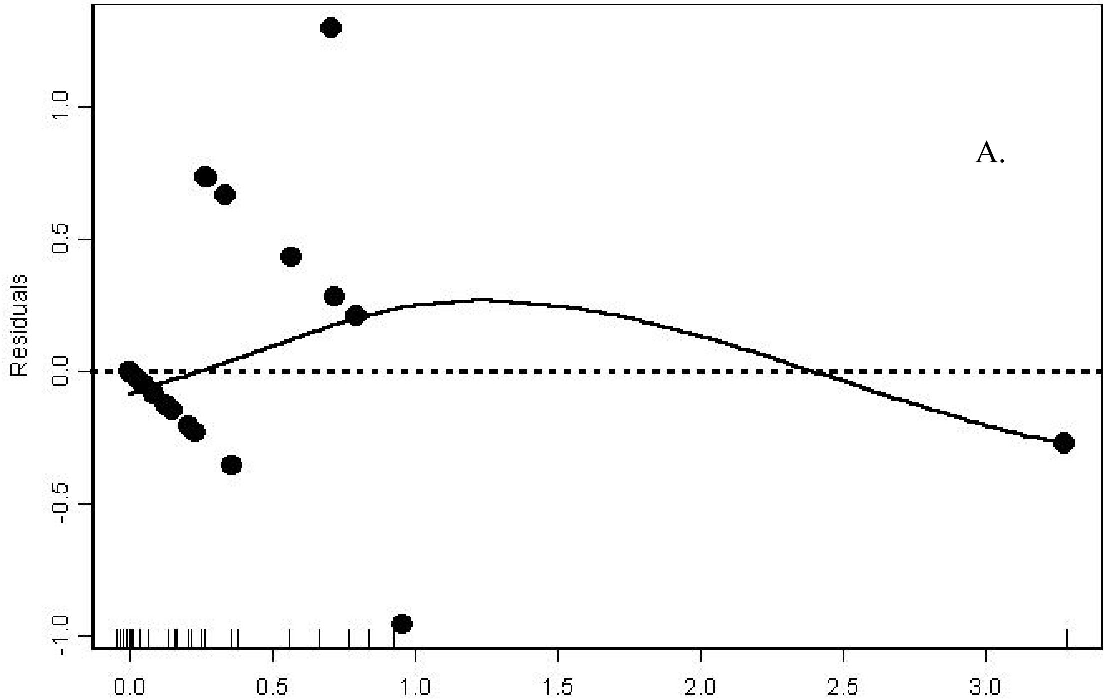


Figure 5. Diagnostic plots of a linear regression between the predicted number of coastal bottlenose dolphin takes versus the observed number of takes. A. Residual plot. B. Actual versus predicted. There is one point for each combination of seasonal management unit, water body, and mesh size category.



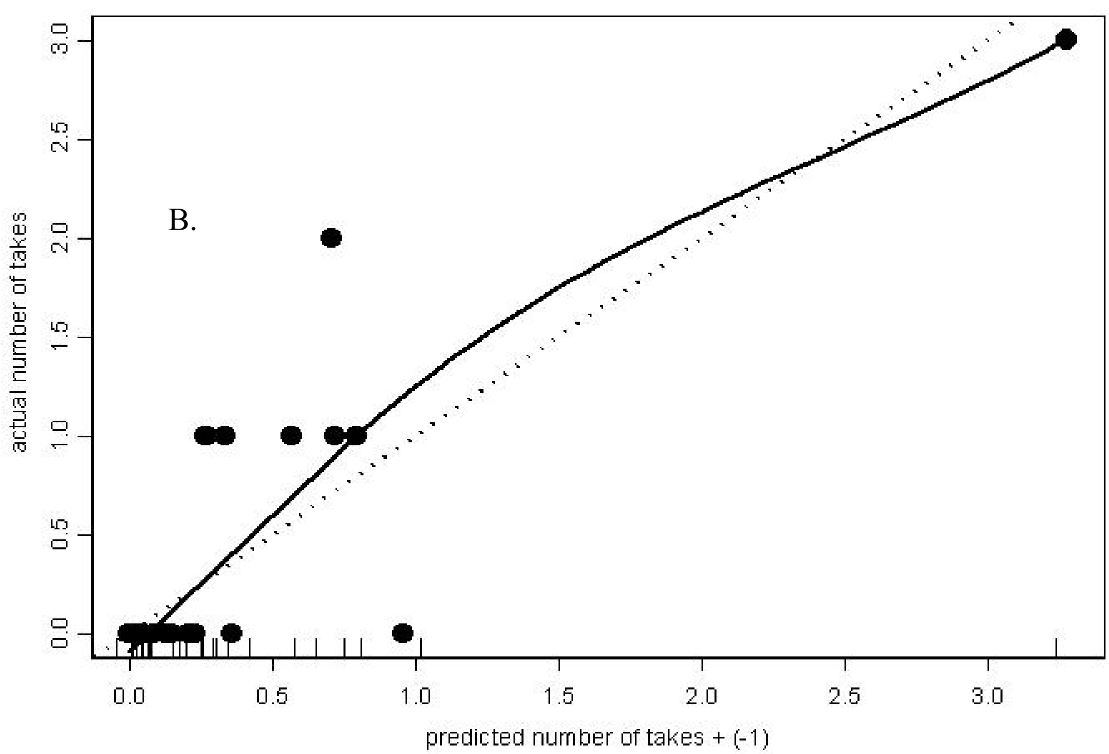


Figure 6. Residual plot of each variable in the GLM of bycatch rates of coastal bottlenose dolphins. Center line in each level of a variable is the mean value, upper and lower lines are the upper and lower standard error (SE). Dots are actual values from each haul. Length of line at bottom of each level is a "rug plot" that represents the number of observations in each level. The wider the rug plot line, the more observations. Levels where the mean is a positive number (from the y-axis) are more highly associated with bycatch than levels that have a negative value.

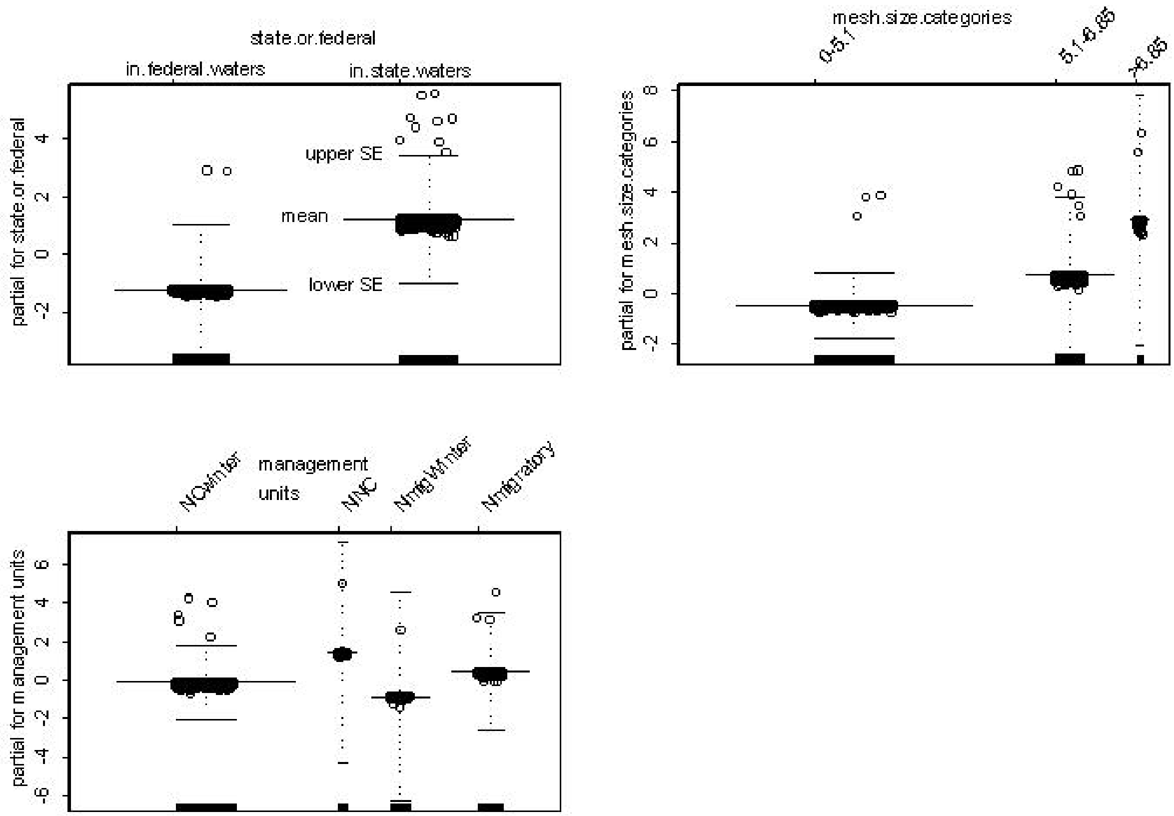


Figure 7. NER reported landings by mesh category, water body and species composition in the winter VA mixed stock sub-management unit (Virginia only) during 1996-2000.

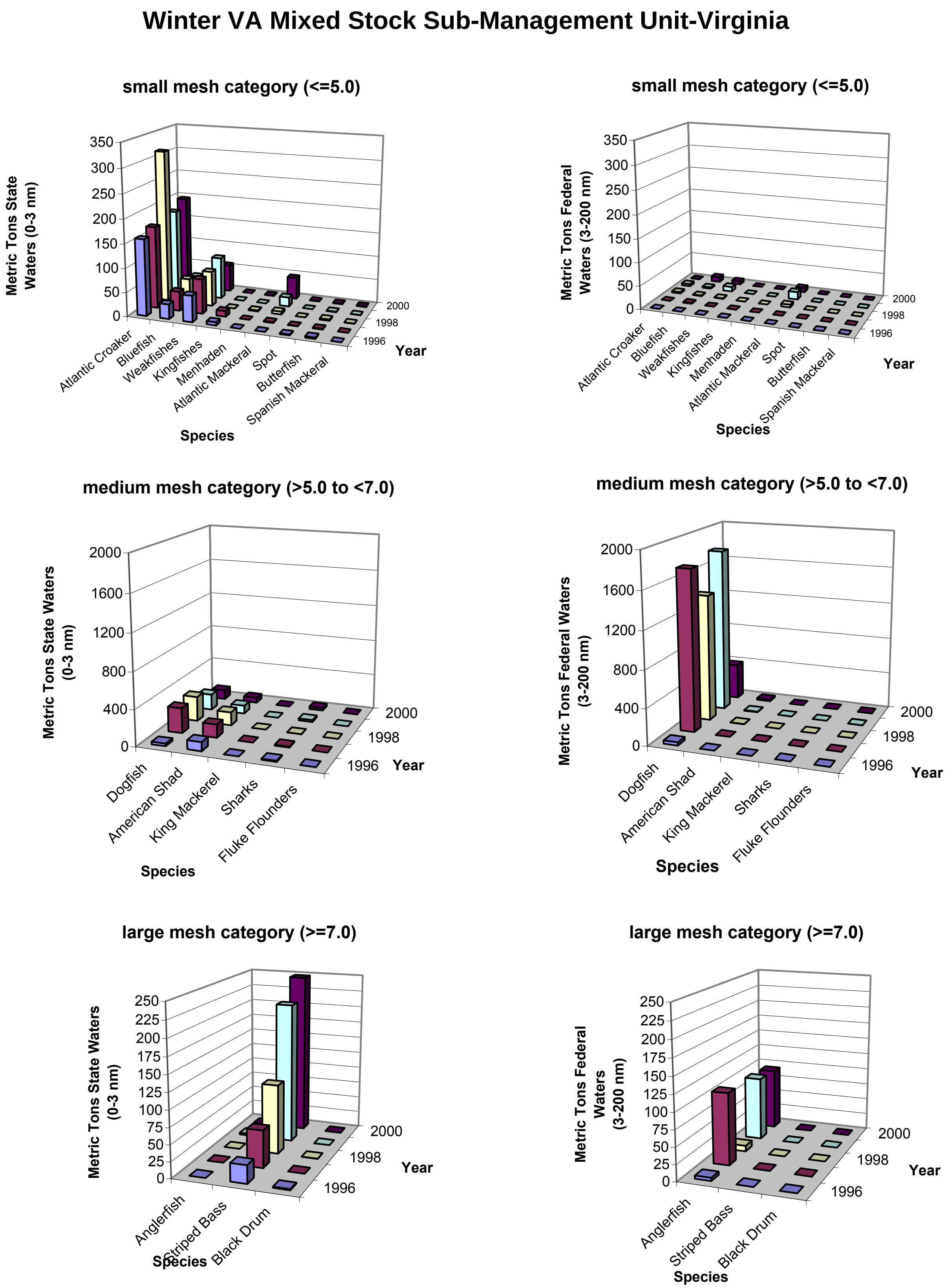


Figure 8. NER reported landings by mesh category, water body and species composition in the summer Northern migratory management unit (Virginia only) during 1996-2000.

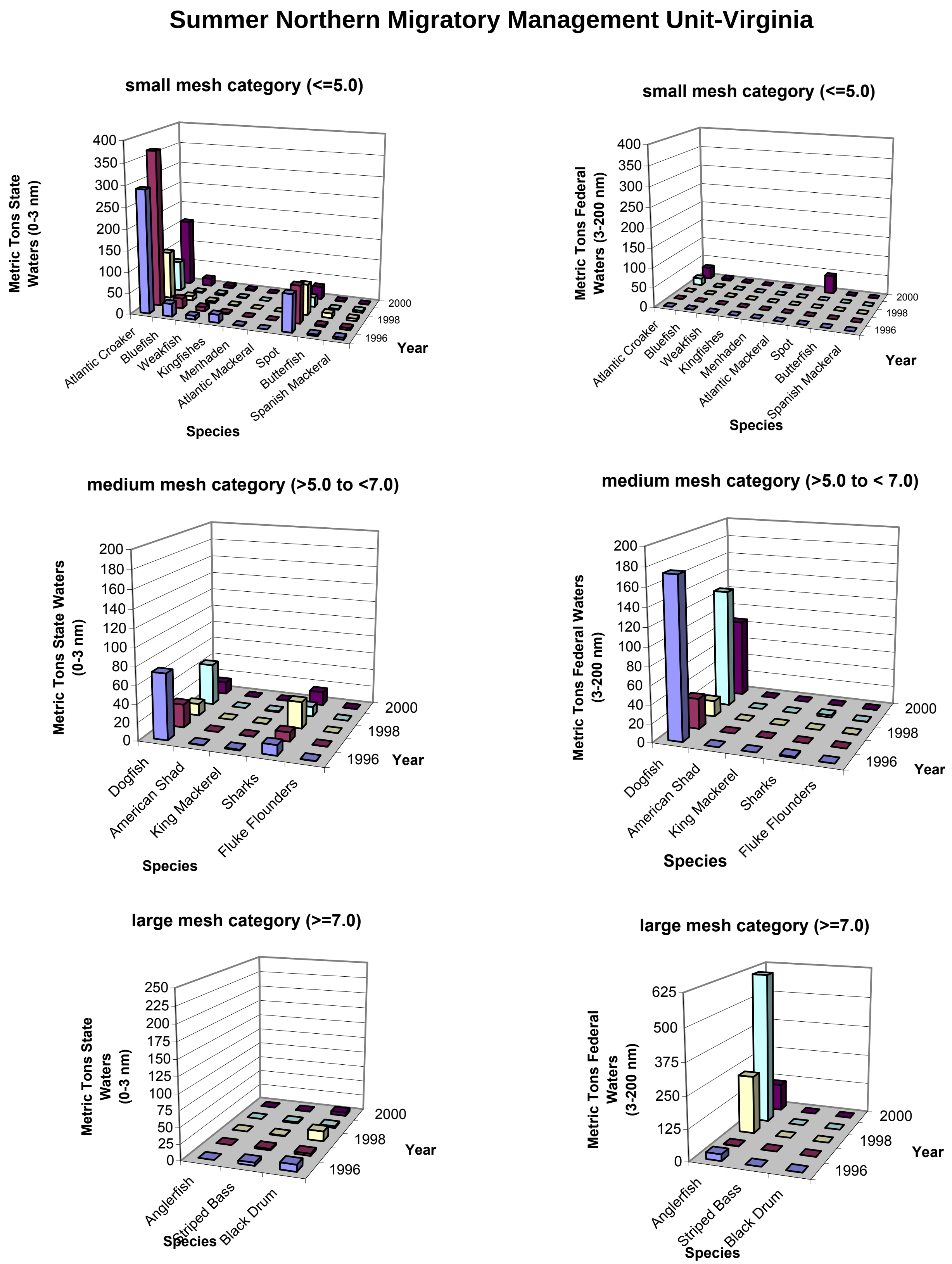
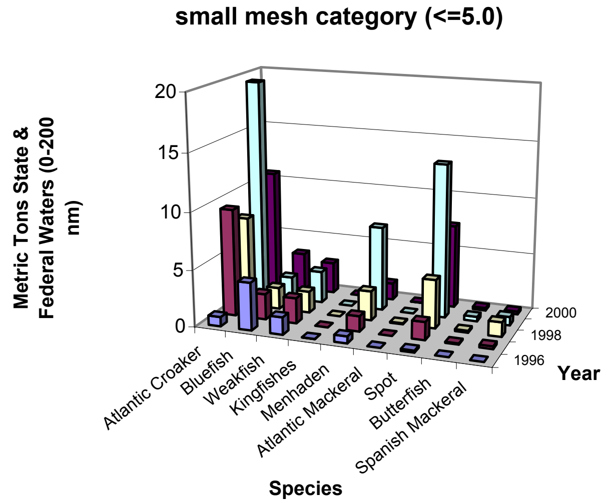
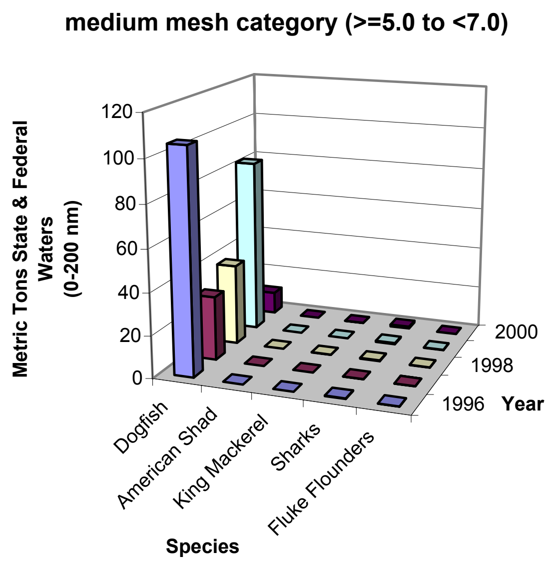


Figure 9. NER reported landings by mesh category, water body and species composition in the summer Northern migratory management unit (Maryland only) during 1996-2000.

Summer Northern Migratory Management Unit-Maryland





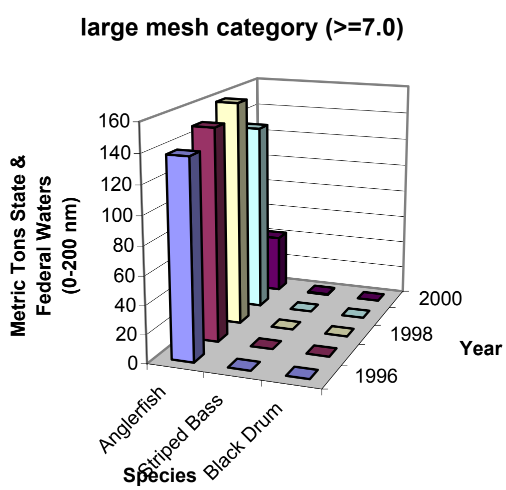


Figure 10. NER reported landings by mesh category, water body and species composition in the summer Northern migratory management unit (Delaware only) during 1996-2000.

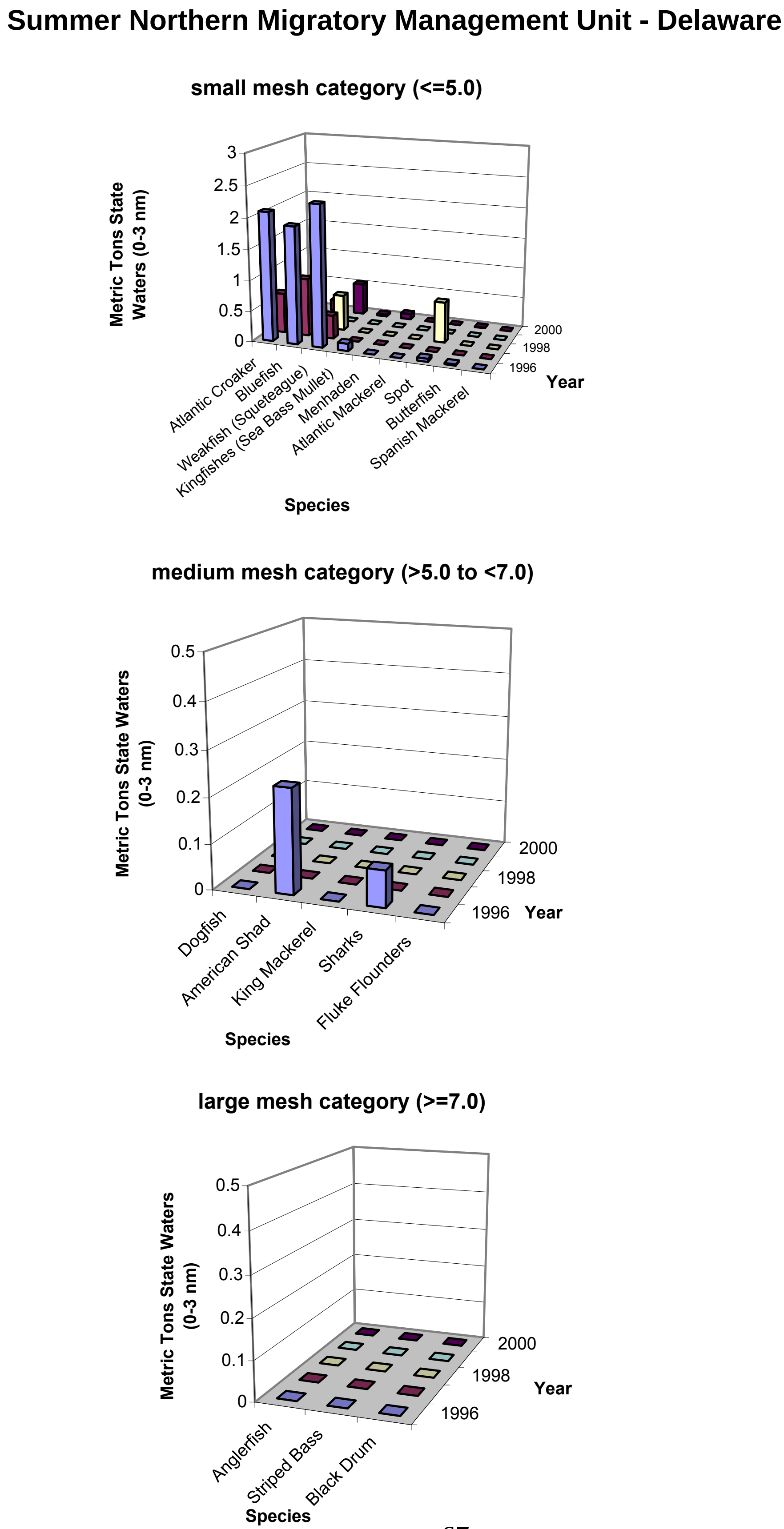
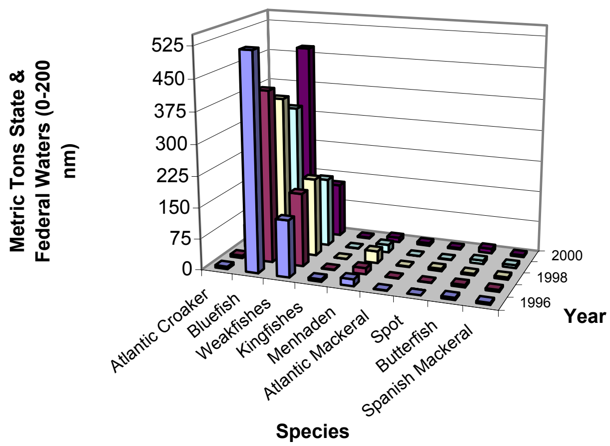


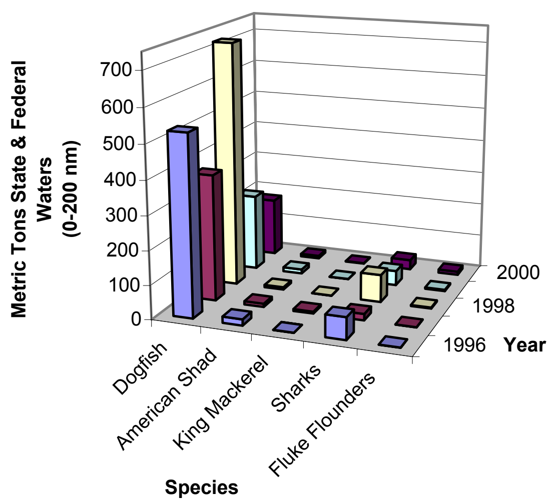
Figure 11. NER reported landings by mesh category, water body and species composition in the summer Northern migratory management unit (New Jersey only) during 1996-2000.

Summer Northern Migratory Management Unit - New Jersey

small mesh category (<=5)



medium mesh category (>5.0 to <7.0)



large mesh category (>=7.0)

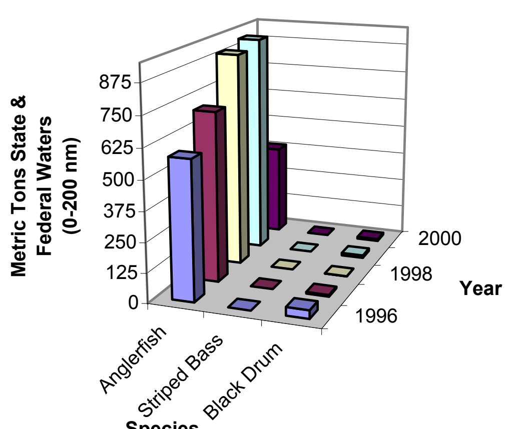


Figure 12. NCDMF reported landings by mesh category, water body and species composition in the winter North Carolina (all counties) mixed stock sub-management unit during 1996-2000.

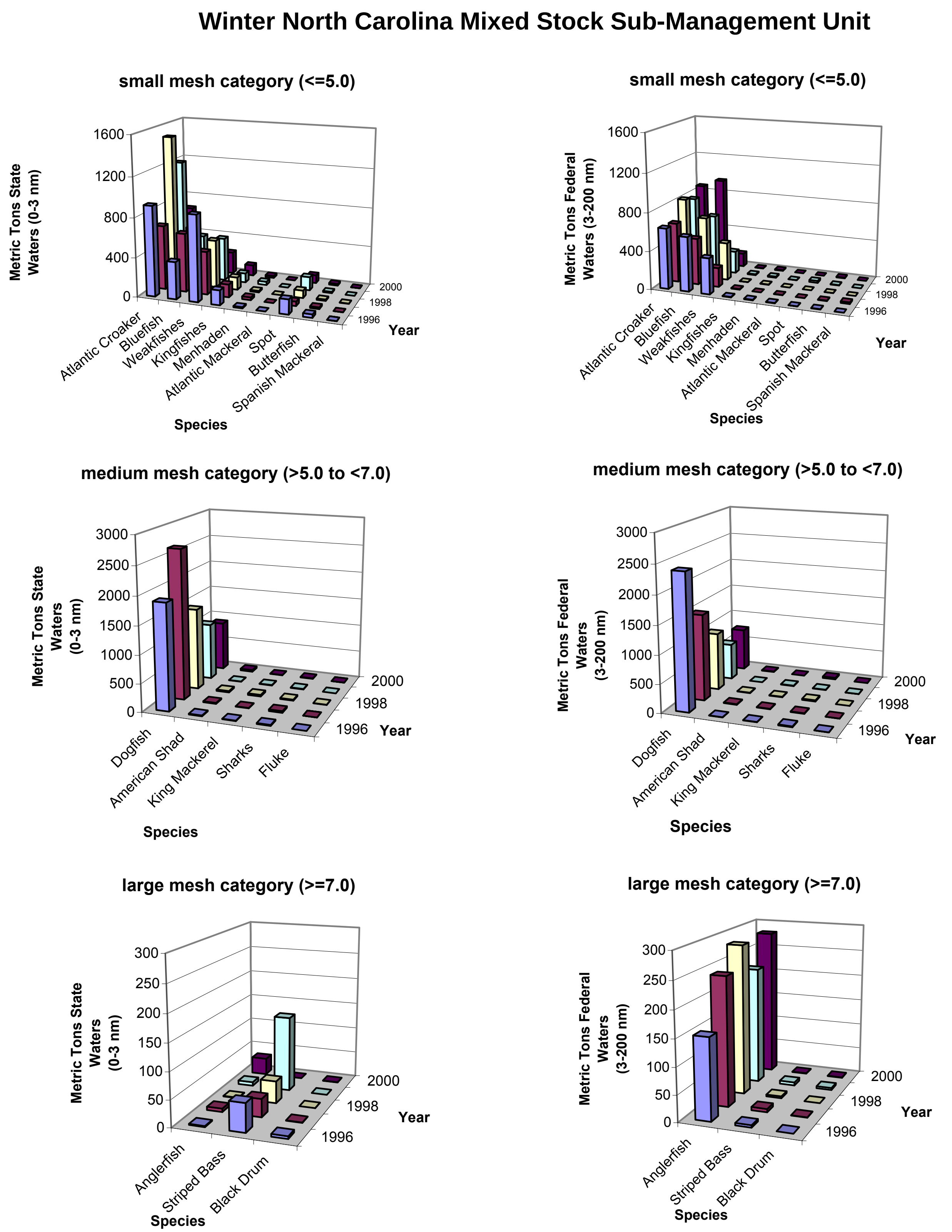


Figure 13. NCDMF reported landings by mesh category, water body and species composition in the summer Northern North Carolina (Dare and Hyde counties only) management unit during 1996-2000.

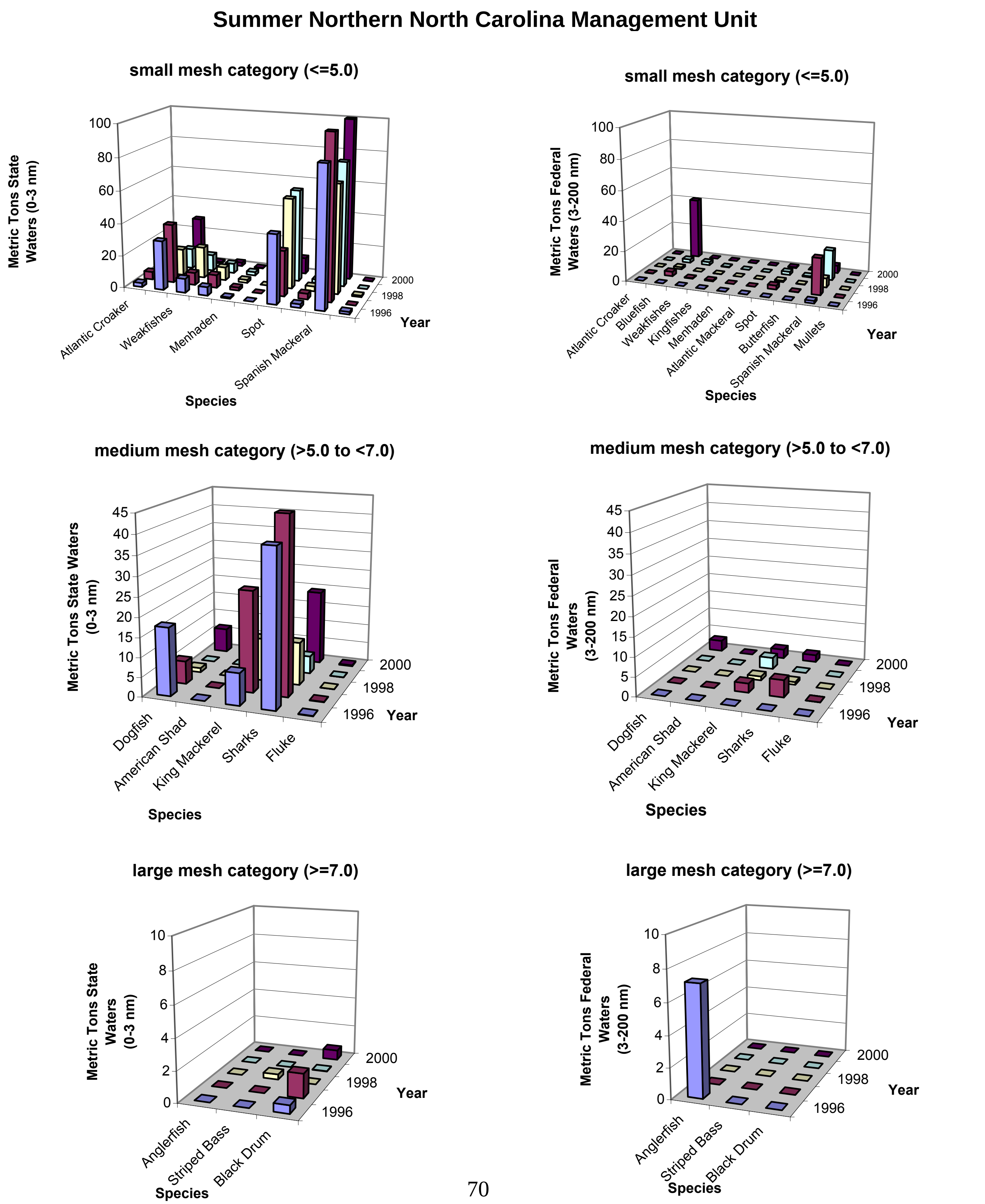
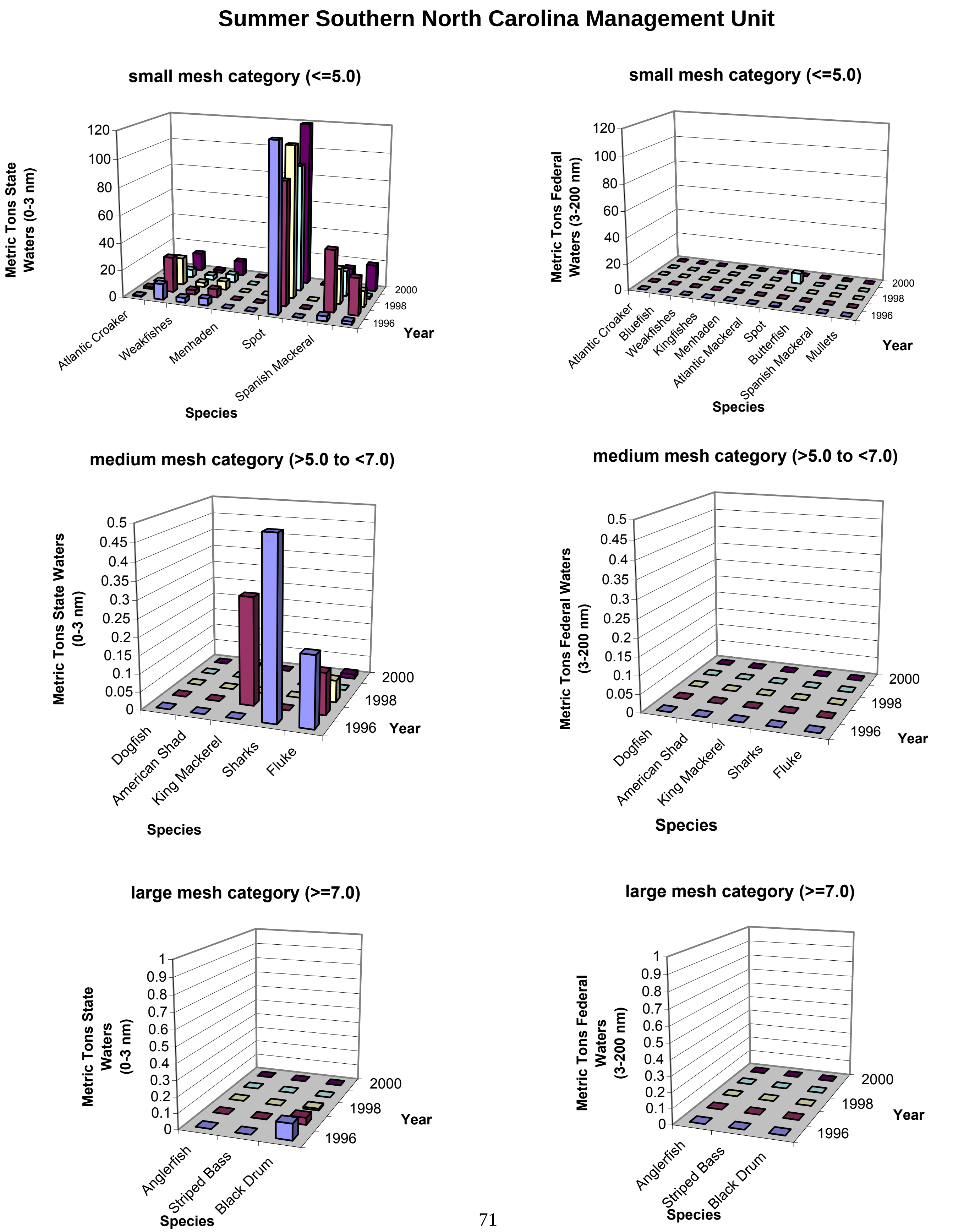
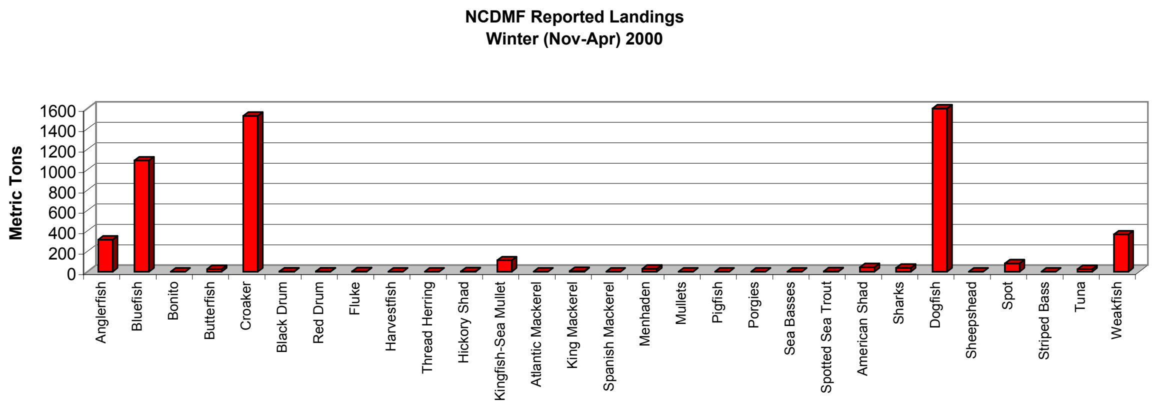
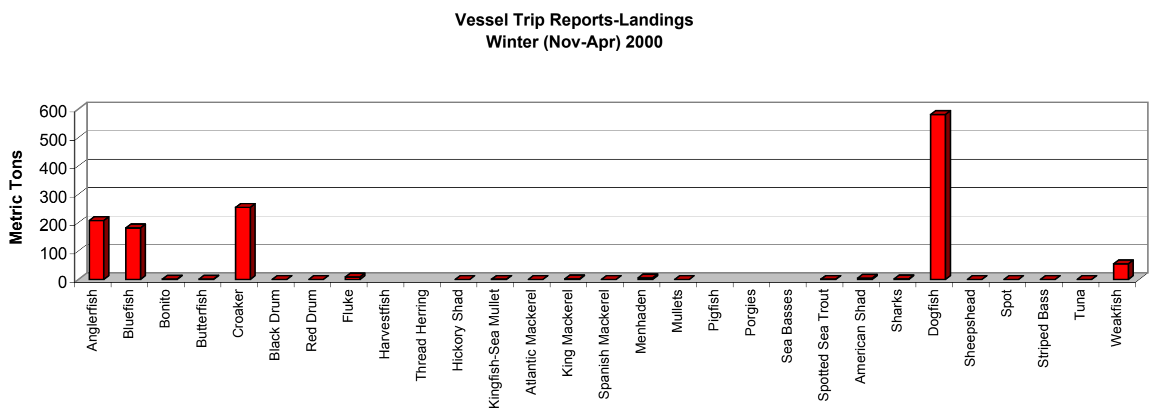


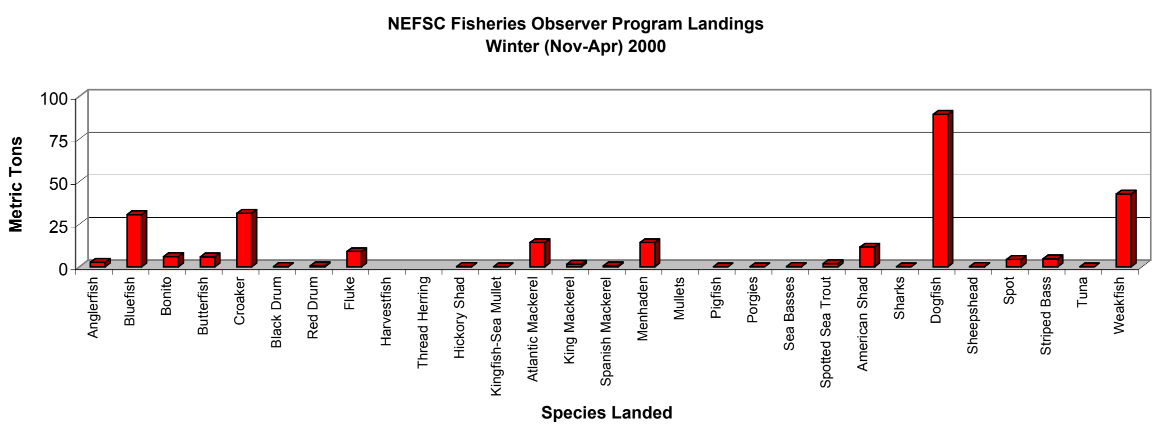
Figure 14. NCDMF reported landings by mesh category, water body and species composition in the summer Southern North Carolina (Carteret, Onslow, Pender, New Hanover, and Brunswick Counties only) management unit during 1996-2000.



APPENDIX A


NCDMF Reported Landings
Winter (Nov-Apr) 2000
Metric Tons
1600
1400
1200
1000
800
600
400
200
0
Anglerfish
Bluefish
Bonito
Butterfish
Croaker
Black Drum
Red Drum
Fluke
Harvestfish
Thread Herring
Hickory Shad
Kingfish-Sea Mullet
Atlantic Mackerel
King Mackerel
Spanish Mackerel
Menhaden
Mullets
Pigfish
Porgies
Sea Basses
Spotted Sea Trout
American Shad
Sharks
Dogfish
Sheepshead
Spot
Striped Bass
Tuna
Weakfish


Vessel Trip Reports-Landings
Winter (Nov-Apr) 2000
Metric Tons
600
500
400
300
200
100
0
Anglerfish
Bluefish
Bonito
Butterfish
Croaker
Black Drum
Red Drum
Fluke
Harvestfish
Thread Herring
Hickory Shad
Kingfish-Sea Mullet
Atlantic Mackerel
King Mackerel
Spanish Mackerel
Menhaden
Mullets
Pigfish
Porgies
Sea Basses
Spotted Sea Trout
American Shad
Sharks
Dogfish
Sheepshead
Spot
Striped Bass
Tuna
Weakfish


NEFSC Fisheries Observer Program Landings
Winter (Nov-Apr) 2000
Metric Tons
100
75
50
25
0
Anglerfish
Bluefish
Bonito
Butterfish
Croaker
Black Drum
Red Drum
Fluke
Harvestfish
Thread Herring
Hickory Shad
Kingfish-Sea Mullet
Atlantic Mackerel
King Mackerel
Spanish Mackerel
Menhaden
Mullets
Pigfish
Porgies
Sea Basses
Spotted Sea Trout
American Shad
Sharks
Dogfish
Sheepshead
Spot
Striped Bass
Tuna
Weakfish
Species Landed

Appendix B

Table 1A. Data from the NEFSC fishery sampling observer database including number of trips and hauls, amount of fish landed (in metric tons), and number of observed bottlenose dolphins from hauls by mesh sizes (small, medium, and large), water bodies (state coastal and federal coastal), year (November 1995 to October 1996 = 1996, etc.), and seasonal management units. Note, trips may not be unique within a year because it is possible that a trip consisted of hauls that used nets with mesh sizes from more than one mesh size category. Also note, summation of hauls within a year-water body may not equal the corresponding sum of hauls in Table 4 because there were some hauls that did not record a mesh size and so were included in Table 4, but not in this Appendix.

A		Winter-VA Mixed Stock Sub-Management Unit (Virginia only)											
		Small mesh (≤ 5 inches)				Medium mesh (>5 to <7 inches)				Large mesh (≥7 inches)			
Water Body	Year	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes
State Coastal Habitat	1996	8	15	4.65	0	1	5	3.81	0	1	1	0.15	0
	1997	8	19	8.40	0	4	9	1.82	0	3	6	0.44	0
	1998	9	21	5.66	0	3	4	2.22	0	4	6	0.31	0
	1999	18	58	15.18	0	8	9	3.39	0	10	22	1.69	1
	2000	31	126	11.02	0	5	6	3.59	0	14	35	2.22	0
Federal Coastal Habitat	1996	8	23	3.63	0	4	19	10.24	0	1	1	0.30	0
	1997	10	65	6.96	0	11	27	12.31	0	3	4	0.29	0
	1998	7	22	5.07	0	9	23	19.94	0	11	28	6.09	0
	1999	26	89	12.68	0	15	27	20.27	0	16	48	6.19	0
	2000	19	53	6.90	0	7	14	5.67	0	18	66	8.61	0

Table 1B. Data from the NEFSC fishery sampling observer database including number of trips and hauls, amount of fish landed (in metric tons), and number of observed bottlenose dolphins from hauls by mesh sizes (small, medium, and large), water bodies (state coastal and federal coastal), year (November 1995 to October 1996 = 1996, etc.), and seasonal management units. Note, trips may not be unique within a year because it is possible that a trip consisted of hauls that used nets with mesh sizes from more than one mesh size category. Also note, summation of hauls within a year-water body may not equal the corresponding sum of hauls in Table 4 because there were some hauls that did not record a mesh size and so were included in Table 4, but not in this Appendix.

B		Summer-Northern Migratory Management Unit (Virginia, Maryland, Delaware, and New Jersey)											
		Small mesh (≤ 5 inches)				Medium mesh (>5 to <7 inches)				Large mesh (≥7 inches)			
Water Body	Year	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes
State Coastal Habitat	1996	15	61	10.54	0	6	17	3.06	0	0	0	-	-
	1997	32	152	14.67	0	1	6	0.04	0	0	0	-	-
	1998	10	20	2.29	0	8	16	1.24	1	1	1	0.01	0
	1999	13	50	4.43	0	6	8	0.78	0	1	1	0.10	1
	2000	33	105	12.22	0	10	35	4.63	0	4	4	0.02	0
Federal Coastal Habitat	1996	16	95	12.04	0	19	66	21.00	0	2	2	0.065	0
	1997	24	102	14.48	0	1	1	0.43	0	0	0	-	-
	1998	10	22	1.77	0	14	19	6.21	0	6	13	1.69	0
	1999	14	50	4.23	0	11	19	5.59	0	1	3	0.01	0
	2000	25	93	10.57	0	14	19	2.20	1	1	1	0.01	0

Table 1C. Data from the NEFSC fishery sampling observer database including number of trips and hauls, amount of fish landed (in metric tons), and number of observed bottlenose dolphins from hauls by mesh sizes (small, medium, and large), water bodies (state coastal and federal coastal), year (November 1995 to October 1996 = 1996, etc.), and seasonal management units. Note, trips may not be unique within a year because it is possible that a trip consisted of hauls that used nets with mesh sizes from more than one mesh size category. Also note, summation of hauls within a year-water body may not equal the corresponding sum of hauls in Table 4 because there were some hauls that did not record a mesh size and so were included in Table 4, but not in this Appendix.

C		Winter-North Carolina Mixed Stock Sub-Management Unit (all counties)											
		Small mesh (≤ 5 inches)				Medium mesh (>5 to <7 inches)				Large mesh (≥7 inches)			
Water Body	Year	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes
State Coastal Habitat	1996	20	84	13.56	1	15	46	4.78	0	1	6	0.23	0
	1997	24	74	6.95	0	21	79	16.56	0	3	6	0.19	0
	1998	39	159	10.33	0	16	40	7.51	0	0	0	-	-
	1999	66	338	22.34	0	30	80	18.38	2	9	14	2.00	0
	2000	63	233	12.86	1	27	70	20.57	1	0	0	0.03	0
Federal Coastal Habitat	1996	34	149	39.30	0	19	59	40.86	0	2	3	0.16	0
	1997	29	105	29.34	0	25	72	29.00	0	3	5	0.16	0
	1998	46	195	40.16	0	37	122	49.61	1	1	2	0.03	0
	1999	38	148	29.00	0	34	106	27.53	0	5	8	1.79	0
	2000	41	130	16.40	0	14	37	18.46	0	3	7	1.38	0

Table 1D. Data from the NEFSC fishery sampling observer database including number of trips and hauls, amount of fish landed (in metric tons), and number of observed bottlenose dolphins from hauls by mesh sizes (small, medium, and large), water bodies (state coastal and federal coastal), year (November 1995 to October 1996 = 1996, etc.), and seasonal management units. Note, trips may not be unique within a year because it is possible that a trip consisted of hauls that used nets with mesh sizes from more than one mesh size category. Also note, summation of hauls within a year-water body may not equal the corresponding sum of hauls in Table 4 because there were some hauls that did not record a mesh size and so were included in Table 4, but not in this Appendix.

D		Summer-Northern North Carolina Management Unit (Dare and Hyde Counties)											
		Small mesh (≤ 5 inches)				Medium mesh (>5 to <7 inches)				Large mesh (≥7 inches)			
Water Body	Year	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes
State Coastal Habitat	1996	13	102	2.36	1	5	41	0.31	0	0	0	-	-
	1997	0	0	-	-	0	0	-	-	0	0	-	-
	1998	12	60	0.31	0	3	16	0.19	0	0	0	-	-
	1999	7	23	1.22	0	2	3	0.06	0	0	0	-	-
	2000	20	117	6.06	0	4	20	0.55	0	0	0	-	-
Federal Coastal Habitat	1996	0	0	-	-	3	3	0.01	0	0	0	-	-
	1997	0	0	-	-	0	0	-	-	0	0	-	-
	1998	5	16	0.32	0	4	12	0.16	0	0	0	-	-
	1999	1	1	1.51	0	2	2	0.09	0	0	0	-	-
	2000	8	16	0.63	0	2	9	0.66	0	2	2	0.01	0

Table 1E. Data from the NEFSC fishery sampling observer database including number of trips and hauls, amount of fish landed (in metric tons), and number of observed bottlenose dolphins from hauls by mesh sizes (small, medium, and large), water bodies (state coastal and federal coastal), year (November 1995 to October 1996 = 1996, etc.), and seasonal management units. Note, trips may not be unique within a year because it is possible that a trip consisted of hauls that used nets with mesh sizes from more than one mesh size category. Also note, summation of hauls within a year-water body may not equal the corresponding sum of hauls in Table 4 because there were some hauls that did not record a mesh size and so were included in Table 4, but not in this Appendix.

E		Summer-Southern North Carolina Management Unit (Carteret, Onslow, Pender, New Hanover, and Brunswick Counties)											
		Small mesh (≤ 5 inches)				Medium mesh (>5 to <7 inches)				Large mesh (≥7 inches)			
Water Body	Year	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes	Trips	Hauls	Metric Tons	Takes
State Coastal Habitat	1996	0	0	-	-	0	0	-	-	0	0	-	-
	1997	0	0	-	-	0	0	-	-	0	0	-	-
	1998	14	44	1.71	0	0	0	-	-	0	0	-	-
	1999	12	32	3.45	1*	1	1	0.01	0	0	0	-	-
	2000	18	37	4.35	0	3	14	0.03	0	0	0	-	-
Federal Coastal Habitat	1996	0	0	-	-	0	0	-	-	0	0	-	-
	1997	0	0	-	-	0	0	-	-	0	0	-	-
	1998	6	15	0.69	0	0	0	-	-	0	0	-	-
	1999	7	13	0.01	0	0	0	-	-	0	0	-	-
	2000	17	38	0.49	0	0	0	-	-	0	0	-	-

* coastal bottlenose dolphin was observed taken and released alive and uninjured.

Research Communications Unit
Northeast Fisheries Science Center
National Marine Fisheries Service, NOAA
166 Water St.
Woods Hole, MA 02543-1026

STANDARD
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Publications and Reports of the Northeast Fisheries Science Center

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "planning, developing, and managing multidisciplinary programs of basic and applied research to: 1) better understand the living marine resources (including marine mammals) of the Northwest Atlantic, and the environmental quality essential for their existence and continued productivity; and 2) describe and provide to management, industry, and the public, options for the utilization and conservation of living marine resources and maintenance of environmental quality which are consistent with national and regional goals and needs, and with international commitments." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Those media are in four categories:

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