Cobia Fishery-Independent Index of Abundance and Length/Age Compositions in US South Atlantic Waters Based on the Coastal Trawl Survey (1990-2023)

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SEAMAP-SA Coastal Trawl Survey Technical Report #2024-02

Abstract

Fishery-independent measures of catch and effort with standard gear types and deployment strategies are valuable for monitoring the status of stocks, interpreting fisheries landings data, performing stock assessments, and developing regulations for managing fish resources. This report presents a summary of the fishery-independent monitoring of Cobia (*Rachycentron canadum*) in the US South Atlantic region through the efforts of the Coastal Trawl Survey (CTS, primarily funded through the Southeast Area Monioring and Assessment Program-South Atlantic [SEAMAP-SA]). Specifically, it presents overall survey efforts and sampling specifically related to Cobia, including annual nominal abundance, standardized abundance, and length and age compositions, in trawls from 1990 to 2023. Index standardization was done through a zero-inflated negative binomial model (ZINB) to account for the effects of potential covariates on abundance estimates. The standardized index was higher than the long-term mean for the survey in the most recent years, but with larger errors than in more historical years. No sampling occurred in 2020. Length and age compositions are only available for the survey in a limited number of years (2012-2023 for lengths and 2012-2019 for ages), but the CTS primarily collects small, young Cobia.

Background

The Coastal Trawl Survey (CTS, funded by the Southeast Area Monitoring and Assessment Program - South Atlantic region [SEAMAP-SA]) has conducted fishery-independent research on nearshore demersal fish, invertebrates, elasmobranchs, and sea turtles between Cape Hatteras, North Carolina, and Cape Canaveral, Florida , since 1986. Standard trawl gear and operating procedures were adopted fully beginning in 1990 and have continued with a few modifications through 2023. Most notably, outer strata (i.e. deeper water strata) were removed from the CTS in the 2000s and, due to recent changes to weather patterns and stagnant funding, the CTS changed from processing catch from two paired nets to a single net in 2021 and from three sampling seasons each year to two in 2023.

Objective

This report presents a standardized relative abundance index of Cobia (*Rachycentron canadum*) derived from the CTS during the years 1990-2023. The year 2020 is excluded during which COVID-19 prevented standard sampling. The standardized index accounts for annual sampling distribution variability, changes in sampling effort, and environmental covariates that may affect catch of Cobia in trawls. Also provided are annual length and age compositions of Cobia captured by CTS to inform gear selectivity. Data presented in this report are based on the CTS database accessed on July 17, 2024 (indices) and July 29, 2024 (length and age compositions).

Methods

Survey Design and Gear

(see Zimney and Smart 2022 for full description)

- Range: Cape Hatteras, North Carolina, to Cape Canaveral, Florida (Fig. 1)
- Depths: 3-14 m (inner strata only, outer strata eliminated)
- Seasons:
  - 1990-2022: Spring (April-May), Summer (July-August), and Fall (September-November)
  - 2023: Spring (April-June) and Fall (August-October)
  - Converted to day of year (DOY) for analysis
- Sample Selection:
  - Stratified random design
  - 24 inner strata defined by latitude and depth (; Fig. 1)
  - Station allocation determined byo within stratum variability from a universe of trawlable stations each year
  - 78-112 allocated stations per season depending on funding and other survey priorities
  - Florida strata removed for Cobia analysis due to population/stock boundaries
- Sampling Gear:
  - 22.9 m Mongoose-type Falcon nets (two nets 1990-2019, one net 2021-2023) without turtle excluder or bycatch reduction devices
  - Body mesh 47 mm
  - Cod end mesh 41 mm
- Effort: 20-minute tows
- Time of Day (TOD): Daylight hours
- Environmental Covariates: Bottom Temperature and Salinity (deepest recording) collected via CTD at each station
- Abundance: can either be direct or derived
  - Direct: small catches are fully processed and all fish counted
  - Derived: large catches sub-sampled and only fish in randomly selected sub-sample counted; abundance is the product of sub-sampled count, sub-sample weight, and total catch weight
- Data Filtering/Inclusion:
  - Excluded any tows with missing covariate information
  - Excluded all tows prior to 1990
  - Excluded all tows with lost catch data
  - Excluded all tows where tow did not adhere to standard procedures (i.e. extremely short, damaged gear, U-turn)

Standardized Index Model Formulation

- Response variable: Fish per tow
- Offset term: Area swept (hectares)

- Dependent variables (all continuous):
  - Year
  - Depth (m)
  - Latitude (oN)
  - Bottom temperature (oC)
  - Day of year (DOY) (accounts for change in season structure)
- Modelled with polynomials
  - Maximum allowed polynomial order set using preliminary generalized additive models (GAMs)
  - Limited polynomial to maximum of fourth order for biological relevance
- Due to widely differing scales, the covariates were centered and scaled
  - Centered – subtract covariate mean
  - Scaled – divided centered values by their standard deviation prior to the GAMs
- Models Tested– Zero-inflated negative binomial, zero-inflated Poisson, negative binomial, and Poisson error distributions were explored
- Mixture model for both zero-inflated error structures
- Two parts to the model, with Bayesian Information Criteria (BIC) used to select the best model from each of the 2 zero-inflated error distributions
  - Presence/absence (binomial sub-model)
  - Catch (count sub-model)
  - Sub-models optimized using a two-step approach due to computational demands
  - Count sub-model was optimized with all covariates removed from the zero-inflation sub-model
  - Binomial sub-model was optimized using fixed count sub-model covariates obtained in previous step
  - Allows for different covariates to be included in the two sub-models
- Bayesian Information Criteria (BIC) also used to select the best model from all model structures tested
- Annual year effect coefficients of variation (CVs) and standard errors (SE) computed using bootstrapping: 5,000 bootstraps

- Software used: R (Version 4.3.0; R Development Core Team 2023)

Length and Age Compositions

Length methods

- Two length methods used
  - All fish in the processed catch measured to nearest centimeter 2017-2023
  - Fish <100 cm in the processed catch were measured to nearest millimeter and retained for ageing 2012-2023 (includes 98.4% of fish collected by CTS)
- Measured lengths were fork length (FL)
- Composition in 1-cm length bins centered on the integer per year for the broadest time series presented here (without fish >99 cm)

Ageing methods

- Fish <100 cm retained for dissection
- Otoliths removed, stored in 70% EtOH for 24 hrs, and dried
- Otoliths mounted and sectioned
- Age = increment count with an estimated increment formation on August 1
- Ages determined 2012-2019

Results

Included tows n = 7,363, ranging from 129 to 279 per year (Table 1)

No sampling in 2020 due to COVID-19

Cobia Catches

- Cobia collected in all years with average % positive of 3.4% and ranging from 0.49 to 6.82 (Table 1, Fig. 2)
- Cobia occurred in all areas and ranges of covariates (Figs. 3, 4, 5), supporting that the data cannot be sub-sampled to improve % positive
- Nominal abundance ranged from 0.005 to 0.114 fish/hectare (Table 1)

Sampling area:Notable deviations from full regional coverage in 2018-2023, due to missed strata in NC (Fig. 3)

Standardized Index Model Formulation

- Depth, latitude, DOY, and temperature were included in the final model
- Final model selected was ZINB (Fig. 6)

Length and Age Composition

- Length compositions 2012-2023 of fish <100 cm (Table 2)
- Age compositions 2012-2019 of fish <100 cm (Table 3)
- Sampling did not occur in 2020 due to COVID-19

References

Bubley, W.J., J.L. Vecchio, T.S. Smart. 2023. Standardized CPUE Based on the Southeast Reef Fish Survey Chevron Trap (1990-2022) and the MARMAP/ SEAMAP-SA Short Bottom Longline (1996-2022) and Long Bottom Longline Surveys (1996-2011 and 2015-2016). SCDNR Reef Fish Survey Technical Report 2023-02.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Zimney, A. and T. Smart. 2022. Impacts of incomplete sampling and standardization on indices of abundance from a fishery-independent trawl survey off the southeast U.S. Atlantic coast. Fish. Bull. 120:252-267.

Table 1. Coastal Trawl Survey sampling effort (Deployments), Cobia catch rates (Positive Tows, % Positive, and Fish Caught), Cobia nominal abundance (Nominal), and Cobia normalized standardized abundance (Standardized), and standardized standard errors (SE) from 1990-2019 and 2021-2023 for Georgia through North Carolina.

Year	Deployments	Positive Tows	% Positive	Fish Caught	Nominal	Standardized	SE
1990	201	9	4.48	10	0.050	0.651	0.201
1991	202	14	6.93	23	0.114	1.67	0.485
1992	203	7	3.45	7	0.034	0.839	0.346
1993	204	2	0.98	3	0.015	0.263	0.171
1994	204	4	1.96	6	0.029	0.609	0.352
1995	203	8	3.94	8	0.039	0.761	0.3
1996	199	2	1.01	2	0.010	0.209	0.137
1997	203	6	2.96	6	0.030	0.616	0.251
1998	203	7	3.45	9	0.044	0.919	0.366
1999	203	5	2.46	7	0.034	0.795	0.385
2000	204	1	0.49	1	0.005	0.094	0.096
2001	243	4	1.65	5	0.021	0.426	0.215
2002	247	3	1.21	3	0.012	0.204	0.119
2003	250	4	1.60	5	0.020	0.399	0.229
2004	250	4	1.60	8	0.032	0.646	0.431
2005	248	6	2.42	20	0.081	2.123	1.653
2006	249	9	3.61	9	0.036	0.723	0.256
2007	248	10	4.03	11	0.044	0.961	0.303
2008	252	8	3.17	8	0.032	0.698	0.251
2009	279	7	2.51	10	0.036	0.868	0.417
2010	273	10	3.66	12	0.044	1.069	0.427
2011	270	19	7.04	24	0.089	1.763	0.471
2012	267	8	3.00	8	0.030	0.53	0.184
2013	231	7	3.03	7	0.030	0.656	0.271
2014	243	10	4.12	15	0.062	1.043	0.339
2015	257	14	5.45	22	0.086	1.692	0.545
2016	261	5	1.92	5	0.019	0.284	0.127
2017	226	12	5.31	15	0.066	1.48	0.508
2018	176	12	6.82	19	0.108	1.969	0.618
2019	208	10	4.81	19	0.091	1.661	0.645
2021	103	1	0.97	3	0.029	1.619	1.66
2022	224	5	2.23	8	0.036	2.37	1.297
2023	129	6	4.65	6	0.047	2.388	0.885

Table 2. Length compositions in 1-cm fork length (FL) bins (centered) in percent for the CTS based on fish processed for life history samples in 2012-2023. This eliminates fish >99 cm, which comprise of ~1.6% of the CTS Cobia catch. Fish denotes total number of fish sampled per year and deployments the number of tows from which fish were measured.

FL_CM	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.500	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	6.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	7.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	7.143	0.000	0.000	0.000	16.667	0.000	0.000	12.500	0.000
25	0.000	0.000	14.286	0.000	0.000	0.000	5.556	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	14.286	0.000	0.000	0.000	0.000	0.000
27	14.286	0.000	0.000	0.000	20.000	0.000	0.000	0.000	0.000	0.000	0.000
28	14.286	0.000	0.000	0.000	0.000	7.143	5.556	0.000	0.000	0.000	0.000
29	0.000	0.000	7.143	6.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	6.667	0.000	0.000	0.000	0.000	0.000	25.000	0.000
31	0.000	0.000	0.000	13.333	0.000	0.000	0.000	5.263	0.000	0.000	0.000
32	0.000	0.000	0.000	6.667	0.000	7.143	5.556	0.000	0.000	12.500	20.000
33	0.000	0.000	7.143	0.000	0.000	7.143	0.000	5.263	0.000	12.500	0.000
34	0.000	0.000	7.143	0.000	20.000	14.286	0.000	15.789	0.000	0.000	0.000
35	0.000	33.333	14.286	0.000	20.000	0.000	0.000	5.263	0.000	0.000	0.000
36	0.000	0.000	14.286	6.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	14.286	13.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	7.143	5.556	5.263	0.000	0.000	20.000
39	0.000	0.000	0.000	0.000	0.000	0.000	5.556	15.789	0.000	0.000	0.000
40	0.000	0.000	0.000	6.667	0.000	0.000	5.556	0.000	0.000	0.000	0.000
41	14.286	0.000	0.000	6.667	40.000	0.000	0.000	5.263	0.000	0.000	0.000
42	0.000	0.000	0.000	6.667	0.000	0.000	0.000	5.263	0.000	0.000	0.000

43	0.000	0.000	0.000	0.000	0.000	7.143	11.111	0.000	0.000	0.000	0.000
44	14.286	16.667	0.000	0.000	0.000	0.000	5.556	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	6.667	0.000	0.000	0.000	10.526	0.000	12.500	0.000
46	0.000	0.000	7.143	0.000	0.000	7.143	0.000	15.789	0.000	0.000	0.000
47	0.000	0.000	0.000	6.667	0.000	7.143	5.556	0.000	0.000	0.000	20.000
48	0.000	16.667	0.000	6.667	0.000	0.000	0.000	0.000	0.000	0.000	40.000
49	0.000	0.000	0.000	0.000	0.000	0.000	16.667	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.263	33.333	0.000	0.000
51	0.000	0.000	0.000	0.000	0.000	0.000	5.556	0.000	33.333	12.500	0.000
52	0.000	0.000	0.000	0.000	0.000	7.143	0.000	0.000	0.000	0.000	0.000
53	0.000	16.667	0.000	0.000	0.000	0.000	5.556	0.000	33.333	0.000	0.000
54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55	14.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
56	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
57	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58	0.000	0.000	0.000	0.000	0.000	7.143	0.000	0.000	0.000	0.000	0.000
59	0.000	0.000	0.000	0.000	0.000	7.143	0.000	0.000	0.000	0.000	0.000
60	0.000	16.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
61	14.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
62	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.263	0.000	0.000	0.000
64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
67	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
68	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
69	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
71	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

73	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
74	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
75	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
77	14.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fish	7	8	14	15	6	28	19	19	3	8	5
Deployments	7	6	10	10	5	12	12	10	1	5	5

Table 3. Age compositions in 1-yr bins (centered) in percent for the CTS based on fish processed for life history samples in 2012-2018. This eliminates fish >99 cm, which comprise of ~1.6% of the CTS Cobia catch. Fish denotes total number of fish sampled per year and deployments the number of tows from which fish were measured.

Age	2012	2013	2014	2015	2016	2017	2018
0	100.00	33.33	85.71	53.33	60.00	57.14	36.84
1	0.00	50.00	14.29	46.67	40.00	42.86	63.16
2	0.00	16.67	0.00	0.00	0.00	0.00	0.00
Fish	1	6	14	15	5	14	19
Deployments	1	6	10	10	5	12	12

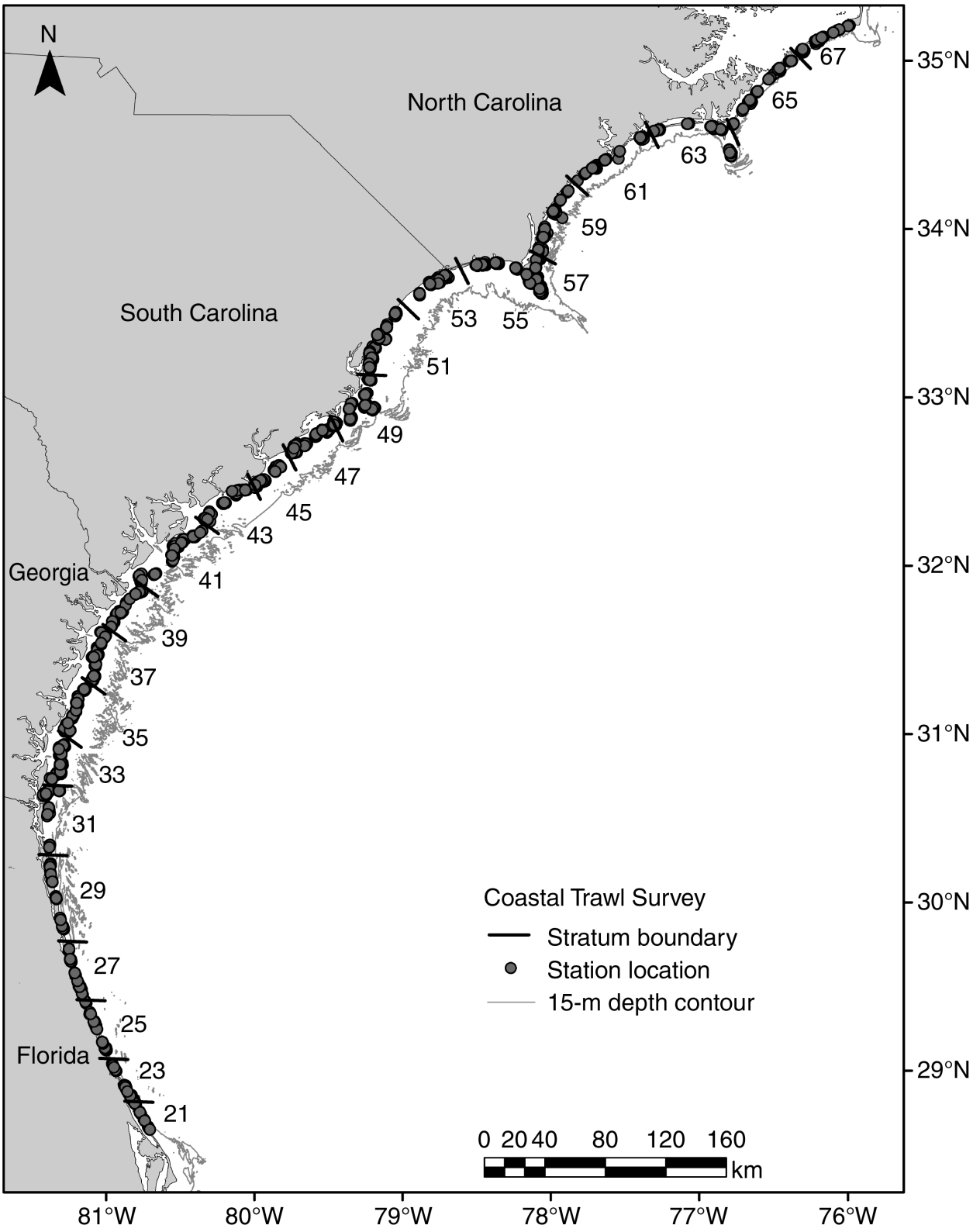


Figure 1. Coastal Trawl Survey station distribution and demarcations of inner strata. For this Cobia work, we only used strata 31-67, eliminating Florida sampling from analyses. From Zimney and Smart (2022).

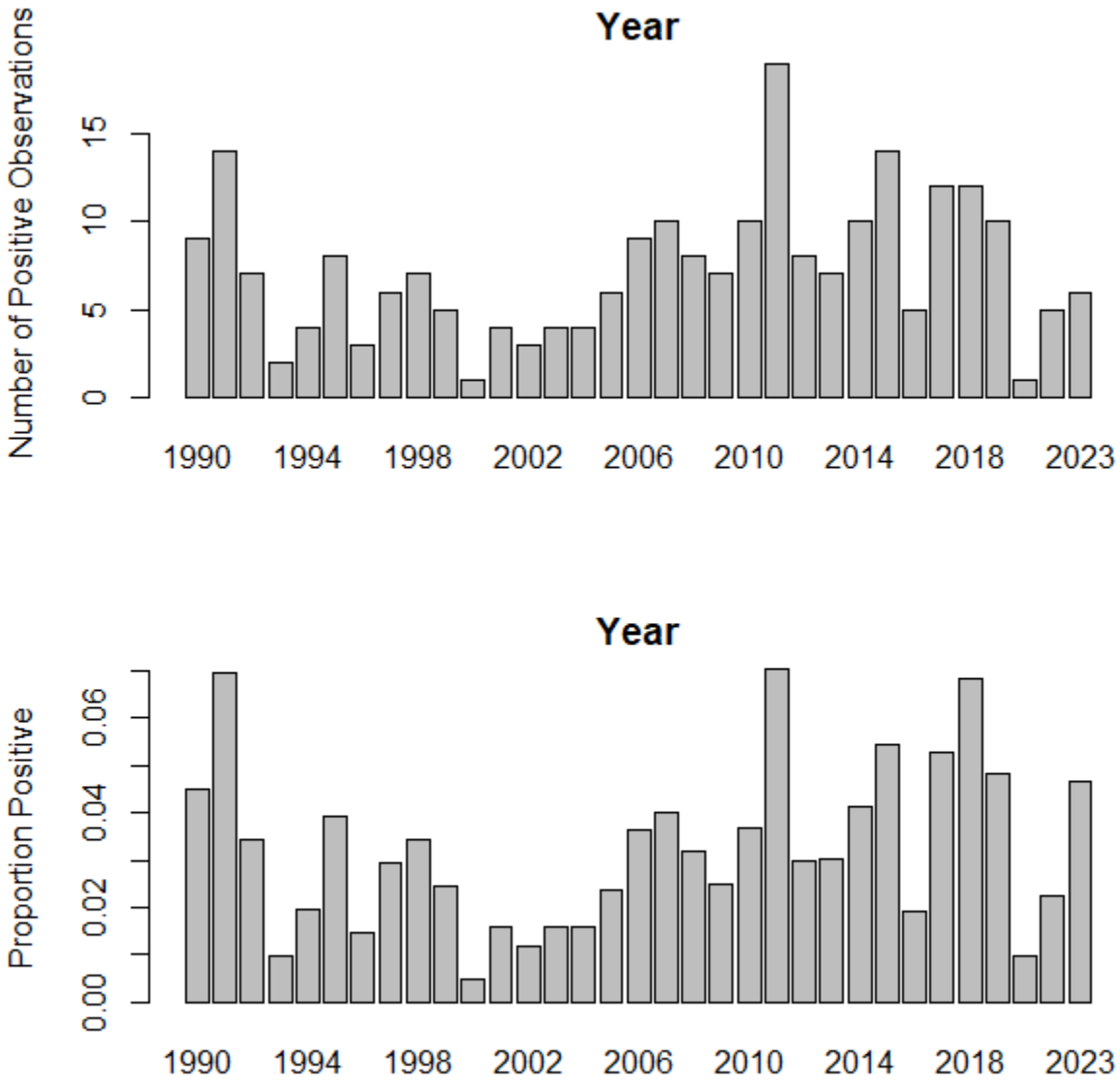
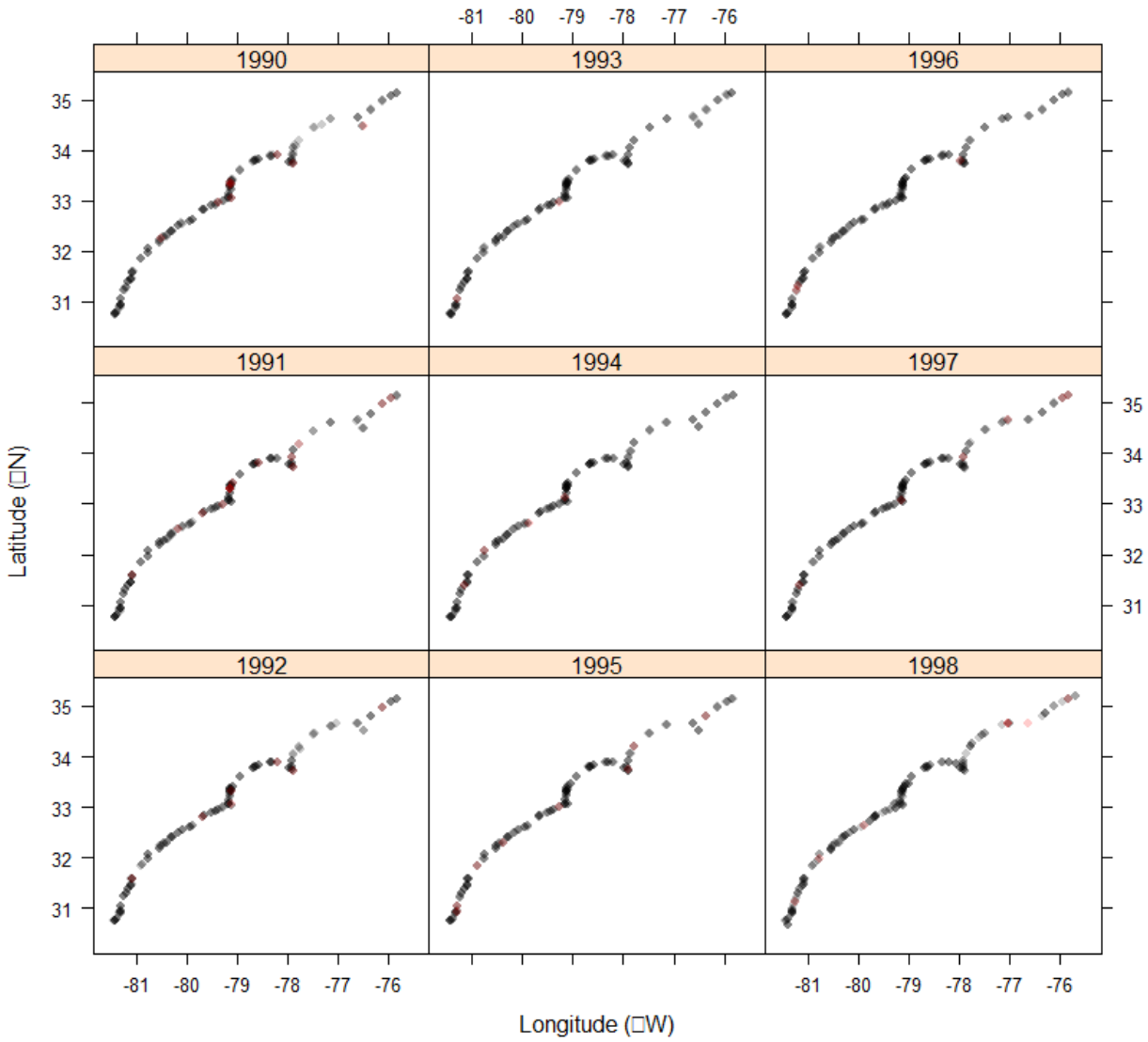


Figure 2. Annual positive observations and percent positive of Cobia in the CTS.


1990
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1996
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1994
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32
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-81
-80
-79
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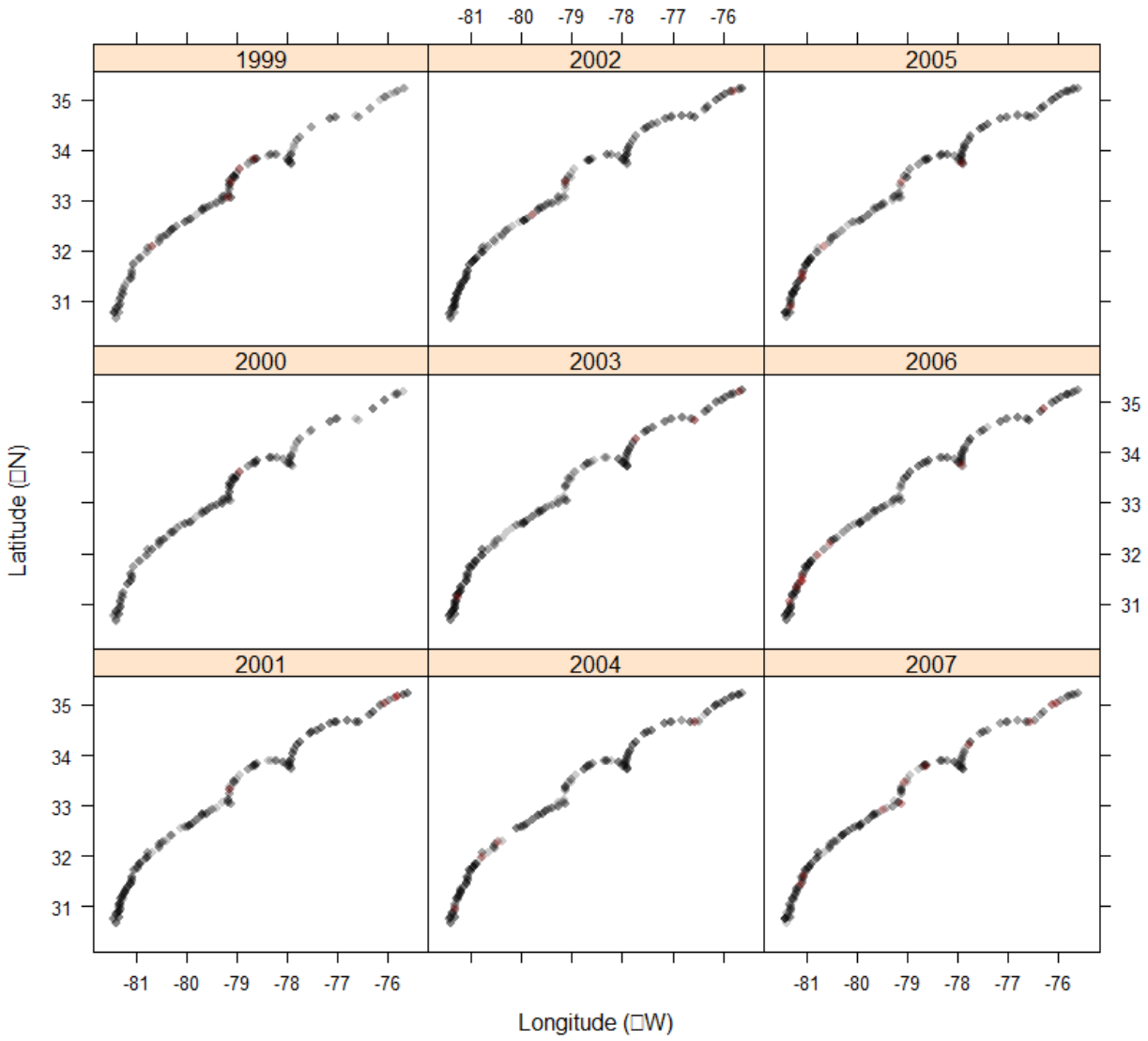
-77
-76
Latitude (□N)
Longitude (□W)


1999
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2003
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2004
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-81
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-76
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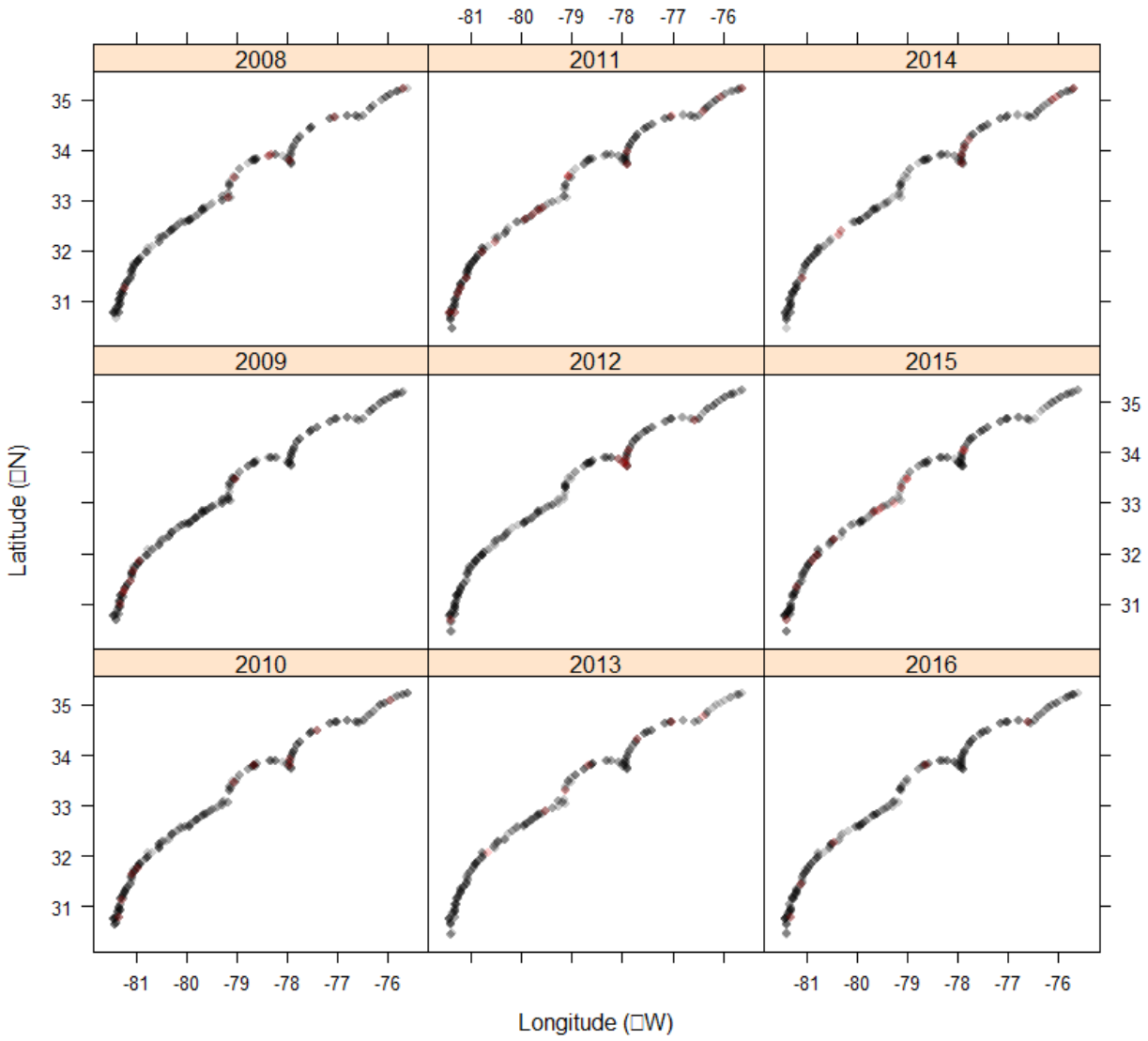
32
31
Latitude (□N)
Longitude (□W)


2008
2011
2014
2009
2012
2015
2010
2013
2016
-81
-80
-79
-78
-77
-76
35
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31
Latitude (□N)
Longitude (□W)

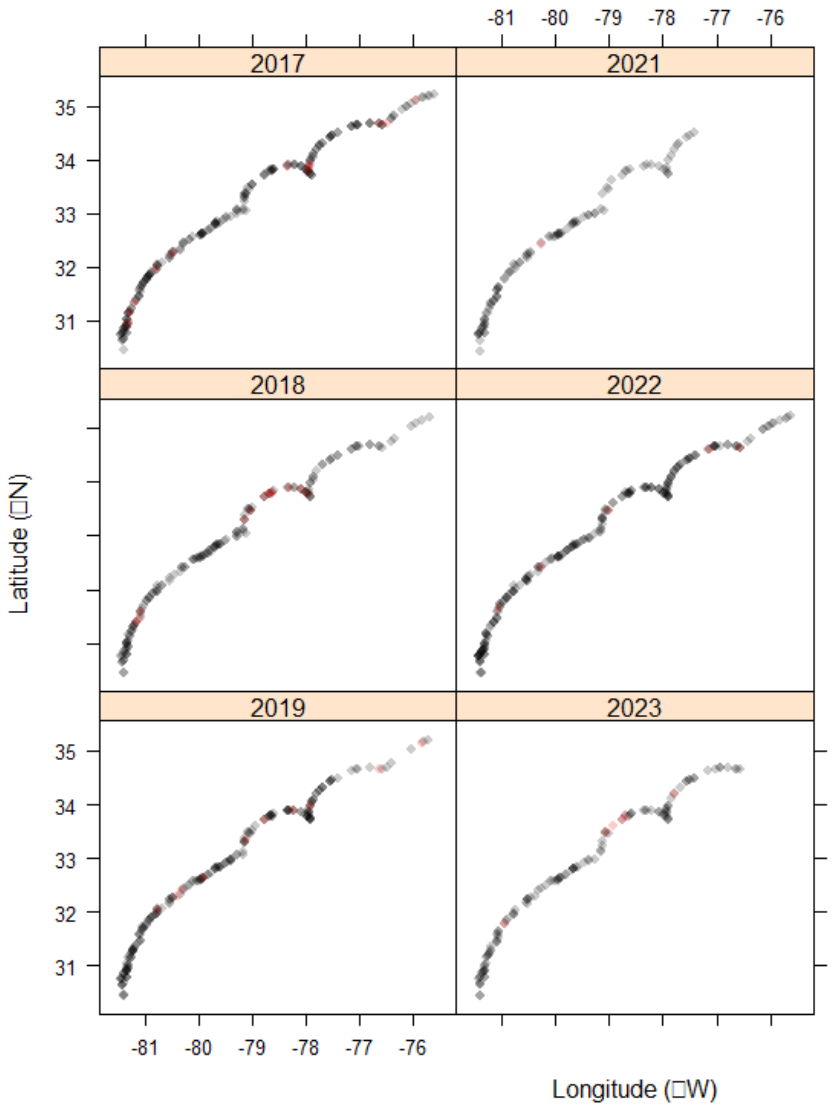


Figure 3. Annual distribution of Cobia collected by the Coastal Trawl Survey (CTS). Black circles indicated tows without Cobia, red circles tows with Cobia. Cobia occurred throughout the survey range, although that varied from year to year.

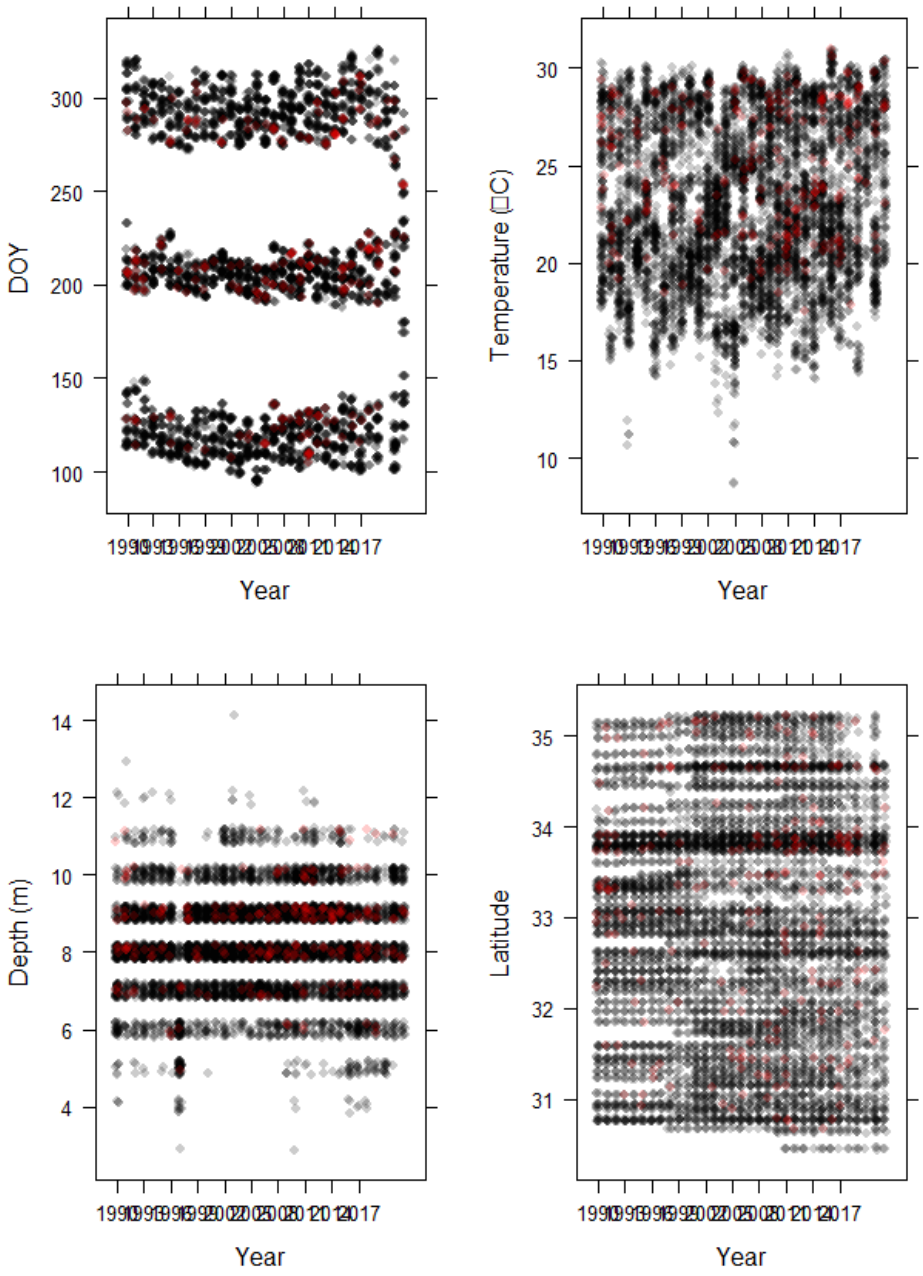
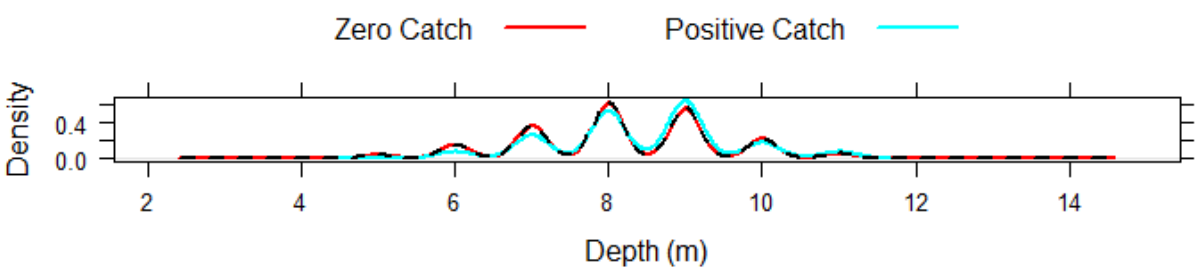
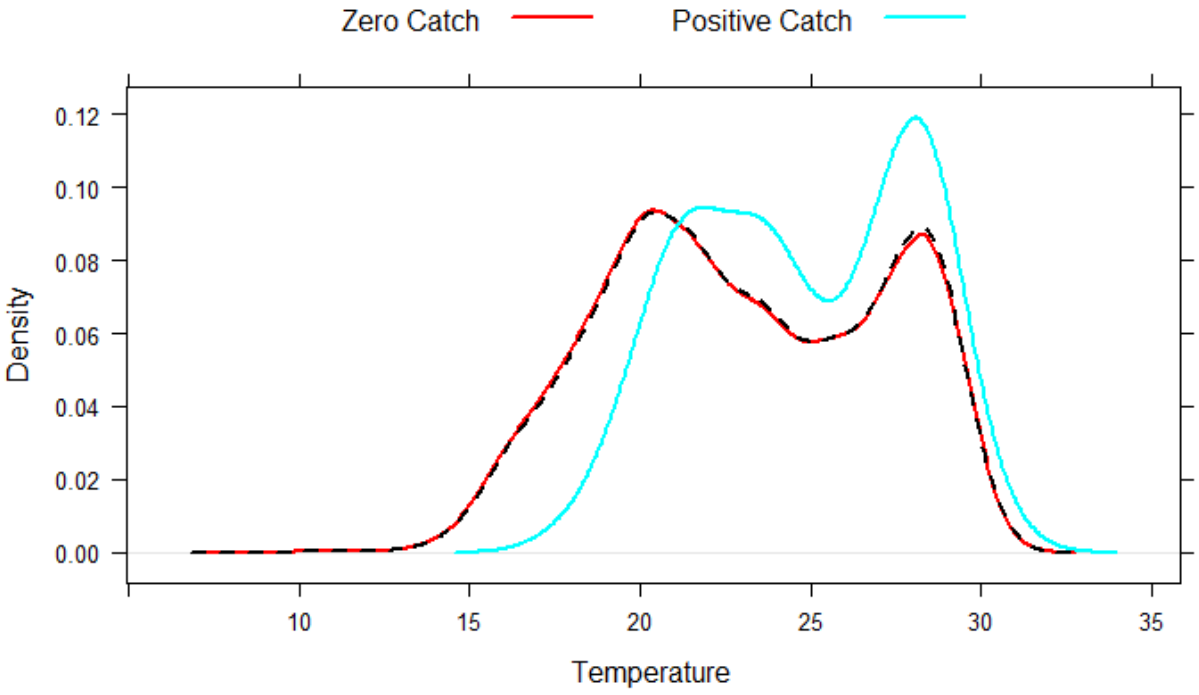
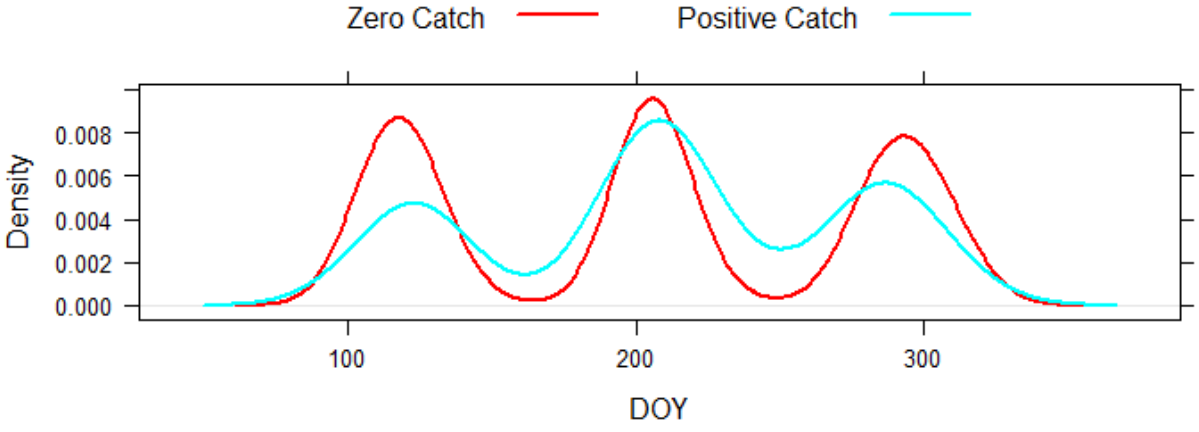


Figure 4. Distribution of Cobia collected among the covariates explored for the index of abundance from the CTS. Cobia occurred across all survey seasons (DOY), bottom temperatures, depths, and latitudes, suggesting we cannot truncate the survey to improve the percent positive.


Zero Catch
Positive Catch
Density
0.4
0.0
2
4
6
8
10
12
14
Depth (m)


Zero Catch
Positive Catch
Density
0.12
0.10
0.08
0.06
0.04
0.02
0.00
10
15
20
25
30
35
Temperature


Zero Catch
Positive Catch
Density
0.008
0.006
0.004
0.002
0.000
100
200
300
DOY

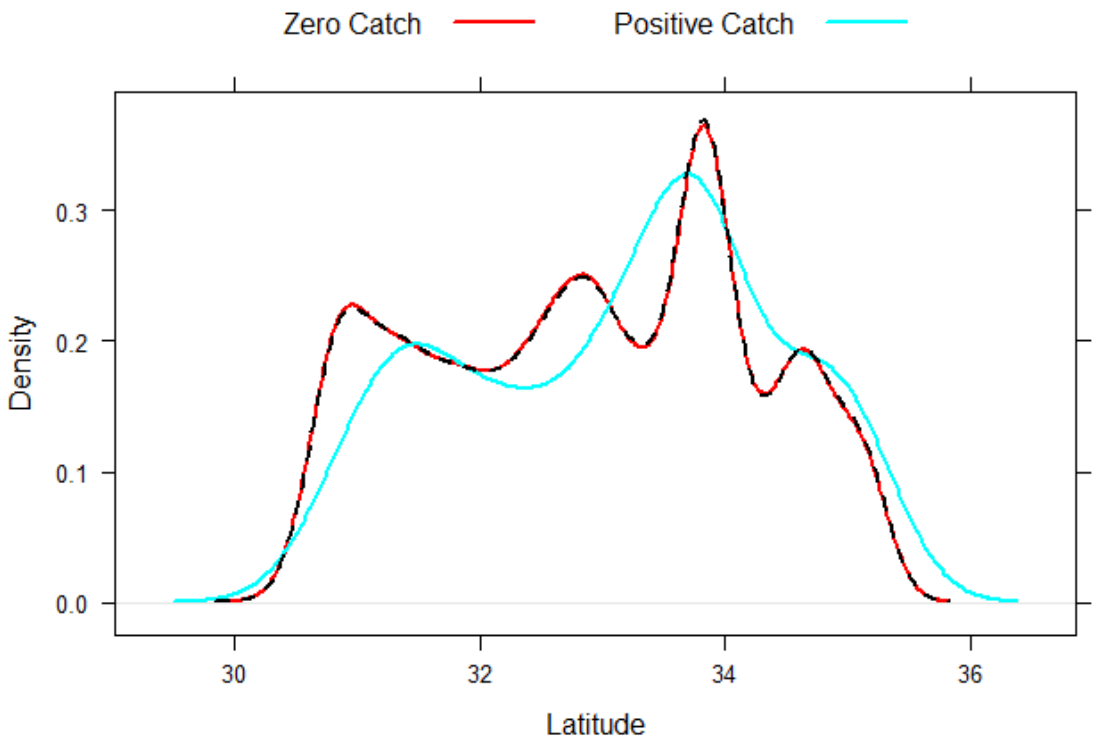


Figure 5. Distribution of all collections (black), no Cobia collections (red), and Cobia positve collections (blue) in the CTS. The high overlap among the three also support no possible truncation to improve % positive.

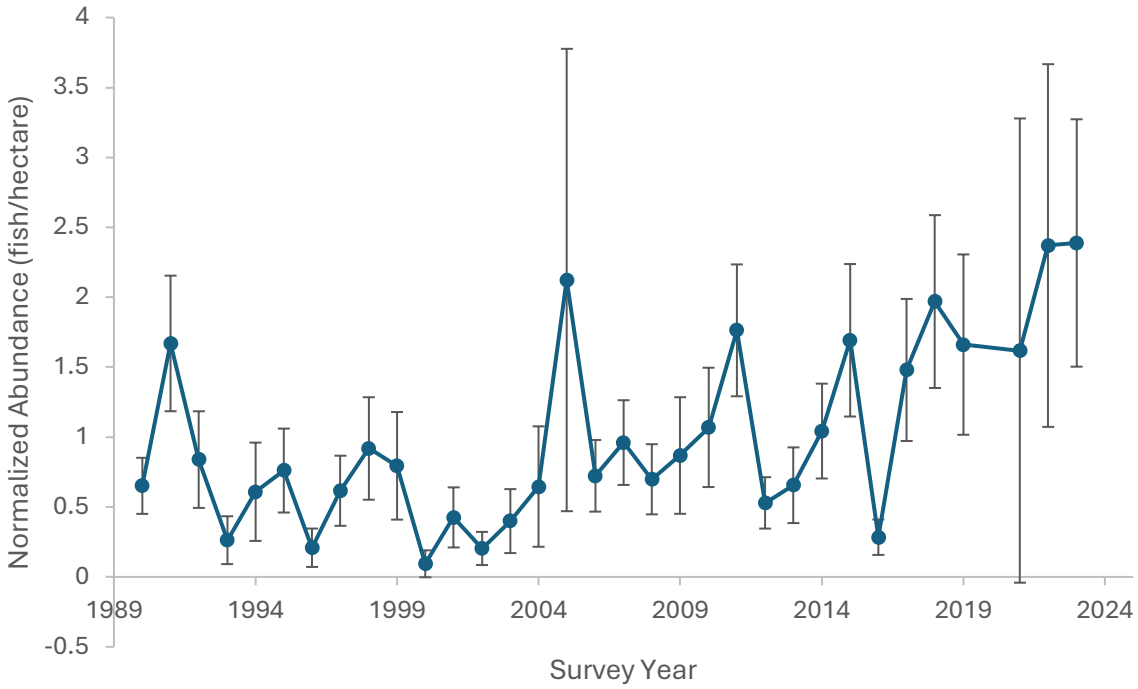


Figure 6. Normalized Zero-Inflated Negative Binomial index of abundance for Cobia with standard errors from the Coastal Trawl Survey 1990-2019 and 2021-2023 with Year, Latitude, Depth, Day of Year, and Bottom Temperature included as covariates. Error developed through bootstrapping (5,000 iterations).