An index of abundance from the Marine Recreational Information Program Data

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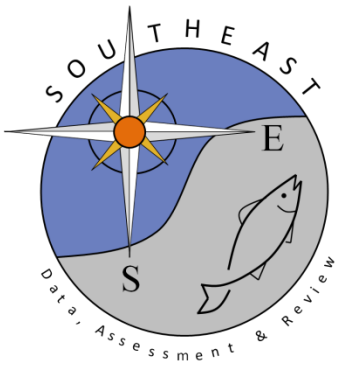

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Abstract
The Marine Recreational Information Program (MRIP) catch data set was used to derive a standardized index of abundance for Atlantic blacktip sharks using delta-lognormal generalized linear mixed models. The fraction of the catch of carcharhinid sharks identified to species in the MRIP data has declined over the last 30 years, as more sharks have been released alive rather than landed so that the data collectors can identify the species. Thus, this index is likely to be biased and probably should not be used in assessment.

Introduction
The Marine Recreational Information Program (MRIP) (Marine Recreational Information Program 2019) conducts dockside interviews with returning recreational anglers, stratified by year (1981- 2018), sub regions (North Atlantic, Mid Atlantic, South Atlantic), fishing mode (shore based, charter/party boat and private boat) and wave (2 month intervals). Additional data are collected on the area of fishing (inland waters, state waters, or federal waters), disposition of the catch (A: landed, B1: dead but not present during the interview, B2: released alive) as well as catch and effort data. The objective of this analysis is to extract unbiased indices of abundance for blacktip sharks (*Carcharhinus limbatus*) from the MRIP intercept survey data. The methods used were similar to those used by Babcock (2010) for sandbar, dusky and blacknose shark and by Ortiz (2005) except that this analysis did not use the target species guild as a potential explanatory variable.

Methods
This analysis used the MRIP catch datasets, which are the reports of the angler-trips actually sampled, not the estimates that have been expanded using the effort data, because we are using catch rates in angler-trips as a potential index of abundance (Marine Recreational Information Program 2019). To focus the analysis on angler-trips that were likely to catch blacktip sharks, we extracted only angler-trips from the Atlantic region (New England through the east coast of Florida) that had caught at least one Carcharinid shark, including those that were only identified to genus or family. Because the goal of this analysis was to extract an index of abundance, rather than to estimate total catch, we excluded strata (wave, sub-region, mode) that reported few catches of blacktip sharks.

A delta-lognormal generalized mixed linear (GLMM) model was used to standardize the index in which the proportion of trips with a positive catch was modeled with a logit link GLMM appropriate for binomial data, and the CPUE (in numbers per angler-trip) of positive trips was lognormal. Potential explanatory variables were year, sub-region, fishing mode and area fished. The index of abundance derived by Babcock (2010) for dusky, sandbar and blacknose sharks used the target species declared by the angler as an explanatory variable, grouped by guilds (Ortiz 2005). However, since fewer than half the angler-trips we examined reported a target species, we

did not use this variable. Second order interactions were also considered as random effects. The best model was selected using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), as well as the fraction of the deviance explained by each factor or interaction (Ortiz and Arocha 2004, Forrestal et al. 2019). The year effects from the binomial and lognormal methods were combined using the method of (Lo et al. 1992) to produce the yearly standardized index. Analyses were conducted in R version 3.6.1, using the lme4 and MASS libraries (Venables and Ripley 2002, Bates et al. 2013, R Core Team 2019).

Results and Discussion

The MRIP catch dataset included 52347 angler-trips from the Atlantic region that reported catches (including live releases) of Carcharinid sharks. The retained catch has decreased over time and the live releases have increased as the recreational fishery has focused more on catch and release fishing (Figure 1, Figure 2). With the increase in live releases, there is an increase in the fraction of the catch that is only identified to family or genus, rather than to species.

Of the 52347 angler-trips that reported Carcharinid catches, 8445 reported a blacktip shark. Of the trips reporting a blacktip shark, 97% were in the south Atlantic region and 90% were in the summer waves (May-October), with substantial numbers caught in all three modes and all three fishing areas (Table 1). We therefore restricted the analysis to those the South Atlantic sub-region during the months of May to October. The final dataset includes 30446 angler trips, which is 58% of the trips that caught Carcharinidae, but 86% of the trips reporting catches of blacktip sharks.

Since we only included the south Atlantic sub-region, there was no need to include sub-region as a variable. Thus, the potential explanatory variables were year, mode and area as well as their 2-way interactions. For the binomial model, both the year:area and the year:mode interactions explained more than 5% of the total deviance when included as fixed effects (Table 2). Thus, we considered these interactions as random effects in the mixed model. The AIC and BIC both selected the model with both interactions. The best model was thus the one that include dyear, area, mode, and the year:area and year:mode interactions. For the lognormal model the AIC best model with fixed effects include year:area and year:mode but not area:mode (Table 3). With random effects, the AIC and BIC both selected the model that included both the year:mode and year:area interaction. Both models appeared to fit adequately according to the residual plots (Figure 3).

When the binomial model and the lognormal model were combined to produce an index, the index was highly variable but appeared to show a decline over time (Figure 4, Table 4). It is likely the some of the increased reporting of unidentified Carcharinidae in recent years includes blacktip sharks that were released alive. Thus, part of the apparent decline in blacktip catch rates may be explained by a lower chance of a blacktip shark being identified to species if it is released rather than landed. Because this index is probably biased by changes in the fraction that are identified to species, the index probably should not be used in assessment. However, it may provide some useful information when compared to other indices.

References

Babcock, E. A. 2010. Indices of abundance from the Marine Recreational Fisheries Statistics Survey.

Bates, D., M. Maechler, and B. Bolker. 2013. Package LME4: Linear mixed-effects models using S4 classes.

Forrestal, F. C., M. Schirripa, C. P. Goodyear, H. Arrizabalaga, E. A. Babcock, R. Coelho, W. Ingram, M. Lauretta, M. Ortiz, R. Sharma, and J. Walter. 2019. Testing robustness of

CPUE standardization and inclusion of environmental variables with simulated longline catch datasets. Fisheries Research **210**:1-13.

Lo, N. C. H., L. D. Jacobson, and J. L. Squire. 1992. Indexes of Relative Abundance from Fish Spotter Data Based on Delta-Lognormal Models. Canadian Journal of Fisheries and Aquatic Sciences **49**:2515-2526.

Marine Recreational Information Program. 2019. Marine Recreational Information Program, *.in* NOAA, editor.

Ortiz, M. 2005. Standardized catch rates for blacktip shark (Carcharhinus limbatus), sandbar shark (C. plumbeus), and large coastal complex sharks from the marine recreational fisheries statistical survey (MRFSS).

Ortiz, M., and F. Arocha. 2004. Alternative error distribution models for standardization of catch rates of non-target species from a pelagic longline fishery: billfish species in the Venezuelan tuna longline fishery. Fisheries Research **70**:275-297.

R Core Team. 2019. R: A Language and Environment for Statistical Computing.*in* R. F. f. S. Computing, editor., Vienna, Austria.

Venables, V. N., and B. D. Ripley. 2002. Modern Applied Statistics with S. 4th Edition. Springer.

Table 1. Number of trips sampled in the MRFSS intercept survey from 1981 to 2018 that reported the catch of at least one Carcharhinid shark, classified by strata, and by whether they reported at least one blacktip shark.

(a) By sub-regions

Blacktip shark	North	Mid	South
Absent	1651	13965	28286
Present	3	281	8161

(b) By area fished

	Ocean <3 mi	Ocean >3 mi	Inland
Absent	9526	15375	19001
Present	3110	1528	3807

(c) By fishing mode

	Shore	Party/Charter	Private/Rented
Absent	4783	10470	28649
Present	1117	3216	4112

(d) By wave

	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Absent	1223	2036	11297	18900	8295	2151
Present	208	288	2799	3785	996	369

Table 2. Results for binomial model

(a) ANOVA table for the AIC best model with fixed effects

	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)	Percent Deviance
NULL	NA	NA	291	6003.159	NA	
year	37	1590.515	254	4412.644	<0.001	0.265
mode	2	788.337	252	3624.307	<0.001	0.131
area	2	1286.748	250	2337.559	<0.001	0.214
year:mode	73	907.534	177	1430.025	<0.001	0.151
year:area	74	553.094	103	876.930	<0.001	0.092
mode:area	3	85.417	100	791.514	<0.001	0.014

(b) AIC and BIC values relative to the best model for mixed models

Model	AIC	BIC
year+mode	2111.52	2096.81
year+mode+area	828.77	821.42
year+mode+area+year:mode	302.37	298.70
year+mode+area+year:area	478.16	474.48
year+mode+area+year:area+year:mode	0.00	0.00

Table 3. Results for lognormal model

(a) ANOVA table for the AIC best model with fixed effects

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)	Percent deviance
NULL	NA	NA	7301	3236.426	NA	NA	NA
year	37	136.671	7264	3099.755	9.740	0.000	0.042
mode	2	82.823	7262	3016.932	109.197	0.000	0.026
area	2	57.001	7260	2959.931	75.152	0.000	0.018
year:mode	68	153.670	7192	2806.261	5.959	0.000	0.047
year:area	73	106.472	7119	2699.789	3.846	0.000	0.033

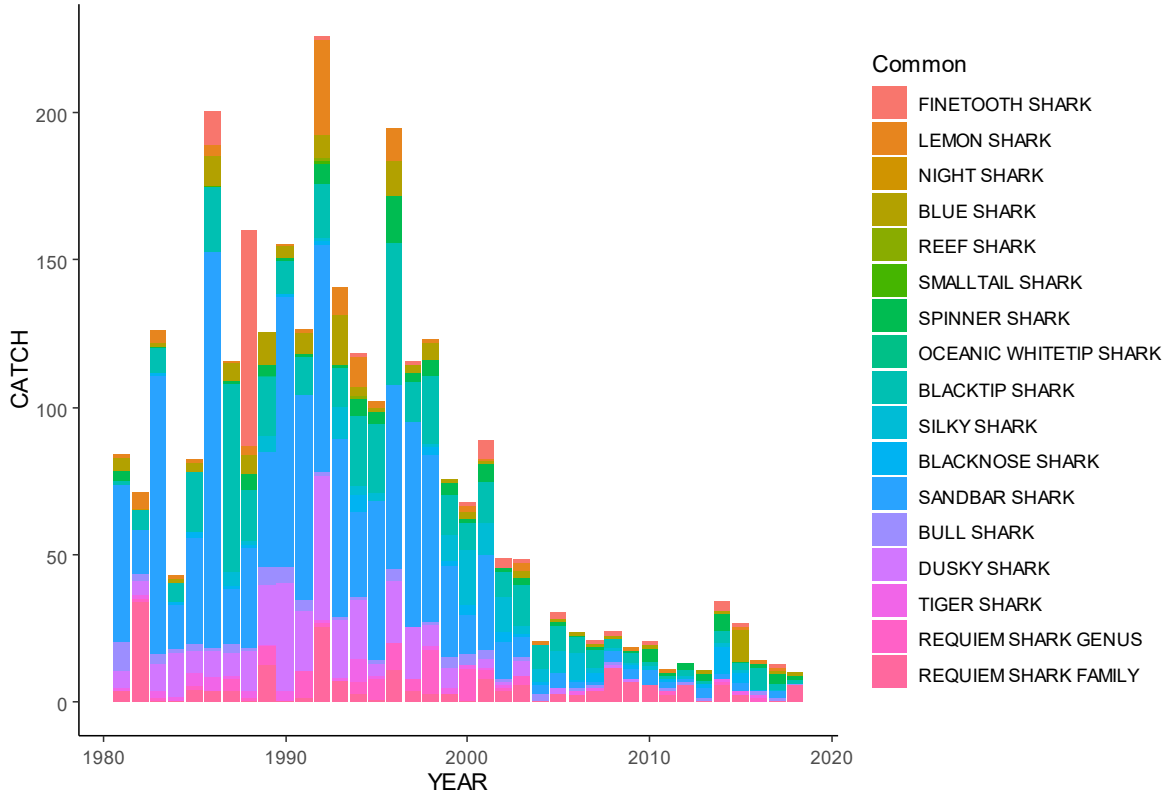
(b) AIC and BIC values

Model	AIC	BIC
year+mode	312.39	284.80
year+mode+area	177.11	163.31
year+mode+area+year:mode	61.10	54.20
year+mode+area+year:area	123.84	116.94
year+mode+area+year:area+year:mode	0.00	0.00

Table 4. Standardized index and its standard error.

Year	Index	SE	Year	Index	SE
1981	2.15	0.40	2000	1.30	0.16
1982	0.70	0.11	2001	1.51	0.19
1983	1.11	0.15	2002	0.96	0.13
1984	1.53	0.26	2003	1.16	0.15
1985	0.99	0.13	2004	0.70	0.10
1986	1.27	0.17	2005	0.88	0.13
1987	1.05	0.14	2006	0.82	0.12
1988	0.97	0.14	2007	0.52	0.08
1989	0.74	0.12	2008	0.83	0.12
1990	1.07	0.16	2009	0.86	0.12
1991	1.28	0.15	2010	1.08	0.14
1992	1.45	0.17	2011	0.28	0.05
1993	0.75	0.12	2012	0.24	0.04
1994	2.56	0.24	2013	0.55	0.08
1995	1.52	0.18	2014	0.53	0.08
1996	1.58	0.19	2015	0.47	0.07
1997	1.12	0.16	2016	0.34	0.05
1998	1.57	0.18	2017	0.65	0.09
1999	0.52	0.08	2018	0.39	0.06

(a) Species composition of Carcharinid sharks retained



(b) Species composition of Carcharinid sharks released alive

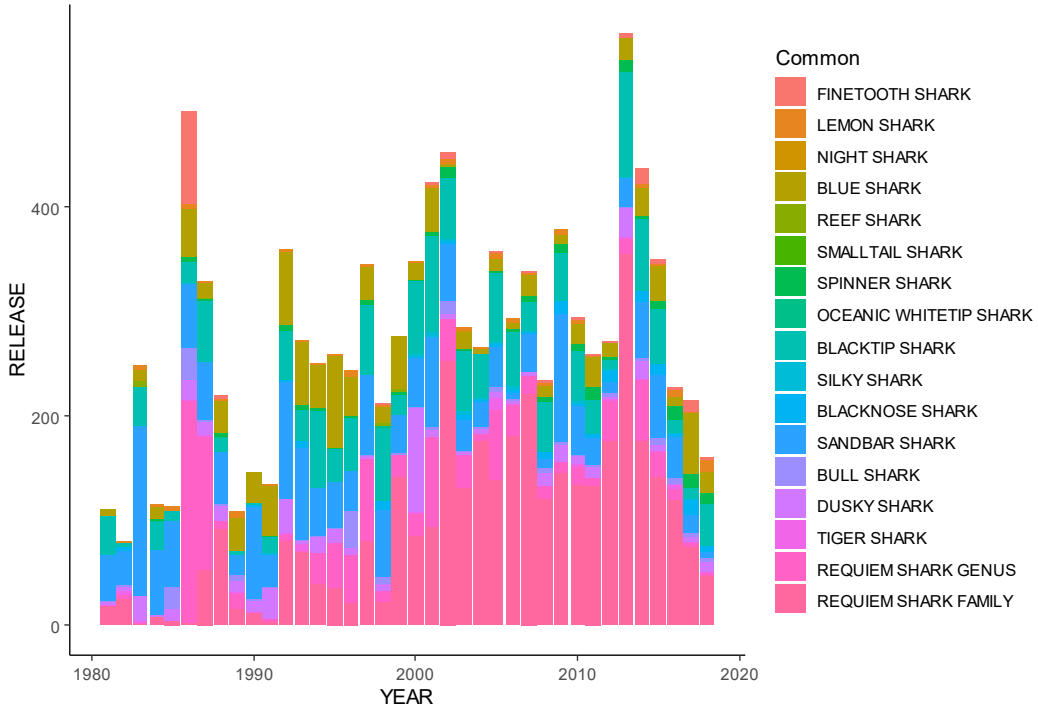


Figure 1. Species composition recorded in the MRIP catch datasets of (a) retained (A+B1) catch, and (b) live releases (B2). These include only the catch dataset, which has not been extrapolated using the effort data, so the species composition may differ from that in the total catch.

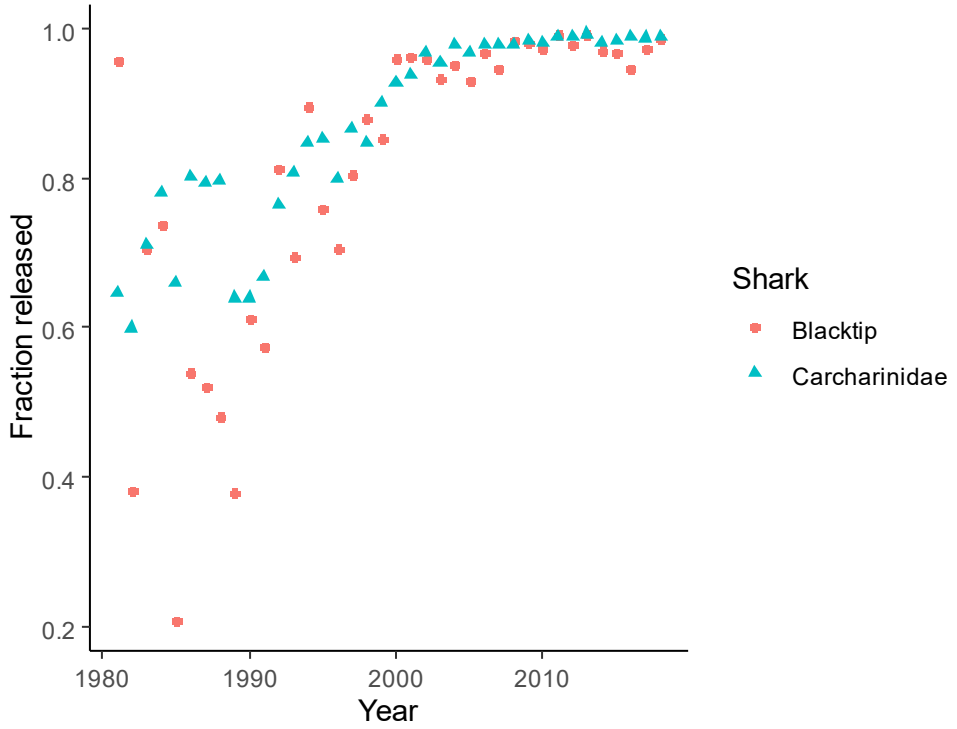
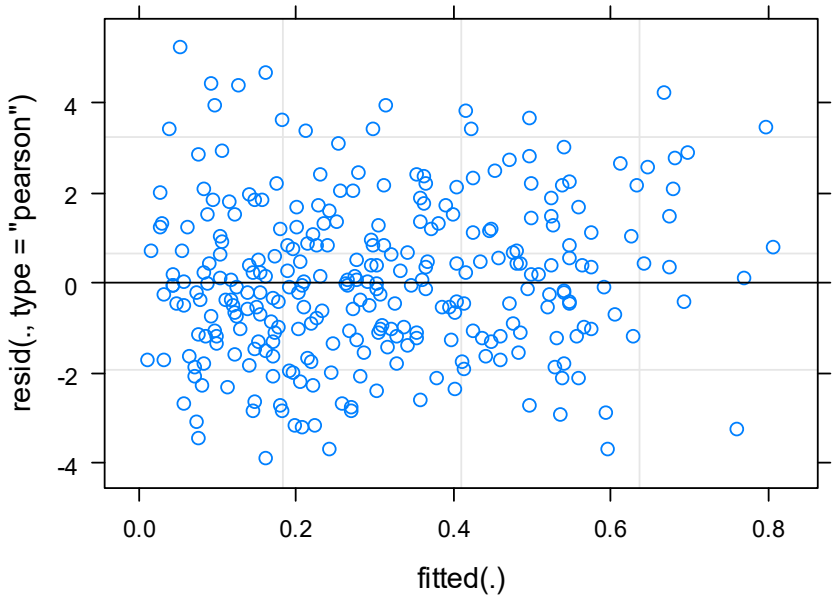


Figure 2. The fraction of sharks in the MRIP catch data for the Atlantic region (New England through the east coast of Florida) that were released for those identified as blacktip, and for all Carcharinidae including those that were not classified to species.

(a) Binomial model



(b) Lognormal model

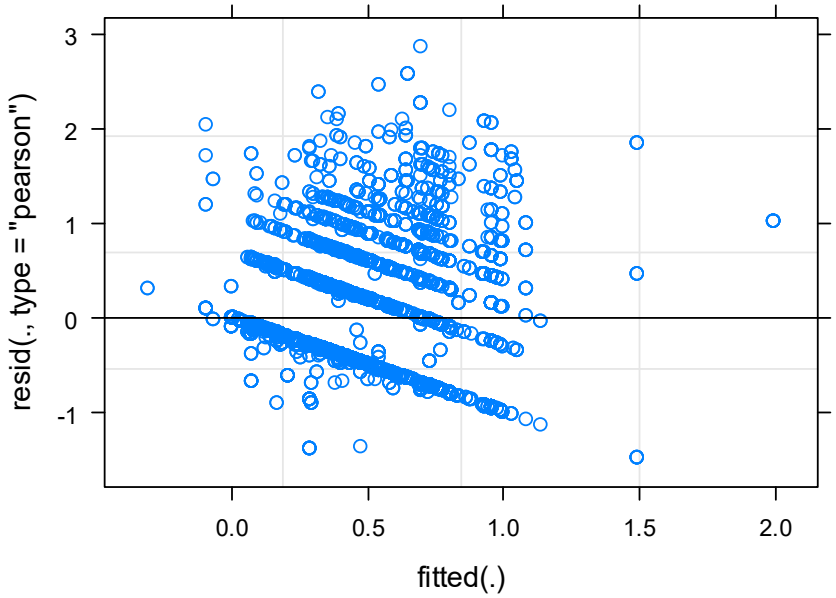


Figure 3. Residuals for (a) the binomial model (comparing the proportion positive in each strata to the predicted proportion positive) and (b) the lognormal model.

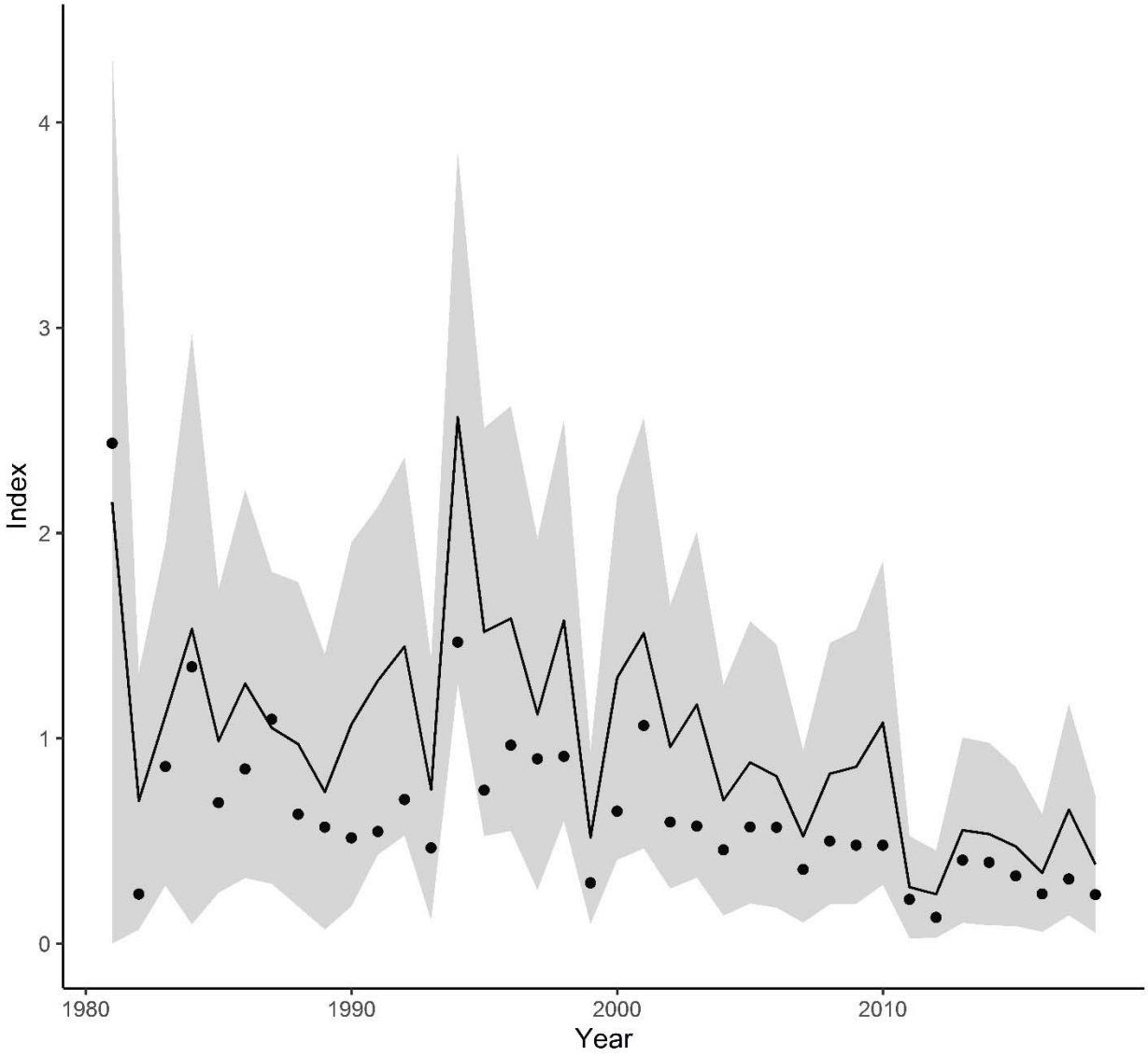


Figure 4. Delta-lognormal standardized index of Atlantic blacktip shark catch per angler trip (lines with shaded 95% confidence interval) along with the simple average catch per angler trip in each year (points).