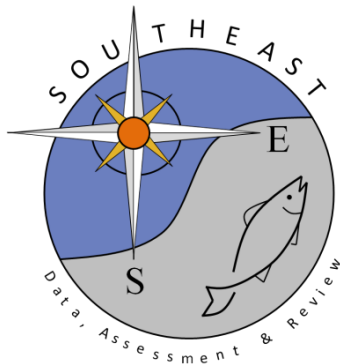


Regional and temporal trends in sandbar depredation risk on the West Florida Shelf

Hannah Aycock & Elizabeth Babcock

SEDAR101-DW-06

13 April 2026



This information is distributed solely for the purpose of pre-dissemination peer review. It does not represent and should not be construed to represent any agency determination or policy.

Please cite this document as:

Aycock, Hannah and Elizabeth Babcock. 2026. Regional and temporal trends in sandbar depredation risk on the West Florida Shelf. SEDAR101-DW-06. SEDAR, North Charleston, SC. 8 pp.

Abstract

Sandbar sharks are commonly implicated in shark depredation, when a shark bites a hooked fish. However, the wide-scale rate of sandbar depredation is unknown. To estimate regional depredation risk, a geostatistical sandbar species distribution model was overlaid with a for-hire fishing event distribution model on the West Florida Shelf. Between 2009 and 2023, sandbar depredation risk increased by 207%. Sandbar sharks accounted for 77% of the total risk in the Northwest region compared to only 18% in the Florida Keys. These findings suggest that regions differ in the composition of shark species contributing to depredation, highlighting the potential for developing targeted, area-specific mitigation strategies

Introduction

Reports of shark depredation, when a shark bites a hooked fish, have increased in the United States over the last decade (Mitchell et al., 2018; NMFS, 2022; NOAA Fisheries, 2023), particularly within Florida recreational fisheries (Casselberry et al., 2022; Klizentyte et al., 2023; McCallister et al., 2025). While many species are involved, sandbar sharks (*Carcharhinus plumbeus*) are among the most frequently implicated (Drymon et al., 2019; Drymon et al., 2022; NOAA Fisheries, 2023; McCallister et al., 2025). Genetic studies have confirmed sandbar depredation at local scales (McCallister et al., 2025), however, regional-scale, species-specific depredation trends remain unquantified. Estimating these trends is critical for informing species-specific depredation management and mitigation strategies (NOAA Fisheries, 2023).

This working paper quantifies the spatiotemporal trends in sandbar-specific depredation risk in the for-hire recreational fishery on the West Florida Shelf. Our methodology builds on the quantitative approach established by Aycock & Babcock (in review), which overlaid geostatistical species distribution models of ten large coastal shark species combined with charter and head boat distribution. This framework is applied here to a single species, sandbar sharks, to assess spatial overlap and relative depredation risk. The purpose of this study is to determine whether spatial overlap between large-bodied sandbar sharks and for-hire fishing fleets has increased over time and how this risk varies regionally across the West Florida Shelf. These findings can help identify regions where sandbar-specific depredation mitigation strategies may be most effective.

Methods

Following the methodology established by Aycock & Babcock (in review), sandbar shark probability of presence was estimated using a geostatistical species distribution model developed with the R package `sdmTMB` (Anderson et al., 2023). A generalized linear mixed model (GLMM) with a binomial distribution was used to model sandbar shark probability of presence using presence–absence data from the NOAA Shark and Red Snapper Bottom Longline Survey (NOAA Fisheries, 2024). The data was filtered to only include sandbar sharks exceeding 150 cm fork length on the West Florida Shelf between 2000 and 2023 (NOAA Fisheries, 2024). Multiple models with different fixed and random effects were tested to compare model performance. These included models with linear and smooth depth as predictor variables, spatial and temporal random effects, autoregressive order 1 (AR1), random walk (RW), and IID spatiotemporal random effects, and a null model that included no fixed or random effects.

Comprehensive details regarding model selection, cross validation, and model diagnostics are available on GitHub ([Sandbar Depredation Risk GitHub Repository](#)). Each model was assessed using the `sanity` function of the `sdmTMB` library (Anderson et al., 2022). Quantile residuals were calculated using maximum likelihood estimation with a multivariate normal error distribution (MLE-MVN). Model performance was assessed by fitting model predictions with a Receiver Operating Characteristic (ROC) curve and calculating the Area Under the Curve (AUC) (Robin et al., 2021). The final model selected by AIC was cross-validated using the `sdmTMB_cv()` function with random ten-fold selection (Anderson et al., 2022).

Probability of presence predictions were generated using a 5.5 km × 5.5 km resolution spatial grid covering the full extent and depth range of the survey area, created with the `marmap` R package (v1.0.5; Pante & Simon-Bouhet, 2013). Final model predictions were overlaid with the for-hire fishing effort distribution from Aycock & Babcock (in review), which shared a matching spatial and temporal extent. Sandbar-specific depredation risk was calculated by multiplying predicted sandbar probability of presence by for-hire fishing event intensity. Sandbar-specific depredation risk was compared with multi-species depredation risk from Aycock & Babcock (in review) to identify notable annual or regional differences.

Results and Discussion

AIC model selection favored a model that included a smooth depth predictor and an RW spatiotemporal random effect. The final model satisfied all sanity function checks. The Q-Q uniform plot of the MLE-MVN residuals indicated appropriate model specification (Figure 1). The model predicted a zero-fraction of 0.856, consistent with the observed fraction of 0.853, and had an AUC score of 0.903 (Figure 1). Cross validation indicated minimal overfitting, as RMSE and MAE only increased by 6.9% and 8.4% respectively.

Average sandbar-specific depredation risk increased by 207.55% between 2009 and 2023 (Figure 2; Table 1). Overall, sandbar sharks accounted for approximately 40% of the aggregate-species depredation risk on the West Florida Shelf (Table 1). Despite this increase, their relative annual contribution remained stable, rising only from 36% to 43.9% over the study period. Depredation risk increased across all regions, with the Tampa Bay and Northwest regions exceeding the shelf-wide average (Figure 3; Table 2). The proportional contribution of sandbar sharks to aggregate depredation risk was not homogeneous across the shelf, ranging from 18% in the Keys to 77% in the Northwest region (Table 2).

This variation indicates that while sandbar sharks are primary drivers of depredation risk in the Northwest region, other species are likely to contribute more substantially to depredation in other regions. Overall, these results suggest that sandbar sharks are major contributors to depredation risk on the West Florida Shelf, although their influence is region dependent. More research is needed to identify which aspects of sandbar presence and fishing effort drive elevated depredation risk in these regions. Depredation patterns appear to reflect regionally distinct species assemblages, indicating that mitigation strategies should be tailored to local shark community composition.

Tables and Figures

Table 1. Sandbar-specific and aggregate depredation risk from 2009 to 2023. Risk values were averaged across three-year time blocks. The percent contribution of sandbar sharks to multi-species depredation risk was calculated by dividing sandbar-specific risk by aggregate depredation risk.

Time Period	Sandbar Depredation Risk	Aggregate Depredation Risk <i>Aycock & Babcock, 2026</i>	% Sandbar of Aggregate Risk
2009 - 2011	0.0042	0.0106	39.7
2012 - 2014	0.0063	0.0159	39.4
2015 - 2017	0.0082	0.0209	39.4
2018 - 2020	0.0096	0.0264	36.4
2021 - 2023	0.0143	0.0326	43.9
Average	0.0085	0.0213	40.1

Table 2. Regional summary of sandbar-specific and aggregate species depredation that includes ten species. Percent sandbar of multi-species risk was calculated by dividing sandbar-specific risk by multi-species depredation risk.

Region	Sandbar Depredation Risk	Aggregate Depredation Risk <i>Aycock & Babcock, 2026</i>	% Sandbar of Aggregate Risk
Northwest	0.0236	0.0307	76.9
Big Bend	0.0010	0.0043	22.5
Tampa Bay	0.0094	0.0317	29.7
Southwest	0.0024	0.0094	25.1
Keys	0.0045	0.0251	17.9
West Florida	0.0082	0.0202	40.4

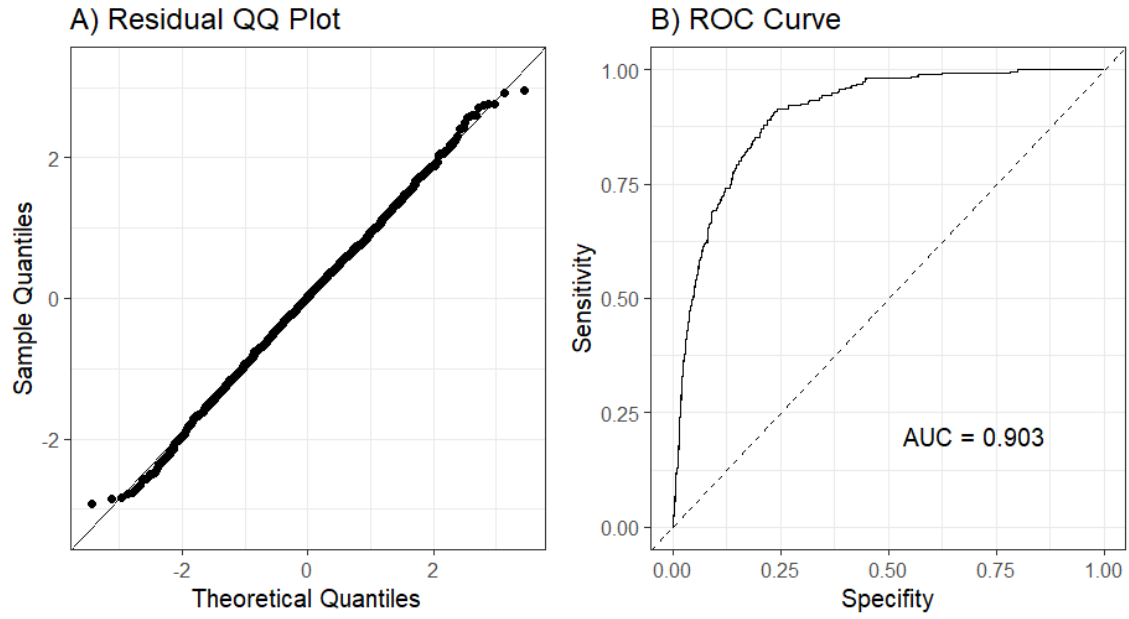


Figure 1. QQ Uniform plot (left) and ROC curve (right) of the depredating shark probability of presence model. The QQ Uniform plot followed a linear pattern, and the model had an AUC score of 0.903.

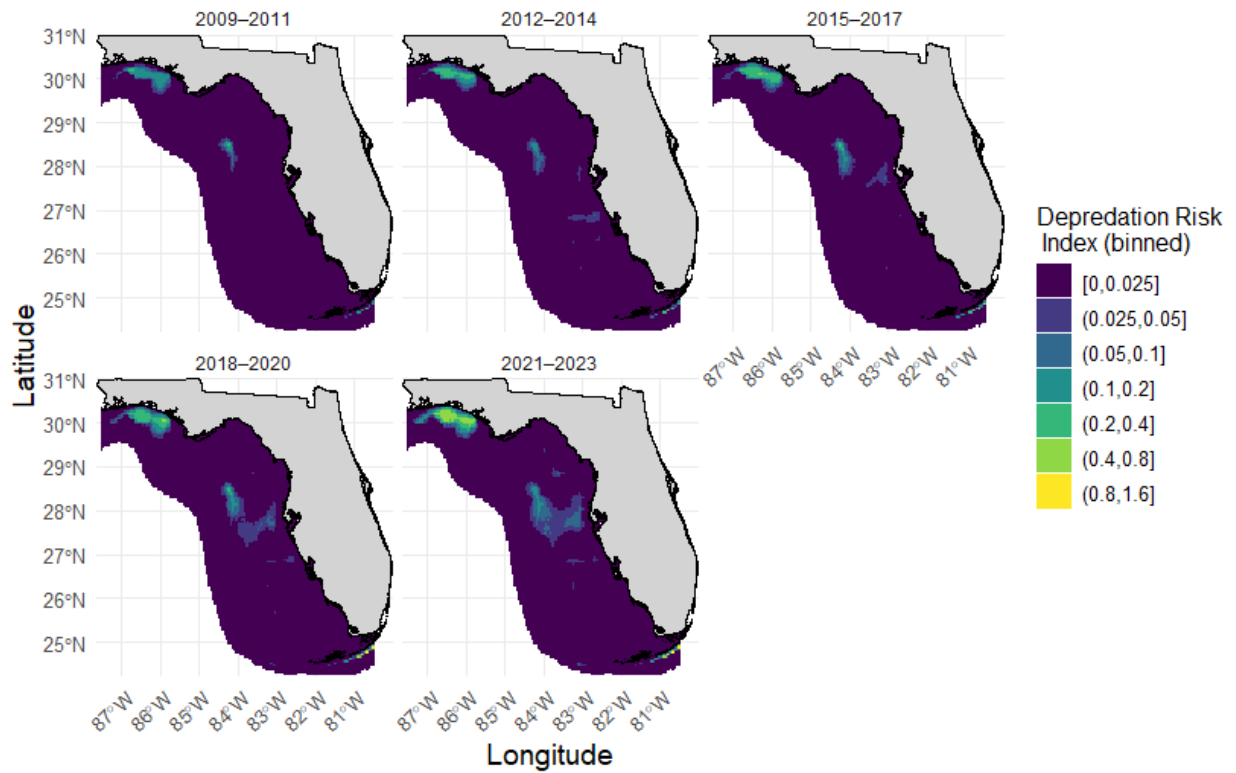


Figure 2. Sandbar-specific depredation risk on the West Florida Shelf from 2009 to 2023. Estimates were calculated by multiplying logit-transformed shark presence probability by log-transformed fishing event intensity predictions. Risk values were averaged across three-year time blocks and displayed in equal \log_2 bins.

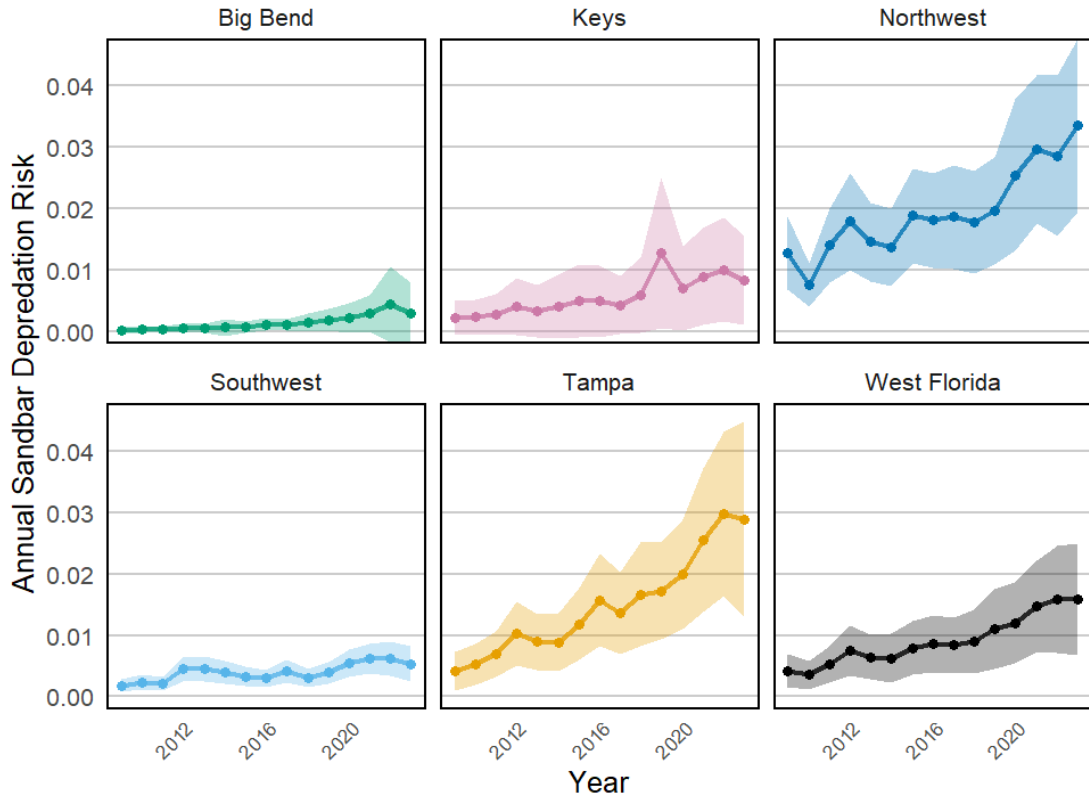


Figure 3. Regional sandbar depredation risk. The west Florida shelf average was calculated by taking the average the predictions of the five regions.

References

- Anderson, S. C., E. J. Ward, P. A. English, L. A. K. Barnett, and J. T. Thorson. 2022. “sdmTMB: An R Package for Fast, Flexible, and User-Friendly Generalized Linear Mixed Effects Models with Spatial and Spatiotemporal Random Fields.” bioRxiv <https://doi.org/10.1101/2022.03.24.485545>
- Casselberry, G. A., Markowitz, E. M., Alves, K., Dello Russo, J., Skomal, G. B., & Danylchuk, A. J. (2022). When fishing bites: Understanding angler responses to shark depredation. *Fisheries Research*, 246, 106174. <https://doi.org/10.1016/j.fishres.2021.106174>
- Drymon, M., Osowski, A., Jefferson, A., Anderson, A., McAree, D., Scyphers, S., Prasky, E., Karnauskas, M., & Gervasi, C. (2022). Co-Producing a Shared Characterization of Depredation in the Gulf of Mexico Reef Fish Fishery: 2022 Workshop Summary Report.
- McCallister, M. P., Brewster, L., Dean, C., Drymon, J. M., Hutt, C., Ostendorf, T. J., & Ajemian, M. J. (2025). A multifaceted citizen-science approach for characterizing shark depredation in Florida’s recreational fisheries. *ICES Journal of Marine Science*, 82(2), fsaf013. <https://doi.org/10.1093/icesjms/fsaf013>
- Mitchell, J. D., McLean, D. L., Collin, S. P., & Langlois, T. J. (2018). Shark depredation in commercial and recreational fisheries. *Reviews in Fish Biology and Fisheries*, 28(4), 715–748. <https://doi.org/10.1007/s11160-018-9528-z>
- National Marine Fisheries Service. (2022). Interactions between bottlenose dolphins and sharks and commercial, for-hire, and private recreational fisheries in the Gulf of Mexico and south Atlantic. National Oceanic and Atmospheric Administration. https://media.fisheries.noaa.gov/2022-08/NMFS-Assessment-Fishing-Interference-RTC-08_29_22.pdf
- NOAA Fisheries. (2023). Final Atlantic shark fishery review. National Oceanic and Atmospheric Administration. <https://www.fisheries.noaa.gov/s3/2023-06/Final-Atlantic-Shark-Fishery-Review-update-6-2023.pdf>
- NOAA Fisheries. (2024). Shark and Red Snapper Bottom Longline Survey from 2010-06-15 to 2010-08-15. NOAA National Centers for Environmental Information, <https://www.fisheries.noaa.gov/inport/item/29395>.
- Pante, E., and B. Simon-Bouhet. 2013. “Marmap: A package for importing, plotting and analyzing bathymetric and topographic data in R.” PLoS ONE 8(9):e73051. <https://doi.org/10.1371/journal.pone.0073051>
- Robin, X., N. Turck, A. Hainard, N. Tiberti, F. Lisacek, J.-C. Sanchez, and M. Müller. 2021. pROC: Display and Analyze ROC Curves. R package version 1.18.0. <https://CRAN.R-project.org/package=pROC>.