Supplementary information:
Characterizing seasonal whale shark habitat in the western North Atlantic

Table of Contents

Text S1. Sightings data sources

(a) Opportunistic data sources

Opportunistic data were defined as cases where a whale shark was spotted by a citizen scientist or someone encountered a whale shark, recorded a location and time, but did not have a dedicated survey method, unlike aerial and shipboard surveys. All reported observations are indicated in Figure 1. Opportunistic data came from the Ocean Biodiversity Information System (OBIS 2023), the Global Biodiversity Information Facility (GBIF 2023a, b), Wildbook for Whale Sharks, and Northern Gulf of Mexico Whale Shark Sightings Survey, hosted by the University of Southern Mississippi (USM). For OBIS and GBIF, opportunistic records and datasets were obtained by querying "*Rhincodon typus"* and restricted by study bounds (100-40˚W, 5-50˚N) (Boisseau, OBIS-SEAMAP, ACCOBAMS, WCDS 2021; Casassovici & Brosens 2022; Del Moral-Flores et al. 2022; Inventaire National du Patrimoine Naturel (2022); DeVries & Lemmens 2023; Froese & Pauly 2023; Hendrickson & Cohen 2023; iNaturalist contributors & iNaturalist 2023; Robert et al. 2023; www.naturgucker.de <https://doi.org/10.15468/uc1apo>). Note that not

all data from GBIF and OBIS were classified as opportunistic, depending on the data source (e.g. individual, during scientific survey). To retrieve Wildbook for Whale Shark occurrences, correspondence occurred with J. Cochran and E. Hoffmayer. Likewise, E. Hoffmayer provided USM sightings within the study bounds.

(i) Southeast Fisheries Science Center (SEFSC) surveys.

From 2017-2020, the National Oceanic and Atmospheric Association (NOAA) SEFSC completed the Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPS) where aerial surveys of U.S. continental shelf waters to the 200-m isobath were conducted. Survey efforts focused on cetaceans, sea turtles, and sea birds, other taxa were recorded if seen. Aerial surveys were completed onboard a DeHavilland DHC-6 Twin Otter aircraft at an altitude of 183-m at approximately 200 kph (Rapucci et al. 2017). Survey track-lines were orthogonal to bathymetric lines and followed a zig-zag pattern between the 200-m isobath and the U.S. coast. Two teams, composed of three individuals, were located at the forward and aft of the aircraft. Each team was on separate intercoms. The forward team had two observers located in bubble windows on the left and right side of the aircraft that maintained visibility of the survey track line. The third member was a dedicated data recorder. The aft team also had two observers, one stationed at a belly port window, the other on the right side of the craft at a bubble window, and a data recorder. Observers would record observations from the track line (0˚) to ~ 60˚ above the vertical. Upon observing an organism, the observer would hold until the aircraft was perpendicular to the organism and then measure the angle between the two with a digital inclinometer. The belly observer only reported the interval for the sighting.

The Southeast Area Monitoring and Assessment Program (SEAMAP) and the Gulfcet programs completed surveys in coordination with one another, the former completing ichthyoplankton surveys and the latter completing cetacean abundance surveys (Southeast Fisheries Science Center 2000). These surveys also focused on cetaceans and sea turtles but recorded other fauna of interest, including whale sharks (Burks et al. 2006). From 1992 to 1994, the SEFSC and Texas A&M University jointly conducted the Gulfcet I program in the northern Gulf of Mexico, where shipboard and aerial line transects were completed (Davis & Fargion 1996; Burks et al. 2006). The study area ranged from the Florida-Alabama border to the Texas-Mexico border between the 100 m and 2,000 m isobaths (Davis & Fargion 1996; Burks et al. 2006). Shipboard line transect surveys were completed seasonally and ranged from 10 to 55 days in duration. Aerial surveys were flown at 229 m and 200 km/h aboard a DeHavilland Twin Otter turbine engine aircraft. Plexiglass observation bubbles were installed on the port and starboard sides of the fuselage (Burks et al. 2006). Seasons were as follows: summer, July-September; fall, October-December; winter, January-March; spring, April-June. SEFSC shipboard survey tracks followed one of two designs to completely survey the study area aboard the NOAA Ship *Oregon II.* Tracks were oriented north-south, equidistant from one another, and were designed so that sampling could be completed with transects perpendicular to the depth gradient. SEFSC ships would sample the study area three times each study period at 18 km/hr. Spring surveys transited tracks one to two times with a random start during daylight hours or for 24 hours if sampling the predetermined track of ichthyoplankton stations. Winter surveys completed the tracks three times; sampling of the ichthyoplankton track could be latitudinal, longitudinal, or both. Observations were completed by two teams of three observers during daylight hours. Two observers used high-power binoculars from the flying bridge, and the third individual used their naked eye or handheld binoculars. Observers would rotate through position every 30-40 minutes; teams would alternate every two hours. Sightings data were recorded with GPS or through LORAN-C navigation receiver.

Aerial surveys were perpendicular to shore, limited to waters associated with the continental slope and Beaufort sea states <4, and restricted to the U.S. exclusive economic zones (Burks et al. 2006). When fauna of interest were identified, the pilot would circle the area until the associated latitude, longitude, and number of individuals were recorded.

Gulfcet II occurred from 1996 to 1998 and was an expansion of the previously mentioned Gulfect I program (Davis et al. 1996; Davis et al. 2000; Burks et al. 2006). Gulfcet II ship-based surveys occurred during winter and summer between 1996 and 1998 (Davis et al. 2000; Burks et al. 2006). Seasons were defined as follows: summer, June-October; fall, November-December; winter, January-mid-March; spring, mid-March-May. Study areas were as follows: EPA Continental Shelf (12,326 km^2); waters of northeastern Gulf south of the western portion of the Florida panhandle, 18.5 km offshore to 100 m deep, 88˚10.0'W to 85˚55.0'W; EPA Continental Slope (70,470 km^2), waters 100-2,000 m deep east of 88˚10.0'W, north of 26˚00.0'N; Gulfcet I study Area (154,621 km^2), waters 100-2,000 m deep west of 87˚30.0'W; oceanic northern Gulf of Mexico waters within the U.S. Exclusive Economic Zone with depth greater than 100 m. Observer observation protocols were identical to those in the Gulfcet I program (Davis et al. 1996). Shipboard surveys were completed in three legs. Legs 1 and 2 (19-21 days duration each) were completed concurrently with ichthyoplankton sampling, following a predetermined track at stations, transited 24 hours a day; line transect sampling was completed between stations during daylight hours, was latitudinal, longitudinal, or both (Davis et al. 2000). Leg 3 (13-14 days) was a dedicated cetacean survey of the EPA shelf and slope in early summer. The track-line consisted of nine equidistant transect lines perpendicular to the depth gradient; surveys occurred during daylight hours. Gulfcet data were downloaded from GBIF (Garrison 2013a-f).

SEAMAP and the former Minerals Management Service also conducted cooperative research surveys to assess cetacean abundances in oceanic and continental shelf waters (Southeast Fisheries Science Center 2000). The NOAA Ship *Gordon Gunter* completed the fourth of these cooperative research surveys. Cetacean visual surveys and ichthyoplankton surveys were completed concurrently along a predetermined track at 10 knots, spanning the northern Gulf of Mexico U.S. EEZ. The survey area ranged from the Texas-Mexico border to the Dry Tortugas. Cetacean visual observation protocols were akin to those of the Gulfcet programs.

(ii) North Atlantic Right Whale Consortium (NARWC) surveys

The NARWC is a data-sharing group composed of more than 200 individuals from various research and conservation organizations aimed at helping to conserve right whale populations. That said, sightings of other taxa are also recorded, including whale sharks that stem from surveys and opportunistic records (North Atlantic Right Whale Commission 2023). The Florida Fish and Wildlife Conservation Commission (FWC) was among the organizations that compose the NARWC with whale shark sightings (Surrey-Marsden et al. 2016). From December 1 to March 13 of 2016 and 2017, the FWC conducted aerial surveys aboard a Cessna 337 Skymaster where a team of two observers, one of which additionally served as a data recorder, completed transects between Savannah, Georgia, to the north of Cape Canaveral, Florida (Gowan & Zoodsma, 2019). Surveys were completed at 305 m at 185 km/hr (1,000 ft, 100 knots). Transects were oriented east to west and were perpendicular to shore.

(iii) New York State Energy Research and Development Authority (NYSERDA) surveys

From the summer of 2016 to the spring of 2019, the New York State Energy Research and Development Authority (NYSERDA) contracted APEM and Normandeau to conduct aerial digital surveys of New York's offshore planning area (OPA; Robinson et al. 2021). The OPA is 43,745.20 km^2, consisting of New York bight waters from Long Island southeast to the continental shelf break. Surveys were conducted quarterly, where linear transects, oriented north to south, covered at least 7% of the OPA. All observed fauna of interest, including sharks, marine mammals, and sea turtles were recorded. The initial summer 2016 survey consisted of 52 parallel transects, ~4.8-km apart at 1,009 ft, and used a Shearwater II camera system (Normandeau-APEM, 2016). Ensuing surveys consisted of 28 transects, ~8.3-km apart at 1,360ft, using a Shearwater III camera system. Neighboring transects were flown antiparallel at ~120 knots. To retrieve NYSERDA survey data, correspondence occurred with J. Willmott, or data were downloaded from the GBIF (APEM, Normandeau Associates 2018, 2019, 2021).

(iv) Beacon Wind Digital Aerial Wildlife surveys

Between 2020 and 2021, Equinor Wind U.S. contracted APEM and Normandeau Associates to conduct digital aerial wildlife surveys in the Massachusetts Lease Area OCS-A 0520, which is located South of the islands of Nantucket and Martha's Vineyard (Normandeau-APEM 2022). All observed fauna of interest, including sharks, marine mammals, and sea turtles were recorded. These surveys also used the Shearwater III camera system deployed in the NYSERDA aerial surveys (Normandeau-APEM 2020). Flying at 1,350 ft and approximately 120 knots, images were taken across 15 transects, 1.9 km across the track, and 0.5 km along the track. Images covered about 10% of the study area. Beacon Wind Digital Aerial Wildlife surveys were obtained from GBIF (Fair 2022).

(v) New York State Department of Conservation (NYSDEC) surveys

From March 2017 to February 2020, the New York State Department of Conservation (NYSDEC) executed 36 monthly aerial surveys within the NY OPA (Tetra Tech & LGL, 2020). These surveys focused on whale and sea turtle species. While whale sharks were not explicitly instructed to be recorded, surveyors took photographs of rare and unusual species. Surveys were conducted onboard a Partenavia P68-C aircraft, using aerial line-transect surveys, and were a minimum of 14 days apart. In practice, surveys were usually 3 to 4 weeks apart. Video along transects was captured by a Sony Digital 4K camera. Still photos of unusual sightings were supplemented by a Canon EOS 7D camera with a Canon EF 100-400 mm f/4.5-5.6L IS USM lens in CR2 and JPEG formats. Transects were designed as follows: 15 parallel transects, northwest to southeast, spaced 16.7 km apart, flown at 305 m (1,000 ft) at 100 to 110 knots, yielding a total transect length of ~2,514 km. Bubble windows were located on both sides of the aircraft, as well as a singular belly port. NYSDEC survey data was downloaded from GBIF (Rickard 2022).

(vi) Department of Navy (DON) surveys

All surveys conducted as part of the search for a potential site for the U.S. Navy's Undersea Warfare Training Range (USWTR), or the Atlantic Fleet and Testing (AFTT), were conducted aboard a Cessna 337 Skymaster, at approximately 305 m and 185 km/hr (1000 ft, 100 knots; Cotter et al. 2019; Foley et al. 2019; McAlarney et al. 2014). Surveys of the Jacksonville Undersea Warfare Training Range (JAX USWTR) consisted of ten 86-km track-lines, 7.4 km apart, covering

a total area of 5,727 km^2 from 2009 to 2014 (Foley et al. 2019). Surveys were conducted from 2009 to 2017 (Foley et al. 2019) and focused on marine mammals and sea turtles but recorded other pelagic fish, including whale sharks (DoN 2011). One observer was located on each side of the aircraft, recording declination angle and group size. In 2015, surveys in the Cape Hatteras and Norfolk Canyons region comprised 28 track-lines, approximately 73.17 to 75.42 km long (McAlarney et al. 2016). In addition to cetaceans and sea turtles, other large pelagic marine vertebrates were recorded. These track-lines were perpendicular to the coastline and evenly spaced, covering a study area of approximately 15,750 km^2. These regions also contained the Virginia Beach (VACAPES) U.S. Navy's operating area offshore of Virginia Beach and Norfolk Canyon, about 9,200 km^2 (Cotter et al. 2019). Separate surveys completed from 2018–2019 also recorded other large pelagic marine vertebrates besides cetaceans and sea turtles. Surveys comprised 15 track-lines, 74 km long, and were oriented east to west. One observer was located on each side in the rear of the aircraft, using an inclinometer to record a vertical angle when an organism was observed. Occurrence data from the JAX USWTR, Cape Hatteras and Norfolk Canyon, VACAPES, and AFTT Hatteras training and/or operating area were obtained from GBIF (McClellan 2011a, b, 2012, 2016; Cotter 2020; McClellan 2021).

Aerial monitoring also occurred in territorial and non-territorial waters (0-22 km offshore; >22 km offshore) off Panama City Beach from June 22-28, 2013, by the Naval Surface Warfare Center, Panama City Division (NSWC PCD) during sonar test events, including the SSAM2 and BOSS tests (Naval Surface Warfare Center 2013, Appendix D). BOSS sonar test event data was downloaded from GBIF (Latusek-Nabholz & OBIS-SEAMAP 2021). These surveys focused on marine mammals, sea turtles, and other species listed on the Endangered Species Act. While whale sharks were not explicitly the focus of the survey, one observation was recorded. Using a Cessna T337H Turbo Skymaster aircraft, two flights were conducted before the test event, four during, and one after. The survey area consisted of 12 parallel track-lines, southwest to northeast, spaced 3.7 km apart, and 27.8 km long. Survey coverage was 1,132 km^2. Flights were conducted at 305 m (1,000 ft) and 185 km/hr (100 knots; Naval Surface Warfare Center 2013, Appendix D). Two observers were onboard the craft on any given flight. Observer protocols were identical to those used in Smultea and Bacon (2012).

(vii) Green Heritage Fund of Suriname (GHFS) surveys

Between December 2008 and September 2013, several geophysical survey vessels hosted dedicated and incidental marine fauna observations (De Boer et al. 2015). *Rhincodon typus* was identified on one dedicated survey aboard the *RV Polarcus Naila* and two incidental surveys aboard the *RV Geo Celtic.* Survey protocols for incidental surveys were not recorded. Dedicated marine fauna observations survey designs were as follows. Research vessels conducted surveys at 7.4 km h^{-1} over 114 parallel transects designed for geophysical activities (De Boer 2015). Observations were conducted from bridge wings and foredeck, 14 m above sea level. One observer looked ahead of and to the vessel's sides either by eye or via binoculars for 1.5-2 hrs. duration between 0900 and 2200 h UTC. GHFS survey data was downloaded from GBIF (Pool & DeBoer 2020a, b, c).

(viii) PELAGIS, REcensement des Mammifères marins et autre Mégafaune pélagique par Observation Aérienne (REMMOA) surveys

From February to October 2008, PELAGIS REMMOA operated aerial surveys offshore of Martinique, Guadeloupe, and Guiana (Ridoux et al. 2010). Surveys were limited to the French

EEZ. A Partenavia P68 with bubble windows, flying at 180 m and 167 km/hr, surveyed a zigzag track layout. Surveys followed the SCANS methodology (Hiby & Lovell 1998). Onboard, a flight leader oversaw data collection, and two observers used naked eyes to spot target organisms, consisting of marine mammals, seabirds, large teleosts, and elasmobranchs (Ridoux et al. 2010). Observers would rotate every maximum of four hours. An inclinometer was for sightings within 500m of the survey track. PELAGIS REMMOA data was downloaded from GBIF (Van Canneyt 2022).

(b) Data without spatial information

Some sightings retrieved from Wildbook for Whale Sharks did not have a coordinate location assigned. Sightings were divided into three groups: those that were described some distance offshore from a city or county on land (with a cardinal direction, if applicable [e.g., 22 mi S.W. of Tampa, FL]), sightings that occurred within a bounded marine area (e.g., Sapodilla Cayes or Ewing Bank), or those that could be assigned a point coordinate from the notes and/or video.

For sightings classified within the first group, a circular boundary was created with a radius, converted to meters, from the original Wildbook for Whale Sharks sighting. The center of the circle was the point on land included in the sightings information. The circular boundary was masked by bathymetry and Atlantic Ocean shapefiles to exclude the assignment of a point on land. If the cardinal direction was provided, the circular boundary was further restricted to only include the corresponding degrees at 60˚ intervals for NSEW (e.g., N = -30˚-30˚; E = 60˚-120˚) and 30˚ intervals for intermediate directions (e.g., NE = 30˚-60˚; SE = 120˚-150˚). One thousand random points were then generated along the boundary, of which one was ultimately selected.

For sightings that could be assigned to a bounded region, the corresponding shapefile was downloaded from the World Database on Protected Areas (WDPA; UNEP-WCMC & IUCN 2024). Occurrences were assigned to corresponding shapefiles and then assigned a location at random. In total, 282 additional occurrences were gathered via these processes.

Table S1. Cleaned presence data background information with n < 10

Group	Source	Data collection	Years	N	Longitude (˚W)	Latitude (˚N)	Area	Description
NYSDEC	GBIF-NYSDEC aerial surveys	Survey	2018-2019	8	71.1-73.0	39.1-40.3	Northeastern United States	New York State Department of Conservation surveys
NOAA, NMFS, SEFSC	SEFSC-GOMMAPPS	Survey	2017-2018	8	82.4-90.9	26.2-28.4	Northern Gulf of Mexico	Southeast Fisheries Science Center Gulf of Mexico Marine Assessment Program for Protected Species
DOD; DON	GBIF-USWTR JAX survey; AFT Hatteras Aerial Survey; SSAM2BOSS Sonar Test Event; UNCW Norfolk Canyon Aerial Survey; VACAPES NFC Aerial Surveys	Survey	2011-2018	7	74.3-85.8	30.0-37.0	Eastern United States	Surveys conducted for the DOD as part of the search for a potential site for the U.S. Navy's Undersea Warfare Training Range. Otherwise, surveys conducted for the DON by the Naval Surface Warfare Center. Specifically, U.S. Navy's Undersea Warfare Training Range (USWTR) Atlantic Fleet and Testing (AFTT) aerial surveys at the Jacksonville Undersea Warfare Training Range (JAX USWTR), Virginia Beach (VACAPES), and

								Cape Hatteras, aerial surveys by the Naval Surface Warfare Center, Panama City Division (NSWC PCD),
GHFS	GBIF	Survey	2008-2017	6	53.6-56.4	6.3-8.3	Northeast South America	Green Heritage Fund of Suriname shipboard surveys
Pelagis	GBIF-PELAGIS REcensement des Mammifères marins et autre Mégafaune pélagique par Observation Aérienne (REMMOA)	Survey	2017	3	51.5-53.8	5.9-6.6	Northeast South America	PELAGIS, Census of Marine Mammals and Other Pelagic Megafauna by Aerial Observation
FWC	GBIF-SEUS Right Whale EWS surveys	Survey	2017	2	80.9-81.1	29.6-30.1	Southeastern United States	Florida Fish and Wildlife Commission right whale early warning system surveys
NYSERDA, APEM, Normandeau	GBIF	Survey	2019	2	77.4-78.2	33.5-33.7	Eastern United States	APEM- Ecological Baseline Studies of the U.S. Outer Continental Shelf

	Personal communication	Opportunistic	2023	2	69.3–69.6	39.5–40.0	Eastern United States	C. Braun, personal communication, 2023
BOEM	GBIF-Beacon Wind Digital Aerial Wildlife surveys for the U.S. Bureau of Ocean Energy Management	Survey	2021	1	70.3	40.9	Northeastern United States	Beacon Wind Digital Aerial Wildlife Surveys for BOEM Lease Area OCS-A 0520
UNB	Turnbull, S. D., and Randell, J. E. (2006).	Opportunistic	1997	1	67.4	44.2	Bay of Fundy	The northernmost record of a whale shark

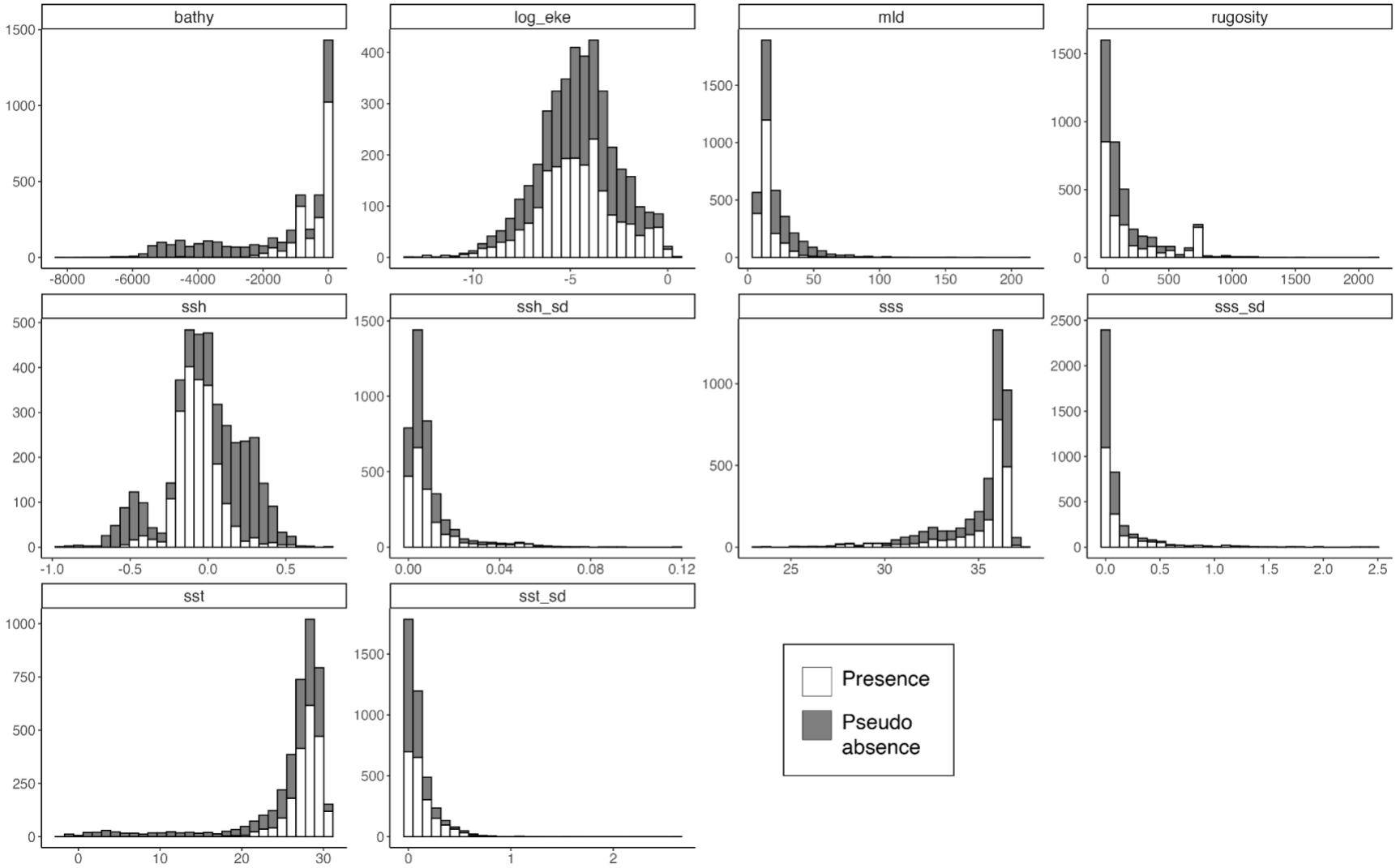

Figure S1. Distributions of presences (white) and pseudoabsences (gray) across all environmental variables

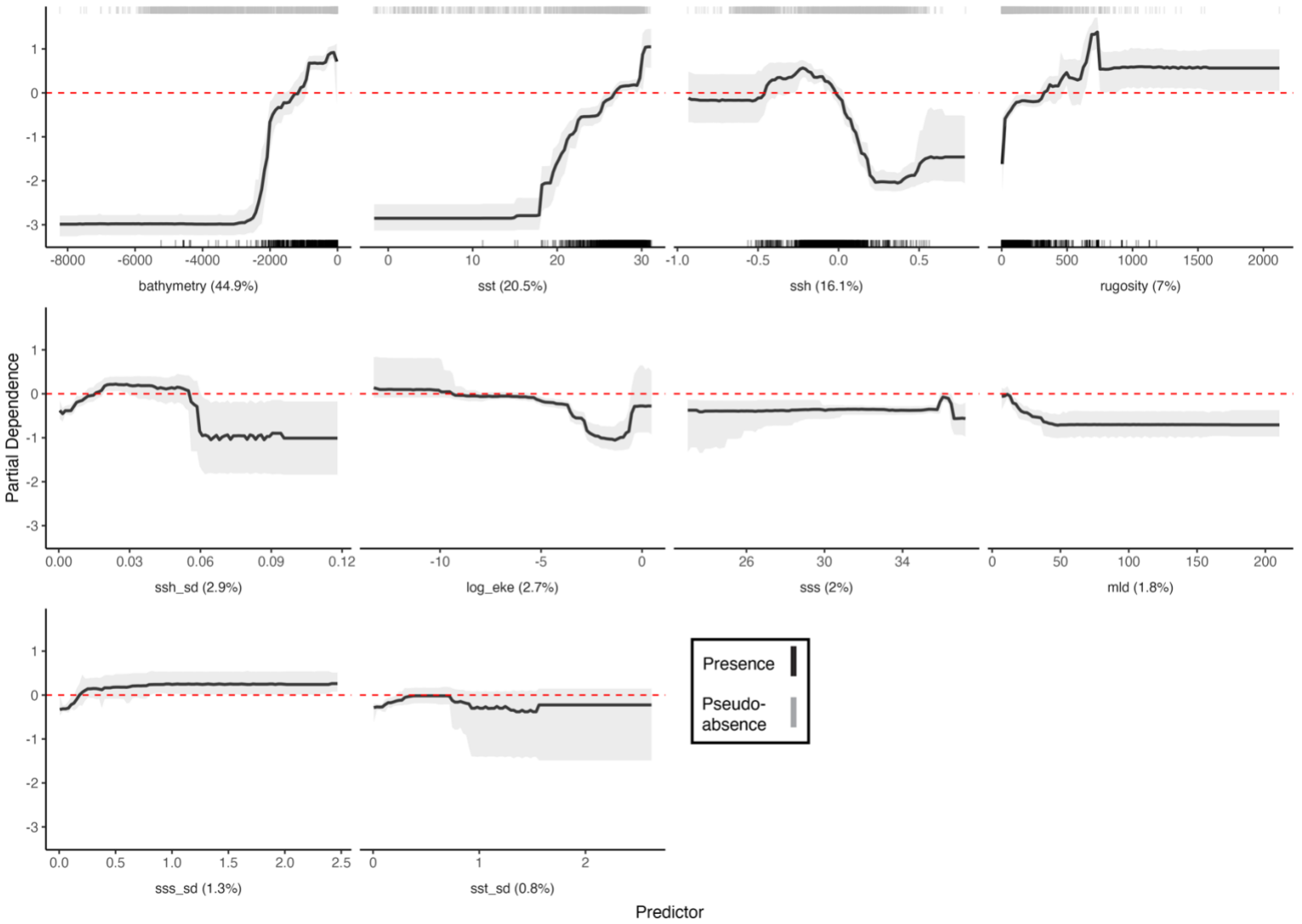

Figure S2. Response curves of all environmental drivers used to develop the boosted regression tree model. Ribbons represent 95% confidence intervals. Rug marks on the plot represent presence (black, bottom) and pseudoabsence (grey, top) points

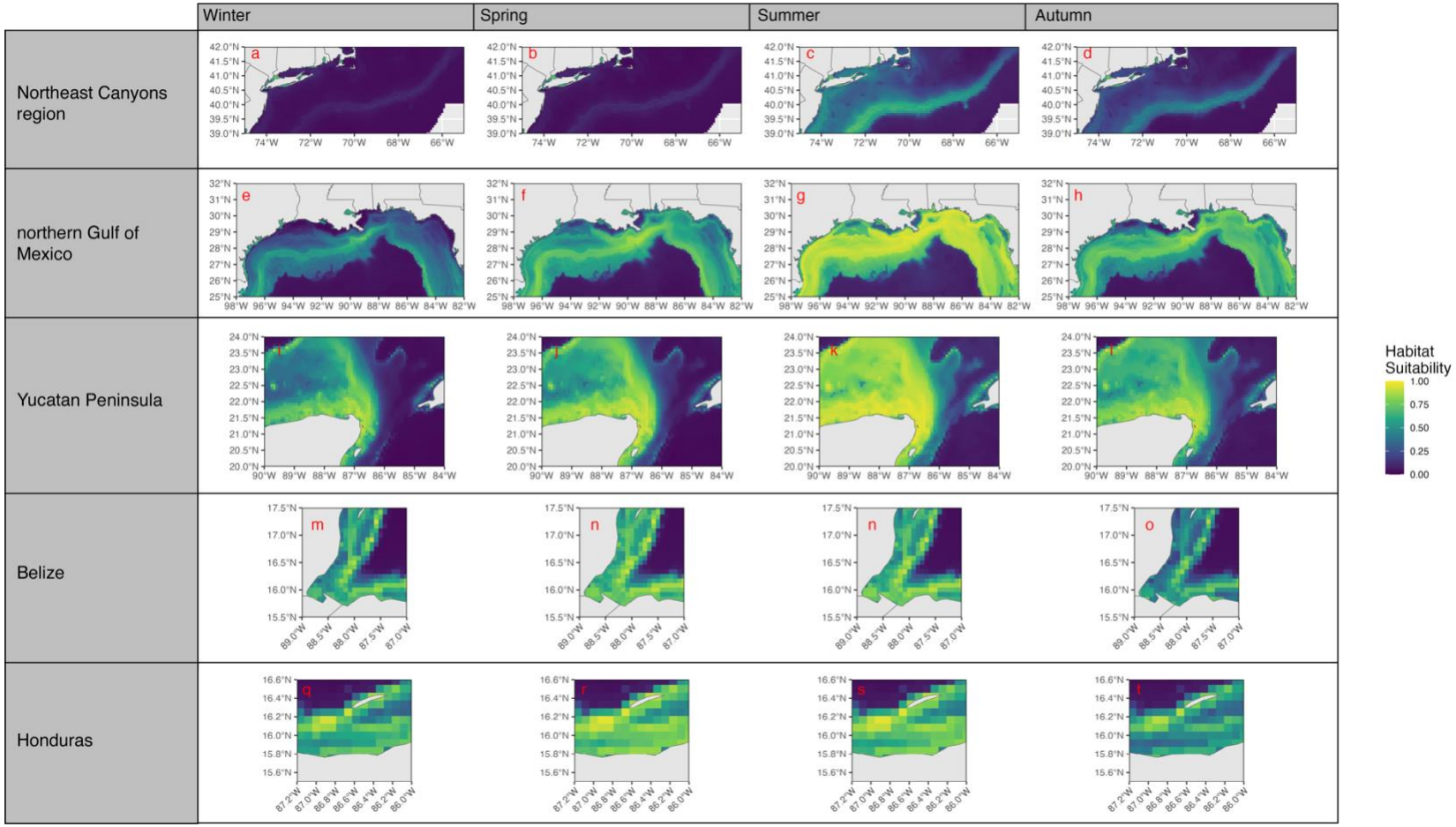

Figure S3. Mean of bootstrapped model-predicted seasonal (averaged monthly; e.g., Winter = December, January, February) habitat suitability from 1993–2023 for the northeast United States (a-d), northern Gulf of Mexico (e-h), Yucatan Peninsula (i-l), Belize (m-p), and Honduras (q-t)

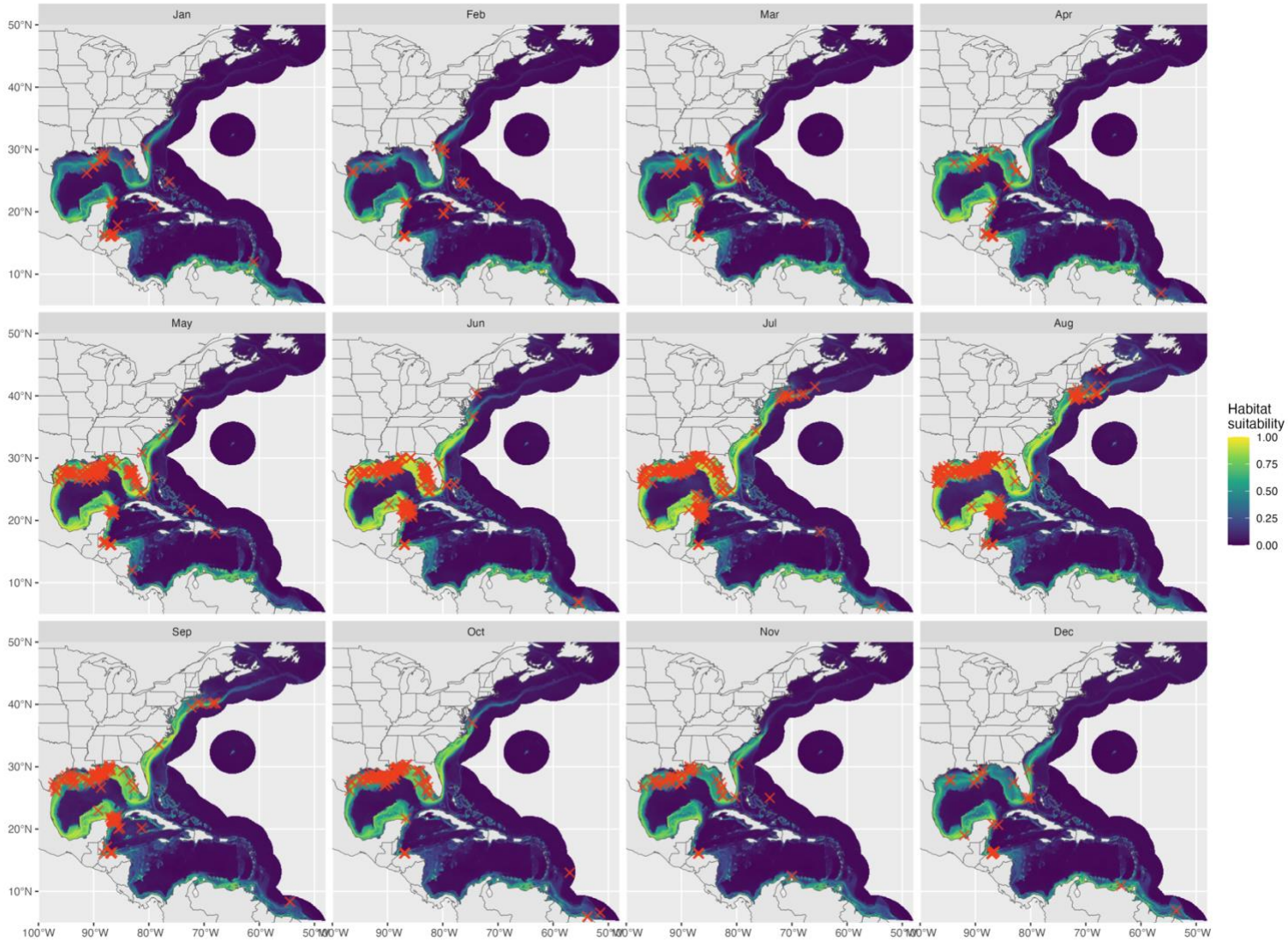

Figure S4. Monthly averaged predicted habitat suitability (1993-2023). Presence data used to train the model are overlaid in red (n = 2,010)

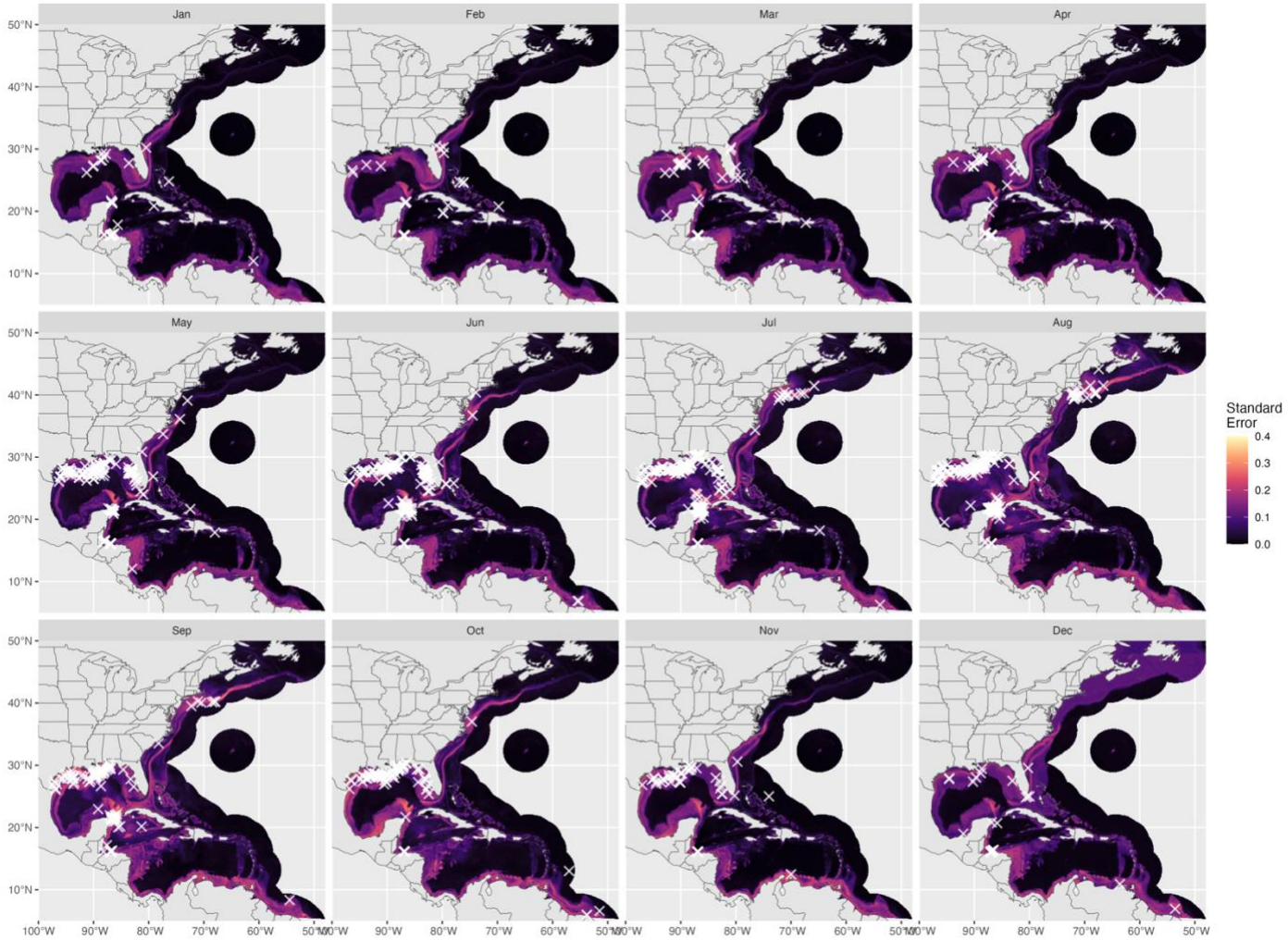

Figure S5. Standard error of bootstrapped predicted habitat suitability by month, calculated as the standard deviation of all predictions for a given month from 1993–2023. Presence data used to train the model are in white (n = 2,010)

Literature Cited

APEM, Normandeau Associates (2018) *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy - OPA 2016.* Prepared for New York State Energy Research and Development Authority. 2018. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1817) on 2023-06-16. https://doi.org/10.15468/28s2hs accessed via GBIF.org on 2023-06-16.

APEM, Normandeau Associates (2019) *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy - OPA 2017.* Prepared for New York State Energy Research and Development Authority. *Data* downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1817) on 2023-06-16. https://doi.org/10.15468/6fzwda accessed via GBIF.org on 2023-06-16.

APEM, Normandeau Associates (2021) *Ecological Baseline Studies of the U.S. Outer Continental Shelf: Option Year 2*. Prepared for the Bureau of Ocean Energy Management (BOEM). https://doi.org/10.15468/x3kybe accessed via GBIF.org on 2023-06-16.

Boisseau O, OBIS-SEAMAP, ACCOBAMS, WDCS (2021) *Visual sightings from Song of the Whale 1993-2013*. OBIS-SEAMAP. Occurrence dataset https://doi.org/10.15468/5c69jn accessed via GBIF.org on 2023-06-16.

Burks C, Driggers W, Mullin K (2006) Abundance and distribution of whale sharks (*Rhincodon typus*) in the northern Gulf of Mexico. *Fishery Bulletin*, 104.

Casassovici A, Brosens D (2022) *Diveboard - Scuba diving citizen science observations*. Version 54.51. Diveboard. Occurrence dataset https://doi.org/10.15468/tnjrgy accessed via GBIF.org on 2023-06-16.

Cotter MP (2019) *Aerial Surveys for Protected Marine Species in the Norfolk Canyon Region: 2018–2019 - Final Report*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D8006 Task Order 18F4019, issued to HDR, Inc., Virginia Beach, Virginia. November 2019.

Cotter MP (2020) *VACAPES NFC Aerial Surveys 2018-2019*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/2059) on 2023-06-16. https://doi.org/10.15468/x3jkjq accessed via GBIF.org on 2023-06-16.

Davis RW, Fargion GS (eds) (1996) *Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Final Report. Volume II: Technical Report*. OCS Study MMS 96-0027. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 357 pp.

Davis RW, Evans WE, Würsig B (eds) (2000) *Cetaceans, Sea Turtles, and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance, and Habitat Associations. Volume II: Technical Report*. Prepared by Texas A&M University at Galveston and the National Marine Fisheries Service. U.S. Department of the Interior, Geological Survey, Biological Resources Division, USGS/BRD/CR-1999-0006 and Mineral Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-003. 346 pp.

De Boer MN (2015) Cetaceans observed in Suriname and adjacent waters. *Latin American Journal of Aquatic Mammals*, 10(1), pp. 2–19. https://doi.org/10.5597/lajam00189.

De Boer MN, Saulino JT, Lewis TP, Notarbartolo-Di-Sciara G (2015) New records of whale shark (*Rhincodon typus*), giant manta ray (*Manta birostris*) and Chilean devil ray (*Mobula tarapacana*) for Suriname. *Marine Biodiversity Records*, 8:e10. https://doi.org/10.1017/S1755267214001432.

De Vries H, Lemmens M (2023) *Observation.org, Nature data from around the World*. Observation.org. Occurrence dataset https://doi.org/10.15468/5nilie accessed via GBIF.org on 2023-06-16.

Del Moral-Flores LF, Morrone JJ, Alcocer Durand J, Espinosa-Pérez H, Pérez-Ponce De León G (2022) *Lista patrón de los tiburones, rayas y quimeras (Chondrichthyes, Elasmobranchii, Holocephali) de México*. Version 1.11. Museu de Ciències Naturals de Barcelona. Occurrence dataset https://doi.org/10.15470/hrl1kv accessed via GBIF.org on 2023-06-16.

DoN (2011) Marine Species Monitoring for the U.S. Navy's Atlantic Fleet Active Sonar Training (AFAST) - Annual Report 2011. Department of the Navy, United States Fleet Forces Command, Norfolk, VA.

Fair D (2022) *Beacon Wind Digital Aerial Wildlife Surveys for BOEM Lease Area OCS-A 0520, Equinor Wind US LLC, March 2021 – October 2021*. Data downloaded from OBIS-SEAMAP (https://seamap.env.duke.edu/dataset/2187) on 2023-06-16. https://doi.org/10.15468/k3dahc accessed via GBIF.org on 2023-06-16.

Foley HJ, Paxton CGM, Cummings EW, McAlarney RJ, McLellan WA, Pabst DA, Read AJ (2019) *Occurrence, Distribution, and Density of Protected Species in the Jacksonville, Florida, Atlantic Fleet Training and Testing (AFTT) Study Area*. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-15-D-8006, Task Orders 29 and 48, issued to HDR, Inc., Virginia Beach, Virginia. May 2019.

Froese R, Pauly D (2023) *FishBase Database*. https://doi.org/10.15468/wk3zk7 accessed via GBIF.org on 2023-06-16.

Garrison L (2013a) *SEFSC GoMex Oceanic 1996*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/25) on 2023-06-16. https://doi.org/10.15468/zkaets accessed via GBIF.org on 2023-06-16.

Garrison L (2013b) *SEFSC GoMex Oceanic 2001*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/23) on 2023-06-16. https://doi.org/10.15468/jn7qu4 accessed via GBIF.org on 2023-06-16.

Garrison L (2013c) *SEFSC GoMex Oceanic 2000.* Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/21) on 2023-06-16. https://doi.org/10.15468/zkke4t accessed via GBIF.org on 2023-06-16.

Garrison L (2013d) *SEFSC GoMex Oceanic 1994*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/19) on 2023-06-16. https://doi.org/10.15468/4b85qk accessed via GBIF.org on 2023-06-16.

Garrison L (2013e) *SEFSC GoMex Oceanic 1992 (199).* Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/13) on 2023-06-16. https://doi.org/10.15468/srkhyc accessed via GBIF.org on 2023-06-16.

Garrison L (2013f) *SEFSC GoMex Oceanic 1993 (S)*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/17) on 2023-06-16. https://doi.org/10.15468/d94krv accessed via GBIF.org on 2023-06-16.

GBIF (The Global Biodiversity Information Facility) (2023a) *What is GBIF?* Available at: https://www.gbif.org/what-is-gbif [accessed 13 January 2020]

GBIF (2023b) GBIF Occurrence Download. (accessed on 16 June 2023)

Gowan, T. and Zoodsma, B. (2019) *SEUS Right Whale EWS Aerial Surveys 2016-17*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1990) on 2023-07-27. https://doi.org/10.15468/5m34nt accessed via GBIF.org on 2023-07-27.

Hendrickson DA, Cohen AE (2023) *Fishes of Texas Project (FoTX) Database - Darwin Core.* Version 1.10. University of Texas at Austin, Biodiversity Collections. Occurrence dataset https://doi.org/10.17603/c3wc70 accessed via GBIF.org on 2023-06-16.

Hiby L, Lovell P (1998) Using Aircraft in Tandem Formation to Estimate Abundance of Harbour Porpoise. *Biometrics* 54(4), pp. 1280–1289. https://doi.org/10.2307/2533658.

iNaturalist contributors, iNaturalist (2023) *iNaturalist Research-grade Observations.* iNaturalist.org. Occurrence dataset https://doi.org/10.15468/ab3s5x accessed via GBIF.org on 2023-06-16.

Inventaire National du Patrimoine Naturel (2022) *Programme CROMIS: carnet de plongée en ligne de la FFESSM - Observations d'espèces subaquatiques collectées par les utilisateurs de CROMIS.* UMS PatriNat (OFB-CNRS-MNHN), Paris. Occurrence dataset https://doi.org/10.15468/63ju7z accessed via GBIF.org on 2023-06-16.

Latusek-Nabholz J, OBIS-SEAMAP (2021) *Sightings for SSAM2-BOSS Sonar Test Event - June 2013*. OBIS-SEAMAP. Occurrence dataset https://doi.org/10.15468/fgtq4m (accessed via GBIF.org on 2023-06-16)

McAlarney R, Cummings E, McLellan B, Pabst A (2014) *Protected species monitoring in the Virginia Capes OPAREA, Cape Hatteras, North Carolina, January 2013–December 2013*. Department of Biology and Marine Biology, University of North Carolina Wilmington.

McAlarney R, Cummings E, McLellan W, Pabst DA (2016) Aerial Surveys for *Protected Species in the Cape Hatteras and Norfolk Canyon Regions: 2015 Annual Progress Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract Nos. N62470-10-3011, Task Orders 49 and 58 and N62470-15-8006, Task Order 05, issued to HDR, Inc., Virginia Beach, Virginia. March 2016.

McLellan W (2011a) *USWTR JAX Aerial Survey -Right side- 2010-2011*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/747) on 2023-06-16. https://doi.org/10.15468/x68x2d accessed via GBIF.org on 2023-06-16.

McLellan W (2011b) *USWTR JAX Aerial Survey -Left side- 2010-2011.* Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/745) on 2023-06-16. https://doi.org/10.15468/nckjes accessed via GBIF.org on 2023-06-16.

McLellan W (2012) *USWTR JAX Aerial Survey -Left side- 2011-2012.* Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/857) on 2023-06-16. https://doi.org/10.15468/6brhpx accessed via GBIF.org on 2023-06-16.

McLellan W (2016) *UNCW Norfolk Canyon Aerial Survey - Right side - 2015.* Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1356) on 2023-06-16. https://doi.org/10.15468/qtqtma accessed via GBIF.org on 2023-06-16.

McLellan W, OBIS-SEAMAP (2021) *AFTT Hatteras Aerial Survey -Right side- 2012-2013.* OBIS-SEAMAP. Occurrence dataset https://doi.org/10.15468/kpvzg3 accessed via GBIF.org on 2023-06-16.

Normandeau Associates, APEM (2016) *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy. Survey Plan Summer 2016, Digital Survey # 1*. July 2016, 23 pp.

Normandeau Associates, APEM (2019) *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy.* Data prepared for New York State Energy Research and Development Authority (NYSERDA). https://doi.org/10.15468/mvszkt accessed via GBIF.org on 2023-06-16.

Normandeau Associates, APEM (2020) *Digital Aerial Wildlife Surveys of BOEM Lease Area OCS-A 520: December 2019 to November 2020*. Scientific Annual Report P00004197-01. Equinor Wind US, 8 April 2021, Final Issue, 322 pp.

Normandeau Associates, APEM (2022) *Digital Aerial Wildlife Surveys of BOEM Lease Area OCS-A 520: July 2021 to October 2021*. Scientific Quarterly Report P00004197-02. Equinor Wind US, 7 March 2022, v1.0 Draft, 41 pp.

North Atlantic Right Whale Consortium (2023) *North Atlantic Right Whale Consortium Sightings Database*. Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA, U.S.A.

NSWC PCD (2013) *Annual Marine Species Monitoring Report (United States Navy Integrated Comprehensive Monitoring Program 2010 Update)*.

OBIS (2023) *Ocean Biodiversity Information System*. Intergovernmental Oceanographic Commission of UNESCO. Available at: www.obis.org

Pool M, de Boer M (2020a) *Opportunistic records of marine megafauna in Suriname*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/2126) on 2023-06-16. https://doi.org/10.15468/r88rfu accessed via GBIF.org on 2023-06-16.

Pool M, de Boer M (2020b) *Marine Fauna Observer data collected on board seismic survey vessels operating around Suriname as part of an EU-funded Marine Spatial Planning project*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/2125) on 2023-06-16. https://doi.org/10.15468/a8z2hb accessed via GBIF.org on 2023-06-16.

Pool M, de Boer M (2020c) *Dedicated boat-based surveys for marine megafauna in Suriname*. Data downloaded from OBIS-SEAMAP. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/2124) on 2023-06-16. https://doi.org/10.15468/868qmz accessed via GBIF.org on 2023-06-16.

Rapucci G, Aichinger Dias L, Barry K, Garrison LP, Litz J (2017) *GoMMAPPS Summer aerial abundance survey during June – August 2017: Summary Report*.

Rickard M (2022) *NYSDEC aerial surveys*. Data downloaded from OBIS-SEAMAP (https://seamap.env.duke.edu/dataset/2209) on 2023-06-16. https://doi.org/10.15468/n4wpnp accessed via GBIF.org on 2023-06-16.

Ridoux V, Certain G, Doremus G, Laran S, van Canneyt O, Watremez P (2010) *Mapping Diversity and Relative Density of Cetaceans and Other Pelagic Megafauna across the Tropics: General Design and Progress of the REMMOA Aerial Surveys Conducted in the French EEZ and Adjacent Waters*. Paper SC/62/E14 presented to the Scientific Committee of the International Whaling Commission, Agadir, Morocco.

Robert S, Lepareur F, Inventaire National du Patrimoine Naturel (2022) *Données d'occurrences Espèces issues de l'inventaire des ZNIEFF*. Version 1.7. UMS PatriNat (OFB-CNRS-MNHN), Paris. Occurrence dataset https://doi.org/10.15468/ikshke accessed via GBIF.org on 2023-06-16.

Robinson Willmott J, Clerc J, Vukovich M, Pembroke A (2021) *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Overview and Summary*. Report to New York State Energy Research and Development, Contract no. 95764.

Smultea MA, Bacon CE (2012) *A comprehensive report of aerial marine mammal monitoring in the Southern California Range Complex: 2008-2012*. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Southwest (NAVFAC SW), EV5 Environmental, San Diego, under Contract No. N62470-10-D-3011 issued to HDR, Inc., San Diego, California.

Southeast Fisheries Science Center (2000) *Cruise Results: Spring Southeast Area Monitoring and Assessment Program (SEAMAP) Ichthyoplankton Survey and Cetacean Survey: NOAA Ship Gordon Gunter Cruise GU-00-02 (007)*. Pascagoula Facility, Mississippi Laboratories, Southeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, US Department of Commerce

Surrey-Marsden C, Accardo C, White M, George C and others (2018) *North Atlantic Right Whale Calving Area Surveys: 2016/2017 Results*. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-SER-8, 16 p.

Tetra Tech, LGL (2020) *Final Comprehensive Report for New York Bight Whale Monitoring Aerial Surveys, March 2017 – February 2020*. Technical report prepared by Tetra Tech, Inc. and LGL Ecological Research Associates, Inc. Prepared for New York State Department of Environmental Conservation, Division of Marine Resources, East Setauket, NY. May 18, 2020.

Turnbull SD, Randell JE (2006) *Rare occurrence of a Rhincodon typus (whale shark) in the Bay of Fundy, Canada*. Northeastern Naturalist, 13(1):57–58. https://doi.org/10.1656/1092-6194(2006)13[57:ROOART]2.0.CO;2.

UNEP-WCMC, IUCN (2024) *Protected Planet: The World Database on Protected Areas (WDPA)* [Online], August 2024, Cambridge, UK: UNEP-WCMC and IUCN. www.protectedplanet.net.

Van Canneyt O (2022) *Observatoire Pelagis aerial surveys 2002-2021*. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1404) on 2023-06-16.