Draft Biological Report for the Designation of Marine Critical Habitat for Six Distinct Population Segments of the Green Turtle, *Chelonia mydas*

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EXECUTIVE SUMMARY

Section 4 of the Endangered Species Act of 1973 (ESA) requires the designation of critical habitat for threatened and endangered species to the maximum extent prudent and determinable, based on the best scientific data available and after taking into consideration national security, economic, and other relevant impacts. Under section 7 of the ESA, Federal agencies are required to consult with the Services to ensure that their actions do not result in the destruction or adverse modification of designated critical habitat. Designated critical habitat is not a marine protected area and does not impact activities that are not authorized, funded, or carried out by a Federal agency. The purpose of this document is to review the best available scientific data in order to identify areas meeting the definition of critical habitat.

The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS), together referred to herein as the Services, jointly administer the ESA regarding sea turtles. NMFS has jurisdiction in the marine environment, and USFWS has jurisdiction in the terrestrial environment (Memorandum of Understanding Defining the Roles of USFWS and NMFS in Joint Administration of the ESA as to Sea Turtles 2015). Designation of critical habitat was prompted by the Services' 2016 final rule that listed 11 threatened or endangered distinct population segments (DPSs) of green turtles (*Chelonia mydas*) and removed the original ESA listing of the globally threatened species with endangered breeding populations in Florida and Mexico's Pacific coast (81 FR 20057; April 6, 2016). Six DPSs occur within waters under U.S. jurisdiction and are therefore eligible for designation of critical habitat: North Atlantic (threatened), South Atlantic (threatened), East Pacific (threatened), Central North Pacific (threatened), Central South Pacific (endangered), and Central West Pacific (endangered).

To begin the critical habitat designation process, NMFS convened a team of green turtle experts from within the agency. The team (we) solicited data and expertise from Federal, State, and Territory agency research programs on green turtles and their habitat. We gathered and reviewed the best available scientific information relevant to the identification of potential critical habitat for each DPS. We used this information to: 1) determine the geographical area occupied by each DPS, 2) identify the physical or biological features essential to the conservation of each DPS (i.e., essential features or EFs) that may require special management considerations or protection, 3) delineate specific areas within the geographical area occupied that contain at least one EF, and 4) assess the conservation value of these specific areas.

We used the best available scientific data to identify the EFs. In general, essential life history requirements of green turtles include reproduction, adult migration between reproductive and foraging/resting areas, and foraging/resting at all life stages. We identified the following EFs that are essential to the conservation of at least one DPS:

- Reproductive: From the mean high water line to 20 m depth, sufficiently dark and unobstructed nearshore waters, adjacent to nesting beaches proposed as critical habitat by the USFWS (published in the Federal Register), to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings. (Did not identify for East Pacific DPS because no nesting occurs within U.S. jurisdiction)
- Migratory: From the mean high water line to a particular depth or distance from shore (as dictated by the best available data for that DPS), sufficiently unobstructed corridors that allow for unrestricted transit of reproductive individuals between benthic foraging/resting

and reproductive areas. (North Atlantic and East Pacific DPSs only because other DPSs do not use a narrow, constricted migratory corridor)

- Benthic foraging/resting: From the mean high water line to 20 m depth, underwater refugia and food resources (i.e., seagrasses, macroalgae, and/or invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction. (All DPSs)
- Surface-pelagic foraging/resting: Convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, and other areas that result in concentrated components of the *Sargassum*-dominated drift community, as well as the currents which carry turtles to *Sargassum*-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements. (North Atlantic DPS only because there is insufficient data to identify this feature for other DPSs)

The reproductive feature is essential to the conservation of green turtle DPSs (except for the East Pacific DPS) because it is required for mating, females' access to and from nesting beaches (i.e., where egg clutches are deposited) and internesting areas (i.e., for rest and egg production), and post-hatchlings' swim frenzy and early dispersal. Without successful mating, nesting, and recruitment, the DPSs cannot recover. The reproductive EF may require special management considerations or protection to avoid obstruction because during reproduction, internesting, post-hatchling swim frenzy and early dispersal, adults and post-hatchlings are concentrated within relatively small areas, exposing a large proportion of the DPS to anthropogenic threats, including nearshore construction and structures, establishment of shipping lanes, fishing or aquaculture activities, dredging, recreational activities, and pollution. To identify specific areas containing the reproductive EFs, we used USFWS' list of nesting beaches proposed as terrestrial critical habitat (i.e., essential nesting habitat). To determine the offshore extent of the specific areas, we reviewed and evaluated published literature and unpublished data on the movement of post-hatchlings, nesting females, and reproductive males in the waters adjacent to these beaches.

The migratory feature is essential to the conservation of DPSs that use narrow corridors (North Atlantic and East Pacific DPSs) because it is required for connectivity between reproductive and foraging/resting areas for adult green turtles; this includes post-nesting migration (for females), post-reproductive migration (for males), and migration of both males and females from foraging/resting areas to the waters off nesting beaches. Obstruction of such corridors would interfere with migration, thus inhibiting recovery. The migratory EF may require special management considerations or protection because reproductive adults that are otherwise spread out over many, and often distant, foraging sites become concentrated into relatively narrow, constricted corridors during migration. This would render a large proportion of adults vulnerable to anthropogenic threats such as oil and gas activities, dredging, energy development and generation, and some fishing and aquaculture activities. However, most DPSs are not restricted to using narrow migratory corridors, and we were unable to identify essential migratory features for these DPSs. To identify specific areas containing the migratory EF, we evaluated published and unpublished data on adult green turtle movements between reproductive and foraging/resting areas.

The foraging and resting EFs are essential to the conservation of green turtle DPSs because they provide the energy required for post-hatchling and juvenile survival, growth, and development and for adult survival, migration, and reproduction. Without energy for successful survival, growth, development, and reproduction, the DPSs could not recover. These EFs may require special management considerations or protection because such food resources and refugia are often vulnerable to habitat destruction or modification from construction, dredging, some fishing practices, recreational activities, and pollution, including run-off, oilspills, and contaminants. To identify specific areas containing the essential foraging and resting EFs that require protection, we evaluated published and unpublished data on green turtle food resources, refugia, and the presence of foraging or resting individuals.

Once we identified all areas containing at least one EF (Figure i; Table i), we evaluated the best available information to assess the qualitative conservation value (i.e., high, moderate, or low) that the area provides to the DPS. All areas containing reproductive or migratory EFs provide a high conservation value because they primarily support adults and are directly linked to population growth and thus the recovery of the DPS. For areas containing only foraging/resting EFs, an area provided a high conservation value if it supported a relatively large number of individuals; whereas an area that supports relatively few individuals would provide a low conservation value. Some areas were data deficient, preventing us from evaluating their conservation value. We did not identify any unoccupied areas.

The information provided in this report may be used by NMFS at a later date to propose a critical habitat designation. This report does not address the exemption of Department of Defense areas (16 U.S.C. 1533(a)(3)(B)) or the exclusion of areas where national security, economic, and other relevant impacts outweigh the benefit of designation, if such an exclusion will not result in the extinction of the species (16 U.S.C. 1533(b)(2)). These two steps are not based solely on scientific data and thus are beyond the scope of this report.

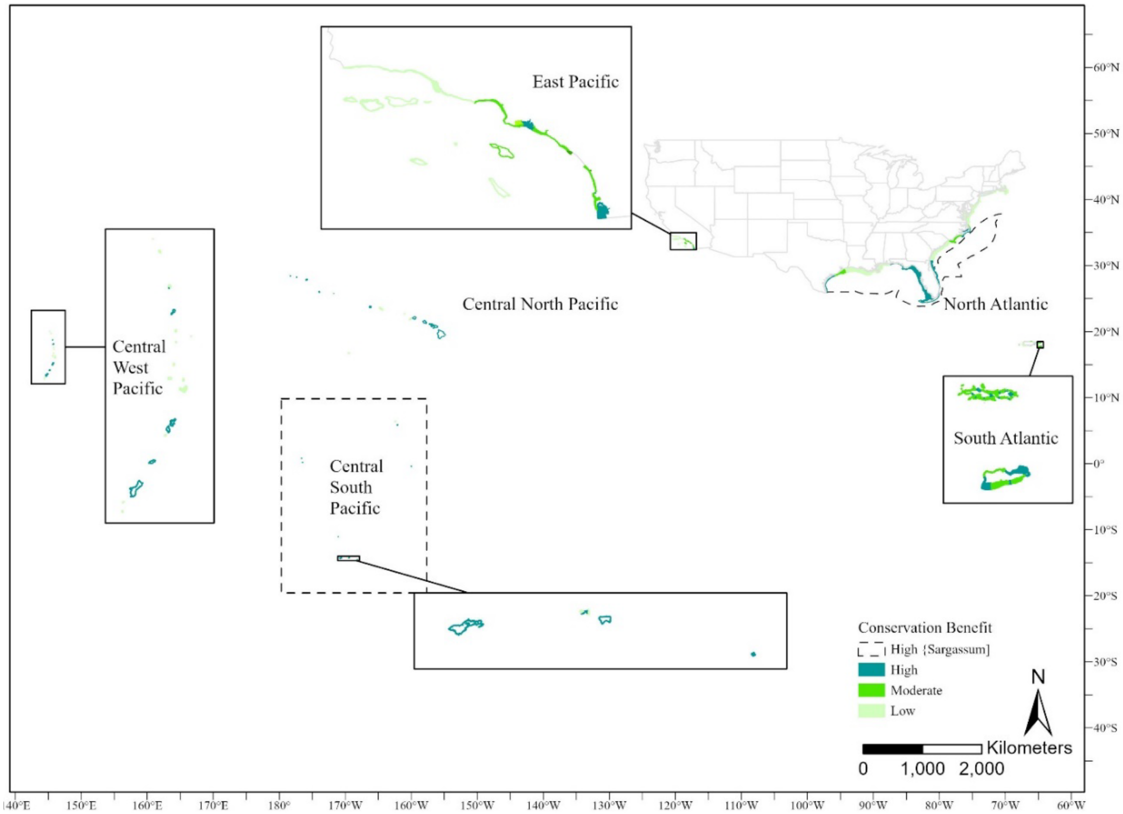

Figure i. Possible critical habitat areas
Areas meeting the definition of critical habitat and their conservation value to the DPS.

Table i. Areas meeting the definition of critical habitat
In-water areas under U.S. jurisdiction that contain the features essential to the conservation of the DPS that may require special management considerations or protection.

DPS	Region, State, or Island	Area (Mean high water line to 20 m, unless otherwise indicated)	Essential Features	Conservation value
North Atlantic	Texas-North Carolina	Sargassum (Gulf of Mexico and Atlantic, 10 m depth to U.S. EEZ)	Surface-pelagic foraging and resting	High
North Atlantic	Texas	Mexico border to Lavaca-Matagorda Bay (including Laguna Madre and Lavaca-Matagorda Bay)	Benthic foraging and resting	High
North Atlantic	Texas	Lavaca-Matagorda Bay to Galveston Bay	Benthic foraging and resting	Moderate
North Atlantic	Texas	All other areas	Benthic foraging and resting	Low
North Atlantic	Louisiana	All areas	Benthic foraging and resting	Low

North Atlantic	Mississippi	All areas	Benthic foraging and resting	Low
North Atlantic	Alabama	All areas	Benthic foraging and resting	Low
North Atlantic	Florida	NW Florida (Panhandle)	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Florida	NW Florida (Big Bend)	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Florida	SW Florida	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Florida	Monroe County	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Florida	SE Florida (from Cape Canaveral to Monroe County) including:	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Florida	NE Florida (from Georgia border to Cape Canaveral)	Reproductive, migratory, and benthic foraging and resting	High
North Atlantic	Georgia	All areas	Benthic foraging and resting	Low
North Atlantic	South Carolina	All areas	Benthic foraging and resting	Low
North Atlantic	North Carolina	Pamlico Sound	Benthic foraging and resting	High
North Atlantic	North Carolina	Core Sound	Benthic foraging and resting	High
North Atlantic	North Carolina	Back Sound	Benthic foraging and resting	High

North Atlantic	North Carolina	Bogue Sound	Benthic foraging and resting	Moderate
North Atlantic	North Carolina	White Oak River	Benthic foraging and resting	Moderate
North Atlantic	North Carolina	New River	Benthic foraging and resting	Moderate
North Atlantic	North Carolina	Cape Fear River	Benthic foraging and resting	Moderate
North Atlantic	North Carolina	All other areas	Benthic foraging and resting	Low
North Atlantic	Virginia	All areas	Benthic foraging and resting	Low
North Atlantic	Maryland	All areas	Benthic foraging and resting	Low
North Atlantic	Delaware	All areas	Benthic foraging and resting	Low
North Atlantic	New Jersey	All areas	Benthic foraging and resting	Low
North Atlantic	New York	All areas	Benthic foraging and resting	Low
North Atlantic	Connecticut	All areas	Benthic foraging and resting	Low
North Atlantic	Rhode Island	All areas	Benthic foraging and resting	Low
North Atlantic	Massachusetts	All areas	Benthic foraging and resting	Low
North Atlantic	Puerto Rico	Culebra Island	Benthic foraging and resting	High
North Atlantic	Puerto Rico	Vieques Island (South)	Reproductive, foraging and resting	High
North Atlantic	Puerto Rico	Vieques Island (East)	Reproductive, foraging and resting	High

North Atlantic	Puerto Rico	Puerto Rico Island (Maunabo)	Reproductive, foraging and resting	High
North Atlantic	Puerto Rico	Puerto Rico Island (Guayama)	Reproductive, foraging and resting	High
North Atlantic	Puerto Rico	Puerto Rico Island (north coast including Punta Salinas, Escambron, and Arrecifes Isla Verde Natural Reserve)	Benthic foraging and resting	High
North Atlantic	Puerto Rico	Mona Island (south coast)	Reproductive, foraging and resting	High
North Atlantic	Puerto Rico	All other areas	Benthic foraging and resting	Low
South Atlantic	USVI	St. Croix: East including Buck Island and East End Marine Park; West including Sandy Point NWR; South	Reproductive, foraging and resting	High
South Atlantic	USVI	St. Croix: all other areas	Foraging and resting	Moderate
South Atlantic	USVI	Little St. James	Foraging and resting	Moderate
South Atlantic	USVI	Great St. James	Foraging and resting	Moderate
South Atlantic	USVI	St. Thomas: Druif Bay, Brewers Bay, Magens Bay, Bolongo Bay, Sapphire Bay/Smith Bay/Red Hook	Foraging and resting	High
South Atlantic	USVI	St. Thomas: all other areas	Foraging and resting	Moderate
South Atlantic	USVI	St. John: Saltpond Bay, Great Lameshur Bay, Watermelon Bay, Maho/ Francis/Leinster Bays, Hawksnest/Honeymoon/ Caneel/Scott Bays, Chocolate Hole, Hurricane Hole/Coral/Round Bays	Foraging and resting	High
South Atlantic	USVI	St. John: All other areas	Foraging and resting	Moderate

East Pacific	California	United States/Mexico border to San Diego Bay including North San Diego Bay	Migratory, foraging and resting	High
East Pacific	California	South San Diego Bay	Foraging and resting	High
East Pacific	California	Central San Diego Bay	Foraging and resting	High
East Pacific	California	Mission Bay (San Diego)	Foraging and resting	Moderate
East Pacific	California	Point Loma to (but not including) La Jolla Shores	Foraging and resting	Moderate
East Pacific	California	La Jolla Shores/Cove	Foraging and resting	Moderate-High
East Pacific	California	La Jolla Shores to Oceanside (including Oceanside)	Foraging and resting	Moderate
East Pacific	California	Agua Hedionda Lagoon	Foraging and resting	Moderate–high
East Pacific	California	Oceanside to San Onofre	Foraging and resting	Data deficient
East Pacific	California	San Onofre	Foraging and resting	Moderate-High
East Pacific	California	San Onofre to Newport (including Newport Bay)	Foraging and resting	Moderate
East Pacific	California	Newport to Huntington Beach	Foraging and resting	Moderate
East Pacific	California	Bolsa Chica Lowlands	Foraging and resting	Moderate
East Pacific	California	Seal Beach Wetland and Nearshore Complex: including San Pedro Bay, San Gabriel River, Alamitos Bay, Anaheim Bay, Huntington Harbor, Bolsa Chica (excluding lowlands), Seal Beach NWR, 7th Street Basin, and offshore waters	Foraging and resting	High
East Pacific	California	LA and Long Beach Harbors	Foraging and resting	Moderate-Low

East Pacific	California	LA and Long Beach Breakwater	Foraging and resting	Moderate
East Pacific	California	Palos Verdes	Foraging and resting	Moderate
East Pacific	California	Santa Monica Bay	Foraging and resting	Moderate
East Pacific	California	Catalina Island	Foraging and resting	Moderate
East Pacific	California	Channel Islands	Foraging and resting	Low
East Pacific	California	Santa Monica Bay to Point Conception	Foraging and resting	Low
Central North Pacific	Johnston Atoll	All areas	Foraging and resting	Low
Central North Pacific	Hawai‘i	Hawai‘i Island	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Maui	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Kaho‘olawe	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Lana‘i	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Moloka‘i	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	O‘ahu	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Kaua‘i	Reproductive, foraging, and resting	High

Central North Pacific	Hawai‘i	Ni‘ihau	Foraging and resting	Low
Central North Pacific	Hawai‘i	Nihoa	Foraging and resting	Low
Central North Pacific	Hawai‘i	Mokumanamana/Necker Island	Foraging and resting	Low
Central North Pacific	Hawai‘i	Lalo/French Frigate Shoals	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Kamole/Laysan Island	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Kapou/Lisianski Island	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Manawai/Pearl and Hermes Atoll	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Kuaihelani/Midway Atoll	Reproductive, foraging, and resting	High
Central North Pacific	Hawai‘i	Hōlanikū/Kure Atoll	Reproductive, foraging, and resting	High
Central South Pacific	American Samoa	Rose Atoll/Motu o Manu	Reproductive, foraging, and resting	High
Central South Pacific	American Samoa	Swains Island	Reproductive, foraging, and resting	High
Central South Pacific	American Samoa	Ta'u Island	Reproductive, foraging, and resting	High
Central South Pacific	American Samoa	Tutuila Island	Foraging and resting	High

Central South Pacific	American Samoa	Ofu and Olosega Island (Airport, Matasina, Vaoto, Fatauana, Toaga, Asagatai, Mafafa, Tuafanua, Olosega and Faiava/Sili/Lalomoana Beaches)	Reproductive, foraging, and resting	High
Central South Pacific	American Samoa	Ofu and Olosega (other areas)	Foraging and resting	Low
Central South Pacific	Pacific Remote Island Areas	Baker Island	Foraging and resting	High
Central South Pacific	Pacific Remote Island Areas	Howland Island	Foraging and resting	High
Central South Pacific	Pacific Remote Island Areas	Jarvis Island	Foraging and resting	High
Central South Pacific	Pacific Remote Island Areas	Kingman Reef	Foraging and resting	Low
Central South Pacific	Pacific Remote Island Areas	Palmyra Atoll	Reproductive, foraging, and resting	High
Central West Pacific	Guam	Guam	Reproductive, foraging, and resting	High
Central West Pacific	CNMI	Saipan	Reproductive, foraging, and resting	High
Central West Pacific	CNMI	Tinian	Reproductive, foraging, and resting	High
Central West Pacific	CNMI	Rota	Reproductive, foraging, and resting	High
Central West Pacific	CNMI	Pagan	Foraging and resting	High
Central West Pacific	CNMI	Aguijan	Foraging and resting	High

Central West Pacific	CNMI	Alamagan	Foraging and resting	High
Central West Pacific	CNMI	Sarigan	Foraging and resting	High
Central West Pacific	CNMI	Agrihan (nesting beach)	Reproductive	High
Central West Pacific	CNMI	Other areas	Foraging and resting	Low
Central West Pacific	Wake	All areas	Foraging and resting	Low

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ACRONYMS AND ABBREVIATIONS

C	Celsius
CCL	Curved Carapace Length
CFR	Code of Federal Regulations
cm	Centimeter
CNMI	Commonwealth of the Northern Mariana Islands
DAWR	Guam Department of Agriculture's Division of Aquatic and Wildlife Resources
DLNR	CNMI Department of Lands and Natural Resources
DMWR	American Samoa Department of Marine and Wildlife Resources
DPS	Distinct Population Segment
E	East
EEZ	Exclusive Economic Zone
EF	Essential physical or biological feature
ESA	Endangered Species Act
GADNR	Georgia Department of Natural Resources
FR	Federal Register
FWC	Florida Fish and Wildlife Conservation Commission
kg	Kilogram
km	Kilometer
Lat.	Latitude
LDWF	Louisiana Department of Wildlife and Fisheries
Long.	Longitude
m	Meter
MHI	Main Hawaiian Islands
n	Number of samples (i.e., sample size)
N	North
NCWRC	North Carolina Wildlife Resources Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWR	National Wildlife Refuge
PIFSC	Pacific Islands Fisheries Science Center (NMFS)
PMNM	Papahānaumokuākea Marine National Monument
PRDRNA	Puerto Rico Department of Natural and Environmental Resources
S	South
SCDNR	South Carolina Department of Natural Resources
SCL	Straight Carapace Length
St.	Saint (e.g., St. Croix)
SEFSC	Southeast Fisheries Science Center (NMFS)
SWFSC	Southwest Fisheries Science Center (NMFS)
U.S.	United States (when used as an adjective)
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USVI	United States Virgin Islands
W	West

1. GREEN TURTLE ESA LISTINGS AND CRITICAL HABITAT DESIGNATION

In 1978, the Services listed the green turtle as a threatened species, except for the Florida and Mexican Pacific coast breeding populations that were listed as endangered, under the ESA (43 FR 32800; July 28, 1978). In 1998, NMFS designated critical habitat for the species in waters surrounding Culebra Island, Commonwealth of Puerto Rico, and its outlying keys (63 FR 46693; September 2, 1998).

On February 16, 2012, the Services received a petition from the Association of Hawaiian Civic Clubs to identify the Hawaiian population as a DPS and to delist it. In response, the Services performed a status review of the entire species (Seminoff *et al.* 2015). On April 6, 2016, the Services published a final rule (81 FR 20057) to remove the original listings and, in their place, list 11 green turtle DPSs as threatened or endangered (Figure 1). The following DPSs occur in areas within U.S. jurisdiction: North Atlantic (threatened), South Atlantic (threatened), East Pacific (threatened), Central North Pacific (threatened), Central South Pacific (endangered), and Central West Pacific (endangered). Table 1 provides the boundary definitions for DPSs within U.S. jurisdiction.

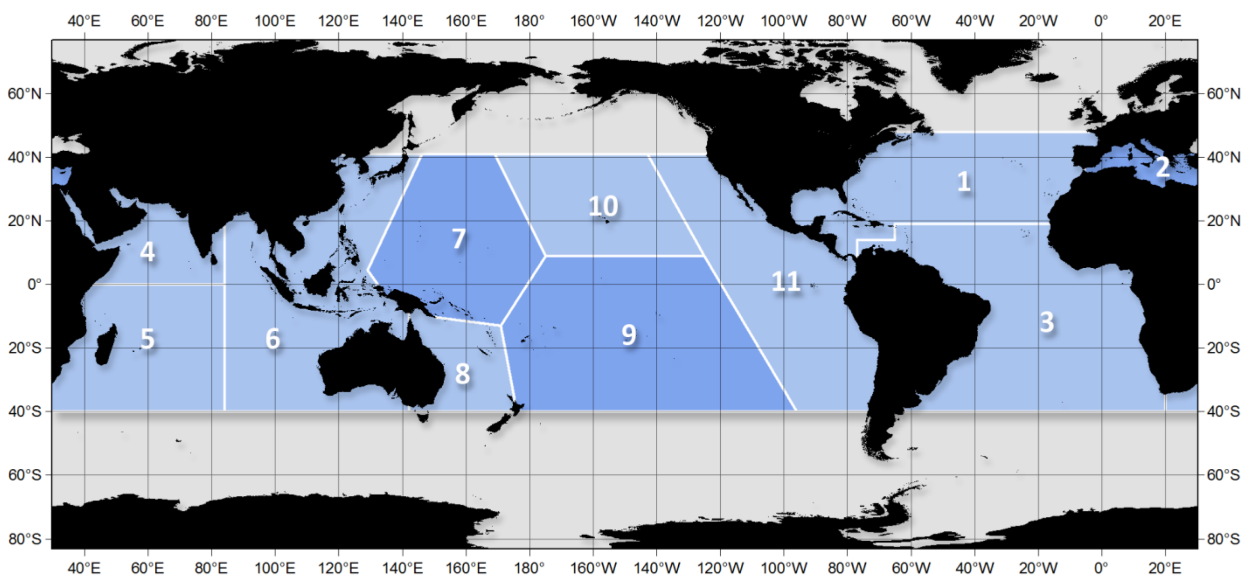


Figure 1. Map of green turtle DPS boundaries

Threatened DPSs shown in light blue, and endangered DPSs shown in dark blue: 1. North Atlantic (threatened); 2. Mediterranean (endangered); 3. South Atlantic (threatened); 4. Southwest Indian (threatened); 5. North Indian (threatened); 6. East Indian-West Pacific (threatened); 7. Central West Pacific (endangered); 8. Southwest Pacific (threatened); 9. Central South Pacific (endangered); 10. Central North Pacific (threatened); and 11. East Pacific (threatened).

Table 1. Green turtle DPSs occurring within waters under U.S. jurisdiction

DPS	Green turtles originating from:	Status
North Atlantic	North Atlantic Ocean, bounded by the following lines and coordinates: 48° N. Lat. in the north, along the western coasts of Europe and Africa (west of 5.5° W. Long.); north of 19° N. Lat. in the east; bounded by 19° N., 65.1° W. to 14° N., 65.1° W. then 14° N., 77° W. in the south and west; and along the eastern coasts of the Americas (north of 7.5° N., 77° W.).	Threatened
South Atlantic	South Atlantic Ocean, bounded by the following lines and coordinates: along the northern and eastern coasts of South America (east of 7.5° N., 77° W.); 14° N., 77° W. to 14° N., 65.1° W. to 19° N., 65.1° W. in the north and west; 19° N. Lat. in the northeast; 40° S. 19° E. in the southeast; and 40° S. Lat. in the south.	Threatened
East Pacific	East Pacific Ocean, bounded by the following lines and coordinates: 41° N., 143° W. in the northwest; 41° N. Lat. in the north; along the western coasts of the Americas; 40° S. Lat. in the south; and 40° S., 96° W. in the southwest.	Threatened
Central North Pacific	Central North Pacific Ocean, bounded by the following coordinates: 41° N., 169° E. in the northwest; 41° N., 143° W. in the northeast; 9° N., 125° W. in the southeast; and 9° N., 175° W. in the southwest.	Threatened
Central South Pacific	Central South Pacific Ocean, bounded by the following coordinates: 9° N., 175° W. in the northwest; 9° N., 125° W. in the northeast; 40° S., 96° W. in the southeast; 40° S., 176° E. in the southwest; and 13° S., 171° E. in the west.	Endangered
Central West Pacific	Central West Pacific Ocean, bounded by the following coordinates: 41° N., 146° E. in the northwest; 41° N., 169° E. in the northeast; 9° N., 175° W. in the east; 13° S., 171° E. in the southeast; along the northern coast of the island of New Guinea; and 4.5° N., 129° E. in the west.	Endangered

In the proposed listing rule, the Services requested information related to the identification of critical habitat, essential physical or biological features (EFs) for this species, and other relevant impacts of a critical habitat designation (80 FR 15271, March 23 2015); however, we did not receive scientific data related to the designation of critical habitat at that time. Upon publication of the final listing rule, the Services lacked the time to review all available scientific data necessary to designate critical habitat. As a result, the Services found designation of critical habitat to be “not determinable” (16 U.S.C. 1533(b)(6)(C)(ii)) at that time but would propose critical habitat designations for the six DPSs within U.S. jurisdiction in future rulemakings (81 FR 20057, April 6, 2016). As the first step in designating critical habitat, this biological report (i.e., the report) identifies the best available science on the habitat needs of those DPSs.

2. APPROACH TO THE REPORT

Section 4 of the ESA requires the designation of critical habitat for threatened and endangered species to the maximum extent prudent and determinable (16 U.S.C. 1533(a)(3)(A)(i)). Critical habitat is defined as:

> "(i) the specific areas within the geographical area occupied by the species, at the time it is listed [under Section 4], on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
> (ii) specific areas outside the geographical area occupied by the species at the time it is listed [under Section 4], upon a determination by the Secretary that such areas are essential for the conservation of the species" (16 U.S.C. 1532(5)(A))."

Section 4(b)(2) of the ESA requires the Services to designate critical habitat "on the basis of the best scientific data available and after taking into consideration the economic impact, the impact on national security, and any other relevant impact, of specifying any particular area as critical habitat." The Services may exclude any area from critical habitat if "the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat," unless the Services determine, "based on the best scientific and commercial data available, that the failure to designate such area as critical habitat will result in the extinction of the species concerned" (16 U.S.C. 1533(b)(2)).

The Services promulgated (49 FR 38908, October 1 1984) and revised (84 FR 45020, September 26, 2019) regulations to implement section 4 of the ESA (50 CFR 424). These regulations (50 CFR 424.12(b)(1)) instruct the Services to identify specific areas occupied by the species for consideration as critical habitat as follows:

> (i) Identify the geographical area occupied by the species at the time of listing.
> (ii) Identify physical and biological features essential to the conservation of the species at an appropriate level of specificity using the best available scientific data. This analysis will vary between species and may include consideration of the appropriate quality, quantity, and spatial and temporal arrangements of such features in the context of the life history, status, and conservation needs of the species.
> (iii) Determine the specific areas within the geographical area occupied by the species that contain the physical or biological features essential to the conservation of the species.
> (iv) Determine which of these features may require special management considerations or protection.

To begin the critical habitat designation process, NMFS charged a team of green turtle and marine habitat experts from within the agency to follow the above steps and write a biological report (i.e., this report) based on the best available information. The team (we) solicited data and expertise from Federal, State, and Territory agency programs researching green turtles and their habitat. For this report, the best available scientific data included information published in peer-reviewed scientific journals and technical memoranda. When peer-reviewed data were not available, we relied on government reports and unpublished data from scientific studies and surveys performed by scientists at: NMFS; USFWS; National Park Service (NPS); U.S. Geological Survey (USGS); U.S. Navy (USN); Florida Fish and Wildlife Conservation Commission (FWC); Louisiana Department of Wildlife and Fisheries (LDWF); Georgia Department of Natural Resources; South Carolina Department of Natural Resources (SCDNR); North Carolina Wildlife Resources Commission; Puerto Rico Department of Natural and Environmental Resources (PRDRNA); U.S. Virgin Islands (USVI) Department of Planning and Natural Resources; Hawai'i Department of Land and Natural Resources Division of Aquatic Resources (HLNDAR); American Samoa Department of Marine and Wildlife Resources (DMWR) Guam Department of Agriculture's Division of Aquatic and Wildlife Resources (Guam DAWR); and the Commonwealth of the Northern Mariana Islands (CNMI) Department of Lands and Natural Resources (CNMI DLNR). We also requested data from sea turtle researchers. Because it too relied on the best available scientific data, we cited the Green Turtle *(Chelonia mydas*) Status Review under the U.S. Endangered Species Act (i.e., the Status Review Report; Seminoff *et al.* 2015). We also referenced the following recovery plans: Recovery Plan for the U.S. Population of the Atlantic Green Turtle (NMFS and USFWS 1991); Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (NMFS and USFWS 1998a); and Recovery Plan for U.S. Pacific Populations of the Green Turtle (NMFS and USFWS 1998b). Although these recovery plans were written for green turtle populations prior to their identification as DPSs, we used them to identify EFs necessary for the conservation of the DPS and whether such EFs may require special management considerations or protection. We used these data to identify the occupied area, EFs necessary for the conservation of the DPS that may require special management considerations or protection, specific areas containing those EFs, and conservation value of each area.

2.1 Geographical Area

As required by the regulations, we identified the geographical area occupied by each DPS, at the time it was listed (50 CFR 424.12(b)(1)(i)). The regulations define this as "an area that may generally be delineated around species' occurrences, as determined by the [Services] (i.e., range). Such areas may include those areas used throughout all or part of the species' life cycle, even if not used on a regular basis, e.g., migratory corridors, seasonal habitats, and habitats used periodically, but not solely by vagrant individuals" (50 CFR 424.02). The original listing (43 FR 32800; July 23, 1978) identified the range of the species as "circumglobal in tropical and temperate seas and oceans." The range of each DPS (with the exception of the Central North Pacific DPS) includes foreign areas. Critical habitat cannot be designated outside of U.S. jurisdiction (50 CFR 424.12). Therefore, in the sections below for each DPS, we identified the U.S. range (including the U.S. Exclusive Economic Zone, EEZ), which extends 200 nautical miles from the coast of the United States and its territories.

The ESA allows designation of critical habitat areas outside the geographical area occupied by the species (i.e., the range of the species) at the time it is listed, if we determine that such areas are essential for the conservation of the species (50 CFR 424.12(b)(2). Each DPS occupies all possible areas that are essential for its conservation; unoccupied areas either fall within the range of another DPS or occur at latitudes beyond the physiological tolerance of the species. Therefore, we did not identify any areas outside the geographical area occupied by any DPS to be essential for its conservation.

2.2 Essential Physical and Biological Features

The regulations define essential physical or biological features (EFs) as "the features that occur in specific areas and that are essential to support the life-history needs of the species, including but not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features. A feature may be a single habitat characteristic, or a more complex combination of habitat characteristics. Features may include habitat characteristics that support ephemeral or dynamic habitat conditions. Features may also be expressed in terms relating to principles of conservation biology, such as patch size, distribution distances, and connectivity" (50 CFR 424.02). We organized our analyses by EFs (i.e., reproductive, migratory, and foraging/resting EFs). To identify the reproductive EFs, we focused on the features required for mating, internesting (i.e., rest, reovulation, and access to nesting beaches), and post-hatchling swim frenzy because mating, nesting, and recruitment are essential to the conservation of each DPS. To identify the migratory EFs, we focused on the features required for movement of reproductive adults between foraging areas and nesting/mating areas (including post-nesting migration for females, post-reproductive migration for males, and migration of both males and females to the waters off nesting beaches) because unobstructed migration is essential to the conservation of each DPS. To identify the foraging and resting EFs, we focused on features required for successful foraging and sheltering at all life stages. Sufficient prey and refugia (i.e., for rest, digestion, and protection from predators) are essential for the growth and development of post-hatchlings and juveniles and provide the energy for adults to migrate and reproduce.

2.3 Special Management Considerations or Protection

The regulations define special management considerations or protection as "methods or procedures useful in protecting the physical or biological features essential to the conservation of listed species" (50 CFR 424.02). "Conservation" means to use and the use of all methods and procedures necessary to bring a threatened or endangered species to the point at which listing under the ESA is no longer necessary (16 U.S.C. 1532). To this, the regulations add "i.e., the species is recovered" (50 CFR 424.02).

As required by the regulations, the team determined whether EFs may require special management considerations or protection (50 CFR 424.12(b)(1)(iv)). To perform this task, we referenced the Recovery Plan for U.S. Population of Atlantic Green Turtle (*Chelonia mydas*) (NMFS and USFWS 1991), Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (*Chelonia mydas*) (NMFS and USFWS 1998a), and Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*) (NMFS and USFWS 1998b). Although published prior to the identification of DPSs, they identified potential threats and necessary protections. We considered activities that may alter EFs and the vulnerability of EFs to such threats.

We also considered circumstances in which EFs may not require special management considerations or protection. For example, migratory EFs may require special management consideration or protection if they include migratory corridors that are narrow or constricted (e.g., by land on one side and the edge of the continental shelf on the other side). Oil and gas exploration, energy development and generation, and some aquaculture projects may alter the migratory EFs in these narrow, coastal corridors. However, in oceanic environments where migration may take place over a broader area (i.e., not a narrow corridor, lacking constraint by land and the continental shelf), turtles would likely be able to avoid such impediments. Therefore, migratory EFs in oceanic environments may not require special management considerations or protection.

2.4 Areas Containing the Essential Physical or Biological Features

As required by the regulations, we determined the specific areas that contain the EFs for each DPS (50 CFR 424.12(b)(1)(iii)). Again, we organized our analyses by EF (i.e., reproductive, migratory, or foraging/resting); however, some areas contain multiple EFs (e.g., green turtles may mate and forage within an area off nesting beaches). We relied on the best available data to determine whether areas contained EFs, as determined by green turtles' use of the EFs in that area. To identify specific areas containing EFs, we relied on positive determinations of green turtle occurrence and use of EFs. We considered areas without documented turtles to be data deficient and did not consider them further.

For this report, we focused on areas in the marine environment (i.e., areas under the jurisdiction of NMFS); however, we included information on terrestrial areas (i.e., nesting beaches under the jurisdiction of USFWS) to explain how we identified corresponding marine reproductive habitat. To identify areas with marine reproductive EFs, we relied on information from USFWS on nesting beaches that they considered for proposed terrestrial critical habitat (USFWS used the best available scientific data on nesting to identify terrestrial EFs and the beaches containing those EFs). Where NMFS conducted beach monitoring (e.g., the Pacific Islands), we included nesting data in this report. If USFWS determined that an area contains terrestrial EFs essential to the conservation of the DPS that may need protection, we determined that the adjacent marine area contains the marine reproductive EFs essential to the conservation of the DPS that may need protection. If USFWS did not consider a nesting beach as potential critical habitat, we did not consider the adjacent marine area for reproductive EFs. In some instances, however, such marine areas may contain migratory or foraging/resting EFs and thus meet the definition of critical habitat. To determine the offshore extent of the reproductive areas, we applied the best available scientific data on adult movement, female internesting, and post-hatchling swim frenzy. This approach is consistent with the approach NMFS took for identifying areas containing reproductive EFs in the Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle, *Caretta caretta* (NMFS 2013). In that report, however, NMFS distinguished between "nearshore reproductive habitat," used by nesting female and emergent post-hatchling loggerheads, and "breeding habitat," where reproductive male and female loggerheads mate, because these areas did not necessarily coincide (NMFS 2013). Because green turtles primarily mate in the same waters used by nesting females and emergent post-hatchlings, we did not distinguish between reproductive and breeding EFs or areas.

We also identified areas containing the migratory EFs that may require special management considerations or protection (i.e., narrow migratory corridors). To identify specific areas that provide connectivity between foraging and reproductive areas and may need protection, we used satellite telemetry (i.e., tracking) data collected from reproductive adults moving between waters adjacent to nesting beaches and foraging areas. This approach is consistent with NMFS' approach for identifying loggerhead turtle migratory corridors.

Finally, we identified areas containing the foraging and resting EFs. We relied on the occurrence of foraging and resting green turtles to determine which areas provide such resources in sufficient condition, distribution, diversity, abundance, and density necessary to support the survival, development, and growth of post-hatchlings or juveniles, or the survival, reproduction, and migration of adults. We reviewed studies on green turtles to identify areas where they forage and rest. The approach we used to identify foraging and refugia areas is consistent with previous critical habitat designations for sea turtles. To identify the foraging and refugia EFs for surface-pelagic juveniles, we applied the approach used in the Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle, *Caretta caretta* (NMFS 2013). This was especially applicable because North Atlantic green and NW Atlantic loggerhead sea turtles of this life stage co-occur within *Sargassum* drift communities (Witherington *et al.* 2012). Similar to the Final Biological Report to Revise Critical Habitat for Leatherback Sea Turtles (NMFS 2012), the team reviewed the best available scientific data to identify the areas containing the foraging/resting EFs for benthic-foraging juvenile and adult green turtles.

2.5 Conservation value to the Species

The ESA states that areas may be excluded from designation if NMFS determines that the benefits of such exclusion outweigh the benefits of inclusion, unless the failure to designate that area will result in extinction (16 U.S.C. 1533(b)(2)). We did not consider economic, national security, and other impacts in this biological report; however, we provided a qualitative assessment (high, moderate, or low) of the conservation value that an area provides to the DPS.

For each DPS, we summarized all areas containing at least one EF. We then used the best available scientific information to determine whether the area provides a high, moderate, or low conservation value to the DPS. All areas containing reproductive or migratory EFs are of high conservation value because they support adults, and often a large proportion of the adults within a DPS. The life history of sea turtles has evolved over tens of millions of years to involve high fecundity, low juvenile survival, and high adult survival (Halley *et al.* 2018). Because they have few natural predators, adult sea turtles have a high probability of living from one year to the next and are likely to mate and reproduce multiple times, which compensates for high juvenile mortality (Heppell *et al.* 2005). However, anthropogenic threats have increased mortality rates for adults, i.e., the life stage that must experience high survival for populations to persist (Heppel *et al*. 2005). Adults and subadults are considered to be more reproductively 'valuable' (Wallace *et al.* 2008) because they are more likely to contribute to future generations than post-hatchlings and juveniles (Heppell 1998). Conservation efforts focused on these life stages are the most likely to lead to the recovery of populations (Heppell 1998). Therefore, areas supporting these life stages would provide a high conservation value to a DPS. We conclude that areas containing reproductive or migratory EFs provide high conservation value because they primarily support adults and are directly linked to population growth and recovery. Often areas contain multiple EFs. As stated above, any area containing reproductive or migratory EFs would provide a high conservation value, and the additional benefits provided by foraging/resting EFs would further support a high rating.

We used different criteria to evaluate areas that contain only foraging/resting EFs. While adults must forage and rest to attain the necessary energy for reproduction and migration, juveniles rely on the foraging and resting EFs to grow and develop. A modeling study indicates that fluctuations in the survival of early life stages drive variation in abundance and suggests protecting early life stages from hostile environments (Halley *et al*. 2018). We agree with protecting areas that are important to early life stages; however, we think that areas supporting foraging and resting adults are also important, given these individuals' high reproductive value. To evaluate the conservation value of areas containing foraging/resting EFs, we instead consider the usage of that area by turtles of any and all life stages. An area that supports a relatively (i.e., for that DPS) large number of foraging and/or resting individuals would provide a high conservation value; whereas an area that supports a relatively low number of foraging and/or resting individuals would provide a low conservation value.

The conservation value of foraging areas is not comparable across DPSs. As defined in the ESA, a species includes any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C. 1532(16)). Therefore, we consider each DPS to be a separate listed entity under the ESA. This reflects the discreteness or marked separation among populations as a consequence of ecological, behavioral, and oceanographic factors, and based on genetic and morphological evidence (Seminoff *et al*. 2015). Furthermore, the DPSs demonstrate very different conservation needs. DPSs differ in their abundance, trend (i.e., increasing or decreasing population size), demographics, and threats. Therefore, we could not use the same quantitative criteria across all DPSs to determine conservation value.
Ideally, we would use standardized data to compare relative abundance at foraging areas throughout the range of the DPS. These data are rarely available; however, one study provided this information across the U.S. range of the Central West, North, and South Pacific DPSs. Becker *et al.* (2019) conducted biennial or triennial nearshore towed-diver surveys throughout the U.S. Pacific Islands Region, comparing green turtle densities, during the month of April from 2002 to 2015 (Figure 2). These analyses were especially valuable for comparing the conservation value of foraging areas used by a DPS because the same methodology is used across time and space, providing an objective measure of benefit to the DPS. Density was an especially important measure for this purpose because it reflects the interplay between reproduction, resource availability, behavior, and top-down forces (Becker *et al.* 2019). While these analyses were important to rate conservation values for a particular DPS, we did not compare densities among DPSs, as described above. Because there is little gene flow and movement among DPSs, high density within one DPS would not provide benefits to any other DPS. Furthermore, what constitutes a high density within one DPS may be considered "low" in another.

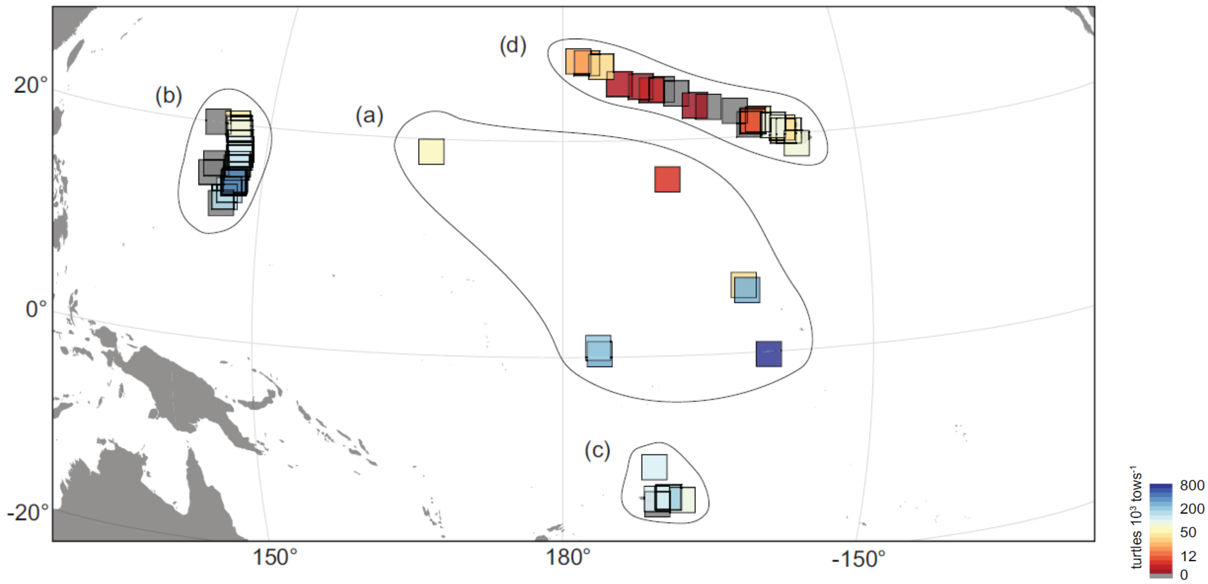


Figure 2. Density of sea turtles in the Pacific Islands
Density of (mainly green) sea turtles in a) Pacific Remote Island Areas; b) Mariana Archipelago; c) American Samoa; and d) Hawaiian Archipelago ([Becker *et al.* 2019](#))

Because we did not have standardized data for all areas containing foraging and resting EFs, we used the best available occurrence data (e.g., observations, tracking, or bycatch data) to determine whether areas containing only foraging or resting EFs provide a high, moderate, or low conservation value. When comparing occurrence data, we considered the data type. For example, satellite tracking is still relatively expensive, so that few individuals are tracked. However, if a large proportion of tracked individuals used the same area for foraging and/or resting, we conclude that the area provides a high conservation value. We also used stranding data in our evaluation. Stranding data includes dead, sick, injured, and cold-stunned turtles. While stranding data are critically important to understanding causes of mortality, we considered the following caveats when using stranding data. Debilitated or injured turtles may have reduced mobility and their movements (and by extension, the places they strand) can be influenced by surface winds, water temperatures, and water currents. Additionally, strandings are more likely to be observed and reported in areas with higher human populations. In one study, 28 percent of carcasses and wooden effigy drifters released at sea came ashore and were easily available for discovery, and 22 percent of beached carcasses were reported (Cook *et al.* 2021). Backtracking models incorporating water temperature, depth (pressure), bathymetry, and postmortem condition have been developed to estimate probable mortality locations (Nero *et al.* 2013; Nero *et al.* 2022). We use stranding data to indicate the presence of green turtles in the general vicinity, but we acknowledge the uncertainty in using such data to infer relative abundance.

3. LIFE HISTORY, HABITAT REQUIREMENTS, AND EFs

The Status Review Report (Seminoff *et al.* 2015) fully described the life history of the green turtle. Rather than repeating that information, we incorporate it by reference and summarize relevant spatial and biological information here, with information specific to each DPS in later sections.

Green turtles are long-lived and late-maturing (Van Houtan *et al.* 2014b). Their complex life cycle contains several life stages that are usually defined by size class; however, such size classes differ for each DPS. Therefore, for the purposes of this report, we define the life stages as follows:

- Hatchling: individuals that have recently emerged from eggs, prior to entering the marine environment.
- Post-hatchling: recently hatched individuals that have entered the marine environment
- Surface-pelagic juveniles: small juveniles that use surface-pelagic habitats for foraging and shelter.
- Benthic juveniles: larger juveniles that use benthic habitats for foraging and shelter.
- Sub-adults: large, benthic-foraging individuals that are not yet sexually mature.
- Adults: sexually mature individuals.

Our identification of reproductive, migratory, and foraging/resting EFs reflects the life-history needs of the species at different life stages. The juvenile life stages require food resources to grow, develop, and mature, as well as underwater refugia for rest and protection from predators. The adult life stage requires unobstructed waters for reproduction and migration between foraging and reproductive areas; adults also need food resources and underwater refugia to support the energy demands of reproduction and migration. These EFs may occur in different habitats. For the purposes of this report, we define these habitats as follows:

- Terrestrial: nesting beaches (under USFWS jurisdiction).
- Neritic: the marine environment (from the water surface to the sea floor), where depths do not exceed 200 m. As described by the Federal Geographic Data Committee (2012) in the Coastal and Marine Ecological Classification Standard, the neritic zone is further divided into nearshore (from the shoreline to water depths of 30 m) and offshore environments (from waters depths of 30 to 200 m). Neritic habitats include nearshore waters, bays, and estuaries, where green turtles forage, rest, reproduce, and access nesting beaches and internesting habitats (adult females) or begin their swim frenzy (post-hatchlings). For this report, data on green turtles reflect that they primarily use neritic habitats from depths of 0 (i.e., mean high water line) to 20 m.
- Oceanic: the marine environment (from the surface to the sea floor), where water depths are greater than 200 m, which adults in some DPSs traverse during migration between reproductive and foraging areas.
- Surface-pelagic: the surface of epipelagic waters (i.e., water surface to 20 m depth), which occur across neritic and oceanic zones (Meylan *et al.* 2011; Witherington *et al.* 2012), where post-hatchlings and early-stage juveniles (i.e., surface-pelagic juveniles) forage and reside.

Table 2 represents a general model of the green turtle life cycle; however, habitat use varies across life stages and EFs. Reproductive, migratory, and foraging/resting EFs may all occur in neritic (and often nearshore) waters. While we mainly associate surface-pelagic foraging with post-hatchlings and small juveniles, some larger juveniles alternate between benthic and surface-pelagic foraging habitat. Some adults do not migrate between nesting and foraging areas, but rather remain “in residence,” foraging near nesting beaches (Sloan *et al.* 2022). Other adults forage in oceanic habitats (Hatase *et al.* 2006).

Table 2. Green turtle EFs by life stage and habitat

Green represents terrestrial habitat, light blue represents neritic habitat, medium blue represents surface-pelagic habitat, and dark blue represents oceanic habitat.

EFs	Life Stage	Habitat
Nesting	Adult female, hatchling	Terrestrial
Reproductive	Adult	Marine (neritic)
	Post-hatchling (swim frenzy)	Marine (neritic)
Foraging/Resting	Post-hatchling and surface-pelagic juvenile	Marine (surface-pelagic)
	Adult, sub-adult, and benthic-foraging juvenile	Marine (neritic)
Migratory	Adult	Marine (neritic)
	Adult	Marine (oceanic)

For the purposes of this report, which applies only to marine areas under U.S. jurisdiction, we grouped the following behaviors under reproduction, which occurs in the neritic waters adjacent to nesting beaches: courtship, mating, transit of nesting females to and from beaches, internesting, and post-hatchling swim frenzy and early dispersal. (Note: we did not include nesting, which occurs on beaches and falls under USFWS' terrestrial jurisdiction). We included post-hatchling swim frenzy and early dispersal because they are the product of reproduction (i.e., productivity) and they use this EF in a manner similar to post-nesting females: they move away from nesting beaches. We distinguish this from migration because post-hatchlings do not move to the same foraging/resting areas as post-nesting females and reproductive males. Similarly, we distinguish between benthic foraging and resting of juvenile and adult turtles in neritic habitats and surface-pelagic foraging, resting, and sheltering of post-hatchlings and surface-pelagic juveniles in marine areas that concentrate algal and invertebrate communities, such as *Sargassum*-dominated drift communities. For the purposes of this report, "migration" refers only to the long distance movement of adult turtles between distant foraging and nesting areas. It does not include the movement that juveniles of the North Atlantic DPS make between distant foraging areas to avoid cold or hypothermic stunning (i.e., immobilization due to cold temperatures). As an ectothermic reptile, the green turtle's distribution is limited geographically and temporally by water temperature. Though there is variance among DPSs, lethal temperatures for the species are generally above 37.5 °C and below 5 °C, which results in cold-stunning, a suppression of metabolic activity (Witherington and Ehrhart 1989; Davenport 1997). Sublethal effects of transitional temperatures include reductions in feeding rates, internesting intervals, and physiological functioning (Bjorndal 1980a; Sato *et al.* 1998; Hays *et al.* 2002).

The following sections explain how we identified the EFs, why they are essential to the conservation of the DPSs, and why they may require special management considerations or protection. Information specific to each DPS is included in later sections.

3.1 Reproductive EFs

Females, and to a lesser extent males, exhibit philopatry (i.e., natal site fidelity), returning to the neritic waters off their natal beaches to reproduce (Bowen *et al.* 1992; Karl *et al.* 1992; Shamblin *et al.* 2014; Shamblin *et al.* 2020). Therefore, it is important to protect these areas from degradation because reproductive individuals will return to them, often regardless of the condition or functionality of the habitat (Dizon and Balazs 1982; Santos *et al.* 2017). Furthermore, adult males and females congregate for weeks in these areas, which host a large proportion of the most valuable individuals in the population (i.e., those contributing to the next generation).

Adult females can mate more than once, with multiple males, over a several-week period prior to nesting. Females can store sperm for several years, and multiple males may sire a single clutch (Pearse and Avise 2001). Reproductive individuals use the waters adjacent to nesting beaches for courtship and copulation (i.e., mating); however, mating may also occur at foraging areas and along migratory corridors (Karl *et al.* 1992; Roberts *et al.* 2004). Courtship involves rubbing, biting, cloacal checking, circling, chasing, and attempted mounting (Comuzzie and Owens 1990; Bevan *et al.* 2016). Copulation involves the male mounting the female from behind and clasping her with his flippers and claws (Witherington *et al.* 2006). Copulating turtles may remain mounted for hours at the surface (Witherington *et al.* 2006), rendering them vulnerable to in-water obstructions and disturbances. Therefore, it is essential to the conservation of green turtle DPSs that such areas remain free from obstructions and disturbances that would harm or interrupt copulating turtles.

Females lay up to nine clutches separated by approximately 2-week internesting intervals (Witherington *et al.* 2006; Hart *et al.* 2013; Balazs *et al.* 2015). During internesting intervals, females use underwater refugia off nesting beaches to avoid harassment from courting males (Booth and Peters 1972), reovulate (i.e., produce eggs for subsequent nestings; Pearse and Avise 2001), and rest (Carr *et al.* 1974). These activities are needed to maintain or increase the productivity of a population, leading to recovery of the DPS. Therefore, it is essential to the conservation of green turtle DPSs that such underwater areas remain free from obstructions and disturbances that would prevent the females from resting, reovulating, and returning to nesting beaches to lay additional clutches.

Green turtle hatchlings pip, escape from their eggs, and move out of the nest over a period of several days (Hendrickson 1958; Carr 1960). Hatchlings emerge from their nests *en masse* and almost exclusively at night (Bustard 1967), presumably using decreasing sand temperatures as a cue (Hendrickson 1958; Mrosovsky 1968; Glen *et al.* 2006). They crawl to the surf, engage in a swim frenzy, and are swept through the surf zone (Carr 1960, 1961; Wyneken and Salmon 1992). Hatchlings first use visual cues, orienting to the brightest horizon, which occurs over the ocean on natural beaches without artificial lighting (Daniel and Smith 1947; Limpus 1971; Salmon *et al.* 1992; Witherington and Martin 1996; Witherington 1997). Hatchlings crawl away from their nests using light cues to orient toward the relatively bright horizon over the ocean; therefore, it is important to limit artificial lighting on beaches. Even after entering the ocean, post-hatchlings are attracted to artificial lighting, which can cause them to linger in neritic habitats and increase their risk of predation (Thums *et al.* 2016). Once in the surf, post-hatchlings begin a swim-frenzy, moving quickly away from land and toward oceanic surface currents. They use wave orientation in the nearshore area and magnetic field orientation to move offshore (Lohmann and Lohmann 2003). Once offshore, they often depend on oceanic currents for dispersal at this early life stage, which is considered to be a critical period because it plays an overriding role in population dynamics (Putman *et al.* 2020; Mansfield *et al.* 2021). As they move from nesting beaches toward surface-pelagic drift communities, which provide the food and shelter necessary for development, they are vulnerable to obstructions, disturbances, and predation (Gyuris 1994; Booth 2009). Although this life stage is generally the most abundant and requires many years and stages of development before contributing to the next generation, it is essential to the recovery of the species because systemic reductions in post-hatchling survival are likely to lead to future reductions in abundance and productivity. Therefore, conservation of green turtle DPSs requires that such areas remain free from obstructions, disturbances, and structures that would concentrate predators, reduce the survival of post-hatchlings, or prevent post-hatchlings from reaching developmental habitats.

Based on the above information, we define the reproductive EFs as sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date), to allow for the transit, mating, and internesting of reproductive individuals and the transit (including swim frenzy and early dispersal) of post-hatchlings. We conclude that these EFs are essential to the conservation of all DPSs because they are required for successful reproduction and recruitment. Without successful reproduction and recruitment, a DPS could not survive (i.e., it would go extinct), and without increased reproduction and recruitment (and/or a reduction of threats) a DPS could not recover (i.e., it would remain at its current threatened status or become/remain endangered). Because reproduction has the most direct link to productivity, and thus recovery, all areas containing these EFs would provide a high conservation value to the DPS. These EFs may require special management considerations or protection against structures or activities that may interrupt, delay, or prevent mating, internesting, females' transit to and from nesting beaches, and the swim frenzy of post-hatchlings. Examples of nearshore threats include in-water structures, artificial lighting, construction, fishing, pollution, and vessel traffic. Specific details are provided for each DPS.

3.2 Migratory EFs

Reproductive individuals migrate between nesting beaches and foraging areas, which may be separated by hundreds to thousands of kilometers (Witherington *et al.* 2006) or as close as a few kilometers (Hart *et al.* 2013; Hart *et al.* 2017). Female remigration intervals range from 2 to 5 years (Hirth 1997); males may remigrate more frequently (e.g., annually). The longest documented reproductive lifespan of a green turtle is 38 years (Nurzia-Humburg *et al.* 2013). The mechanisms by which environmental variability triggers or limits green turtle migration and reproduction remain largely unknown; however, annual and decadal oceanographic oscillations likely play a role (Bruno *et al.* 2020). Migration requires adequate food stores and body condition (with sufficient energy left for reproduction). Without successful migration, adults would not be able to forage *and* reproduce, and the DPS could not recover. Based on this information, we concluded that sufficiently unobstructed migratory pathways are essential to the conservation of all DPSs because they are required for connectivity between nesting beaches and foraging areas. Green turtles may use relatively narrow paths (i.e., migratory corridors) to move between foraging and reproductive areas, and these DPSs may be particularly vulnerable to anthropogenic threats within narrow migratory corridors because reproductive individuals (i.e., those that have survived to the last stage of the life cycle and are therefore the most important individuals for conservation) that are otherwise spread out over many, often distant, foraging sites become concentrated into relatively small areas (e.g., Foley *et al.* 2013). Such migratory EFs may require special management consideration or protection. For example, pollution, development, and some fishing activities may alter the migratory EFs in narrow or constricted coastal corridors. However, in oceanic environments where migration may take place over a broader area (i.e., not a narrow corridor), green turtles may be able to avoid such impediments and would not require special management consideration or protection. To identify areas containing the migratory EFs that may require special management consideration or protection (i.e., narrow migratory corridors), we reviewed satellite telemetry data of turtles moving between reproductive and foraging areas. Because migration is directly linked to population growth and recovery, areas with migratory EFs provide a high conservation value to each DPS.

3.3 Foraging and Resting EFs

At all life stages, foraging and rest are essential for the conservation of the DPSs. Together they provide the energy required for post-hatchlings and juveniles to develop, grow, and transition into the next life stage and for adults to migrate and reproduce. Foraging includes locating and consuming food resources (e.g., seagrasses, macroalgae, and/or invertebrates). Resting includes the use of underwater refugia for digestion, protection from predators, thermoregulation, and recuperation.

Green turtles are omnivores, foraging on seagrasses, algae, and invertebrates (Esteban *et al.* 2020). Bjorndal *et al.* (2017) found that green turtles feeding primarily on seagrasses (n = 3911 growth increments) have significantly higher growth rates than those feeding primarily on algae (n = 871), seagrass/algae mix (n = 1337), or an omnivorous diet (n = 82). Furthermore, individual turtles may target specific food resources, and this preference may change across life stages (Bjorndal 1980) or with changes in resource availability (Russell and Balazs 2009). Therefore, we generally defined the foraging and resting EFs as refugia and food resources of sufficient condition, distribution, diversity, abundance, and density to support the survival, development, growth, and reproduction of green turtles. Because foraging and rest provide the energy for survival, development, growth, and reproduction (and thus recovery), the foraging/resting EFs are essential to the conservation of all DPSs.

During the post-hatchling and surface-pelagic juvenile stages, green turtles generally inhabit open ocean pelagic habitats where surface waters converge to form local downwellings that result in linear accumulations of floating material, especially macroalgae (e.g., *Sargassum* spp.) (Carr 1987; Witherington *et al.* 2012; Mansfield *et al.* 2021). They remain at the sea surface, where thermal benefits promote the growth and survival of young turtles (Mansfield *et al.* 2021).

These turtles do not behave simply as passive drifters but also exhibit directional swimming behavior (Putman and Mansfield 2015). The smallest green turtles associated with these areas are relatively active, moving both within algal mats and in nearby open water, which may limit the ability of researchers to detect their presence (Smith and Salmon 2009; Witherington *et al.* 2012). Food resources available to these turtles include: *Sargassum* spp. and associated hydroids, bryozoans, polychaetes, gastropods, cnidarians, and other pelagic invertebrates, fish eggs, and organic debris (Witherington *et al.* 2006; Boyle and Limpus 2008; Jones and Seminoff 2013). Therefore, the availability of large, continuous accumulations of *Sargassum* spp. and associated communities is essential to these early life stages because it provides the food, shelter, and thermal benefit required for survival, growth, and development (Mansfield *et al.* 2021). These EFs may require special management considerations or protection against activities that reduce available food and shelter, such as oil spills or other marine pollution, *Sargassum* harvesting, or the removal of marine debris and plastics. The turtles themselves may be impacted by an abundance of marine debris and plastic in their environment, which may contribute to their mortality via entanglement and ingestion. Although many areas contain *Sargassum* spp., they may not occur in sufficient quality, abundance, and availability to support the survival, development, and growth of post-hatchlings or surface-pelagic juveniles. Therefore, to identify areas containing these EFs, we used the best available information to signify the presence of these early life stages, indicating sufficient resources.

The surface-pelagic juvenile stage lasts for up to seven years until the turtles reach 20 to 30 cm straight carapace length, SCL (Mendonça 1981; Goshe *et al.* 2010), after which they recruit to benthic foraging and refugia areas (Bolten 2003). However, some juveniles alternate between benthic and surface-pelagic foraging (Plotkin 2003; Hatase *et al.* 2006), and some adults forage in surface-pelagic waters (Plotkin 2003; Hatase *et al.* 2006; Seminoff and Shanker 2008; Parker *et al.* 2011).

To compare diets of individuals beyond the surface pelagic juvenile stage (i.e., greater than 25 cm curved carapace length, CCL), Esteban *et al*. (2020) performed a global review (i.e., 67 studies, 89 datasets at 75 sites, 13 geographic sub-regions, and three oceans) of four diet components (i.e., seagrass, macroalgae, terrestrial plants (including mangroves), and animal matter) at the sub-regional and foraging site levels. They found that at sea surface temperatures (SST) greater than 25 °C (at least 6 months annually), the green turtle diet was predominantly herbivorous (mean = 92.97 percent; SE = 9.85; n = 69 datasets); at higher latitude sites and in cold-water currents with SST less than 20 °C (at least 6 months annually), the green turtle diet included a large percentage of animal matter (mean = 51.47 percent; SE = 4.84; n = 20 datasets). Based on these and other data (Bjorndal 1997), we conclude that benthic foraging juveniles and adult green turtles forage on food resources that include seagrasses, macroalgae, terrestrial plants, and/or invertebrates. They are characterized as generalist herbivores that exhibit differing foraging preferences among sites and varying degrees of omnivory (Jones and Seminoff 2013; Long *et al*. 2021). The relationship between specific food resources and juvenile abundance or growth rates is complex and dependent on other factors such as nutrient pollution and predator risk (Long 2021). For these reasons, we include site-specific dietary data, where available, for each DPS.

Generally, benthic-foraging juveniles and adult green turtles spend the majority of their lives in neritic foraging areas, which are characterized by nearshore waters of open coastline as well as protected bays and lagoons. These marine habitats are often highly dynamic, with annual fluctuations in water and air temperatures, which cause the distribution and abundance of food resources to vary substantially among seasons and years (Carballo *et al.* 2002). Primarily or partially herbivorous diets result in slow growth rates, with green turtles maturing at 12 to 50 years and 60 to 100 cm SCL (Seminoff *et al.* 2002; Bell *et al.* 2005; Zurita *et al.* 2012; Avens and Snover 2013; Van Houtan *et al.* 2014a). For benthic-foraging juveniles, these diets must support survival, development, and growth. For adults, these diets must support energy-expensive migration and reproduction. Thus, multiple and/or large foraging areas are needed to support these life stages. In addition, nearby refugia areas are necessary for underwater rest, digestion, thermoregulation, and protection from predators. Diving studies off the coast of Georgia demonstrate that green turtles use tall ledges with deep undercuts to rest and appear to demonstrate fidelity to these refugia over 8 years (Auster *et al.* 2020).

Without successful foraging and resting at all life stages to fuel population growth and/or expansion, a DPS could not recover. Therefore, adequate foraging resources and refugia are essential to the conservation of each DPS. Foraging and resting EFs may require special management consideration or protection. For example, refugia may be modified or destroyed by dredging or development. Seagrasses and algae are sensitive to pollution, water quality, and other anthropogenic activities. Though many areas contain foraging resources or refugia, they may not occur in sufficient quality, abundance, and availability to support the survival, development, and growth of benthic-foraging juveniles or the reproduction and migration of adults. Therefore, to identify areas containing these EFs, we used the best available information to identify foraging and/or resting turtles, the presence of which suggest sufficient resources. Large numbers of turtles in an area demonstrates a high conservation value, whereas few individuals may reflect a low conservation value.

4. NORTH ATLANTIC DPS

4.1 Geographical Area Occupied by the North Atlantic DPS

The North Atlantic DPS is defined as green turtles originating from the North Atlantic Ocean, including the U.S. East Coast, Gulf Coast, and Puerto Rico. The range of the DPS is bounded by the following lines and coordinates: 48° N. Lat. in the north, along the western coasts of Europe and Africa (west of 5.5° W. Long.); north of 19° N. Lat. in the east; 19° N., 65.1° W. to 14° N., 65.1° W. then 14° N., 77° W. in the south and west; and along the eastern coasts of the Americas (north of 7.5° N., 77° W.). This area includes waters outside of U.S. jurisdiction. If we apply the U.S. EEZ, we are left with the range of the DPS within U.S. jurisdiction (Figure 3).

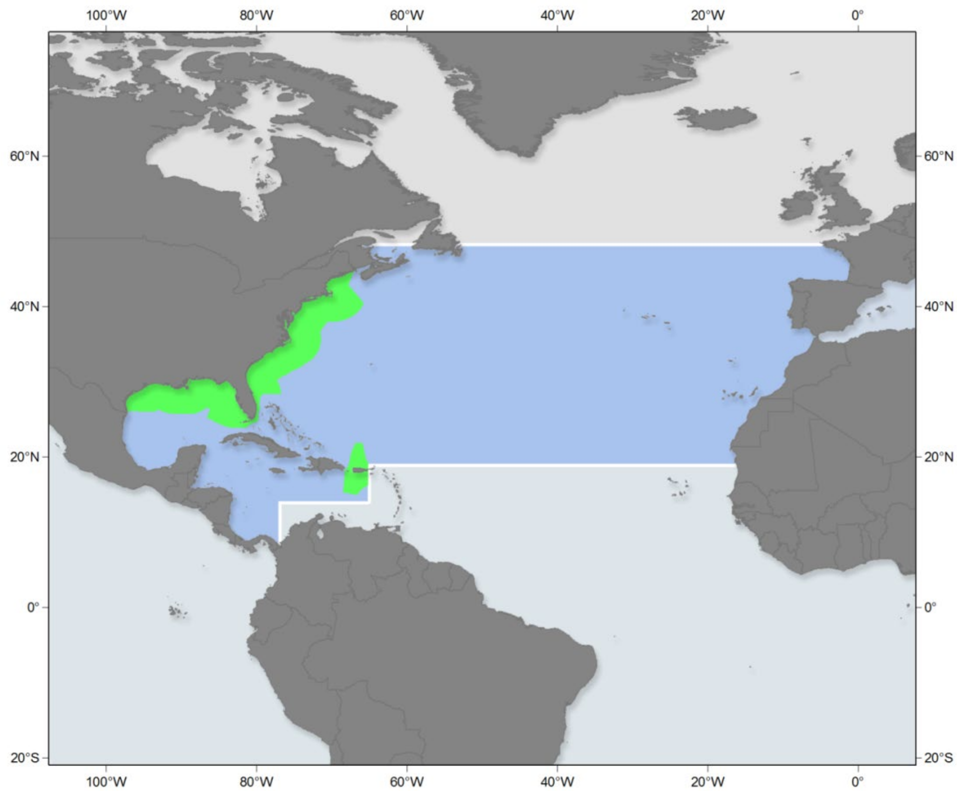


Figure 3. Range of the North Atlantic DPS within U.S. jurisdiction
Blue indicates the defining boundaries of the DPS; green indicates the range of the DPS within the U.S. EEZ.

4.2 Essential Features

A recovery plan, with associated recovery criteria, has yet to be developed for the North Atlantic DPS. To identify the EFs essential to the conservation of the North Atlantic DPS, we referenced the Recovery Plan for the U.S. Population of the Atlantic Green Turtle (NMFS and USFWS 1991), which includes the North Atlantic DPS within U.S. jurisdiction and identifies the following recovery criteria to delist the species (i.e., the goal of the plan):

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years
- At least 25 percent (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses greater than 50 percent of the nesting activity
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds
- All priority one tasks have been successfully implemented

To achieve these criteria, the plan indicates a need to protect and manage nesting habitat from the following terrestrial threats: beach erosion, coastal development (including beach armoring, renourishment, and cleaning), artificial lighting, recreational beach use (including beach driving), non-native vegetation, nest predation, storm events, pollution (including beach oiling and marine debris that washes ashore), and poaching. Recovery also requires protection of marine habitat, as follows:

> "Available sea turtle habitat has been significantly reduced over the past century. Among the factors contributing to this loss of habitat are coastal development and industrialization, increased commercial and recreational vessel activities, river and estuarine pollution, channelization, offshore oil and gas development, and commercial fishing activities. If present trends continue the cumulative loss of suitable habitat could reduce the likelihood of recovery of the species" (NMFS and USFWS 1991).

The plan identifies the following activities needed to protect marine habitat:

1. Identify important habitat, including foraging habitat and habitat requirements of specific age/size/sex classes. This includes the pelagic habitat of post-hatchling and small juvenile turtles (e.g., *Sargassum* habitat).
2. Prevent degradation (due to contamination and/or loss of food sources) and improve water quality (resulting from industrial pollution, channel dredging and maintenance, harbor activities, farm runoff, sewage disposal, etc.) of important turtle habitat
3. Prevent destruction of habitat (e.g., coral reefs, seagrass beds, sponges, and other live bottom habitats) from fishing gears and vessel anchoring
4. Prevent destruction of marine habitat from oil and gas activities; of particular concern are impacts, of oil spills, drilling mud disposal, disposal of other toxic materials, pipeline networks associated with oil and gas fields, onshore production facilities, increased vessel traffic, domestic garbage disposal, and explosive removal of obsolete platforms
5. Prevent destruction of marine habitat from dredging activities
6. Restore and limit further development in important foraging habitats (e.g., seagrass beds, which are relatively fragile habitats requiring low energy and low turbidity waters)

4.2.1. Reproduction

The recovery of the North Atlantic DPS is dependent on successful reproduction. While nesting occurs on beaches (i.e., terrestrial habitat, under USFWS jurisdiction), the marine areas surrounding the nesting beaches are essential for mating, movement of reproductive females on and off nesting beaches, internesting, and the swim frenzy and early dispersal (i.e., transit) of post-hatchlings.

4.2.1.1 Reproductive EFs Essential to the Conservation of the North Atlantic DPS

The following reproductive EF is essential to the conservation of the North Atlantic DPS: In depths up to 20 m, sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date), to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings.

To identify the reproductive EF, we used information on the life history of the species (section 3). Much of that information was gathered from data on the North Atlantic DPS, which is the best studied DPS. Here we provide additional details, specific to this DPS and its EF.

Upon reaching sexual maturity, male and female green turtles return to the waters off their natal nesting beaches to mate (FitzSimmons *et al.* 1997a; FitzSimmons *et al.* 1997b). This is called philopatry or natal homing. Females exhibit strong philopatry and rarely colonize new nesting habitat, as demonstrated by strong differentiation among nesting beaches maternally inherited mitochondrial control region sequences (Shamblin *et al.* 2015; Shamblin *et al.* 2018; Shamblin *et al.* 2020). Less is known about reproductive behavior in males, although they are thought to breed more frequently than females and are reproductively active for about a month (Limpus 1993). Comparing samples from Atlantic nesting beaches, Naro-Maciel *et al.* (2014) found highly significant population structure at microsatellite loci, which are biparentally inherited genetic markers. Such results are consistent with male philopatry, and the authors concluded that male-mediated gene flow may be less frequent than previously inferred (Naro-Maciel *et al.* 2014).

Mating and internesting occur in waters off nesting beaches. Mating occurs prior to and during the nesting season, generally from May to September (Witherington *et al.* 2006). During this time, males and females occupy a similar neritic area adjacent to nesting beaches (D. Bagley, University of Central Florida unpublished data 2016; K. Hart, USGS unpublished data 2016). Evaluating nine nesting females tracked via satellite tags, K. Mazzarella (Mote Marine Laboratory, unpublished data 2022) found that the maximum distance between all nests laid by one individual ranged from 759.3 m to 21.6 km, with a mean of 10.7 km. The clutch frequency ranged from 2 to 6 nests (mean = 4.8 nests) with an internesting interval of 9 to 21 days (mean = 10.8 days), with the caveat that some nests may have been missed and females may have nested prior to being tagged (K. Mazzarella, Mote Marine Laboratory unpublished data 2022). Other studies have documented an internesting interval of 9 to 14 (Sloan *et al.* 2022) and 9 to 18 days, with a mean of 12 days (Hart *et al.* 2013).

USFWS reviewed nesting data to identify beaches considered for terrestrial critical habitat. To determine the offshore boundary of the reproductive EF, we reviewed published and unpublished satellite tracking data on internesting females and males during temporary residence (i.e., prior to migration to foraging areas) in waters adjacent to nesting beaches. Most females (n = 6) and males (n = 8) tagged near Melbourne Beach within the Archie Carr National Wildlife Refuge (NWR) remained within maximum water depths of 30 m (D. Bagley, University of Central Florida unpublished data 2016). Eleven females tagged in the Archie Carr NWR generally remained in depths of less than 20 m (Figure 4) and traveled a maximum distance of 30 km from their nesting beach (B. Schroder, NMFS unpublished data 2016). Females (n = 21) and two males tracked from the Dry Tortugas remained in nearshore waters of less than 26 m depth and within 6 to 11 km of nesting beaches (Hart *et al.* 2013; USGS unpublished data 2016). Between nesting events, females (n = 8) tagged at nesting beaches on Sanibel and Keewaydin Islands (SW Florida) inhabited mean water depths of 6.3 m and traveled a mean distance of 21 km/day (Sloan *et al.* 2022); six of the eight traveled between the nesting beach and a distinct in-water location approximately 30 km west of Cape Sable during the internesting period to forage and rest (Figure 5; Sloan *et al*. 2022). Nine females tagged at Casey Key remained within 20 km of the nesting beach during the internesting period (K. Mazzarella, Mote Marine Laboratory unpublished data 2022). A female tagged at Gulf Islands National Seashore remained in nearshore waters along the coast to Panama City (M. Nicholas, Gulf Islands National Seashore, NPS, unpublished data 2002;

http://www.conserveturtles.org/satellitetracking.php?page=satguis_halie). Internesting females (n = 14) tracked from nesting beaches in NW Florida spent the majority of their time (92 percent) in depths of 20 m or less (M. Lamont, USGS unpublished data 2022).

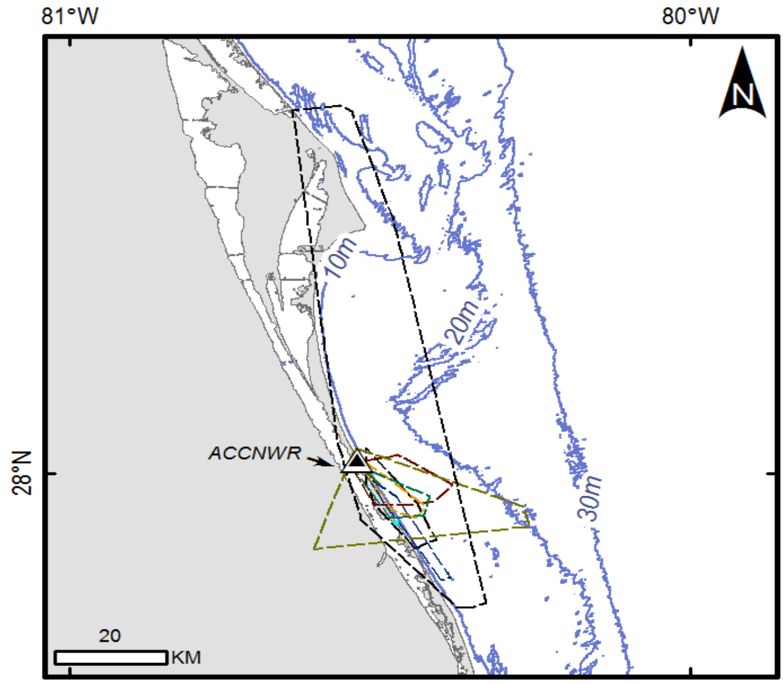


Figure 4. Internesting areas of females tracked from Archie Carr National Wildlife Refuge
Minimum convex polygons of post-nesting females tracked from the Archie Carr National Wildlife Refuge (ACNWR). Dashed lines contain the extent of positions collected from deployment until the initiation of the post-nesting migration. Each polygon represents a different individual animal. Bathymetric contours are shown in blue (10, 20, and 30 meters; B. Schroeder, NMFS unpublished data 2022).

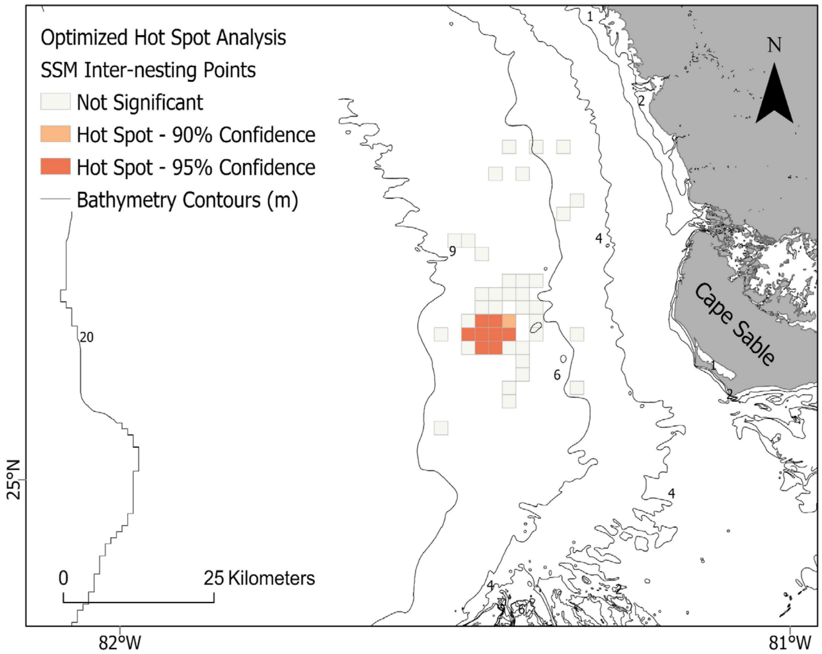


Figure 5. Internesting hotspot off Cape Sable, Florida

During the internesting period, six of eight females tracked from nesting beaches at Sanibel and Keewaydin Islands traveled to to an area approximately 30 km west of Cape Sable to forage and rest (Sloan *et al*. 2022)

Such depths and distances are similar to those used by internesting females throughout the North Atlantic DPS. Of the 26 females tracked from nesting beaches at Tortuguero, Costa Rica (within the range of the North Atlantic DPS but outside of U.S. jurisdiction), 19 remained within 4.8 km of shore and maximum depths of 24 m of depth; however, one individual moved 14.5 km offshore (Meylan 1982). Based on these data (i.e., the best available data on green turtle use of neritic waters during the reproductive period), we conclude that unobstructed neritic waters of up to 20 m depth, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date), are essential to mating adults and internesting females.

After hatching and moving from the beach to the water, post-hatchlings transit toward offshore habitats. This transit includes swim frenzy, directional movement, and early dispersal transport. To maximize their chances of survival during swim frenzy, post-hatchlings exhibit the greatest swimming speed (by exerting the greatest swim thrust) upon first entering the water (Booth 2009). Green turtle post-hatchlings swim continuously for at least 4 (Frick 1976) and up to 24 hours (Wyneken and Salmon 1992); however, their mean swim thrust decreases by about 30 percent after the first 2 hours of swim frenzy (i.e., the rapid fatigue phase; Booth 2009). The average swimming speed for green turtle post-hatchlings is 1.57 km per hour, based on the speeds of 24 post-hatchlings tracked for 0.68 to 6.48 km from shore (Frick 1976). After the swim frenzy and during their first week at sea, post-hatchlings alternate between daytime swimming and resting during the night (Wyneken and Salmon 1992; Mansfield *et al.* 2021). While this stage was once thought to consist of passive migration, based on sightings of post-hatchlings downcurrent from nesting beaches, passive drifter studies have shown that turtles engage in directional movement (i.e., active swimming) at this stage (Putman and Mansfield 2015). Post-hatchlings appear to move toward currents that then carry them to distant offshore pelagic habitats (Mansfield *et al*. 2021). Thus, early transit is considered to be a critical period because it plays an overriding role in population dynamics (Putman *et al.* 2020). Threats at this important stage include predation, obstructions, and artificial lighting on land. These threats are most likely to occur in shallow water (Gyuris 1994), or depths of up to 20 m, where post-hatchlings and predators are concentrated, most submerged or emergent structures occur, and land-based lighting appears the strongest. Furthermore, within 20 m depth, post-hatchlings are likely to encounter the currents needed to carry them to distant offshore pelagic habitats, where they will forage and rest in *Sargassum* habitats. Based on these data, we conclude that dark, unobstructed neritic waters of up to 20 m depth, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date), are essential to post-hatchlings' transit toward surface pelagic habitats.

4.2.1.2 Special Management Considerations or Protection

The Recovery Plan and its conservation objectives provide justification that the reproductive EF may require special management considerations or protection to maintain unobstructed access to and from nesting beaches and disturbance-free neritic areas for mating and internesting. The reproductive season is a time of increased vulnerability for sea turtles because a large proportion of adults concentrate within relatively small areas adjacent to nesting beaches (Meylan 1982). Copulating turtles may remain mounted for hours at the surface (Witherington *et al.* 2006), limiting their mobility, vigilance, and ability to avoid in-water obstructions or operations. Internesting females require underwater areas near nesting beaches to rest (Carr *et al.* 1974; Meylan 1982), escape courting males (Booth and Peters 1972), and to produce eggs for subsequent nesting (i.e., reovulation; Pearse and Avise 2001). Females and post-hatchlings need unobstructed waters to move to (females only) and from (both females and post-hatchlings) nesting beaches. Darkness is another important feature because artificial lighting can cause post-hatchlings to linger in nearshore habitats, which increases their risk of predation (Thums *et al.* 2016).

The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the destruction of habitats from oil and gas, dredging, fishing, and vessel activities. The reproductive EF may also require special management considerations from activities involving nearshore structures or operations, construction activities, beach renourishment and dredging, aquaculture, seismic surveys, and military activities. Nearshore structures or operations have the potential of blocking the passage of nesting females and post-hatchlings. They may constrain post-hatchlings' movement through several mechanisms, including: disorientation due to lighting, concentration of predators, disruption of wave patterns necessary for orientation, and creation of excessive longshore currents. Alternative energy facilities (such as wind farms and underwater turbines) and fishing, dredging (for beach renourishment, as mentioned above, and in support of navigation), and aquaculture activities may also block passage of females and post-hatchlings. Oil spills pose a considerable threat by obstructing or contaminating access to and from nesting beaches (Meylan 1982; Shigenaka *et al.* 2021). Construction (on land and in water), vessel traffic, military activities, and seismic surveys may also act as deterrents (visual or auditory) to reproductive individuals, preventing their use of preferred areas.

4.2.1.3 Areas Containing the Reproductive EFs

To identify areas containing the reproductive EFs essential to the conservation of the DPS, we used information on nesting beaches considered for proposed critical habitat designation by USFWS. USFWS selected nesting beaches within the geographical range of the DPS which have: (1) the highest nesting densities, (2) a good representation of total nesting, (3) a good spatial distribution (to ensure protection of genetic diversity), and (4) the inclusion of expansion areas - beaches adjacent to those with the highest density nesting.

Although green turtles nest on beaches throughout the southeastern United States, the vast majority of nesting occurs in Florida. Therefore, USFWS applied these criteria to nesting beaches in Florida, where nesting occurs in all coastal areas, except the Big Bend area of west central Florida. The bulk of nesting, however, occurs along the Atlantic coast of eastern central and south Florida. For the main nesting distribution within Florida, USFWS ranked nesting densities by distinct genetic subunits identified in Shamblin *et al.* (2015). USFWS selected high density nesting beaches and recovery beaches (i.e., the two upper quartiles) but also included small stretches of beach between high density and recovery beaches and allowed for 3.2 km of internesting distance. USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat within Florida and which will be published as a proposed rule in the Federal Register. For each of the nesting areas, we identified the associated marine area, from the shoreline to the 20 m depth contour, as containing the reproductive EFs essential to the conservation of the DPS that may need special management consideration or protection.

For Puerto Rico, USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat and which will be published as a proposed rule in the Federal Register. For each of the areas, we identified the associated marine area, from the shoreline (mean high water line) to 20 m depth, as containing the reproductive EFs essential to the conservation of the DPS and which may need special management consideration or protection.

4.2.2 Migration (reproductive)

The recovery of the DPS requires that adult turtles forage and reproduce. When foraging and reproductive areas are geographically separated, recovery also requires that adults successfully migrate between these areas.

4.2.2.1 Migratory EFs Essential to the Conservation of the North Atlantic DPS

The following migratory EF is essential to the conservation of the North Atlantic DPS: In depths up to 20 m, sufficiently unobstructed waters that allow for unrestricted transit between foraging and nesting areas for reproductive individuals.

To identify the migratory EF, we used the natural history summary for the species (Section 3) and additional information provided here for specificity. In the North Atlantic DPS, adults frequently use narrow, constricted migratory corridors to move between reproductive and foraging areas. Females generally remigrate biennially to mate and nest near their natal beaches (Bowen *et al.* 1992; Witherington *et al.* 2006); however, some individuals may switch nesting beaches between years (e.g., 3 of 11 satellite tracked individuals; Hart *et al.* 2013). Males may remigrate annually (Witherington *et al.* 2006), and mating site fidelity may be lower in males than females (Karl *et al.* 1992). During migration, turtles may also engage in mating and foraging behaviors (Karl *et al.* 1992; Roberts *et al.* 2004; Sloan *et al*. 2022; M. Lamont, USGS, pers. comm. 2022).

After mating (males) and nesting (females), adults generally migrate to foraging areas in southern Florida using nearshore waters. Post-nesting females (n = 19) and two adult males tracked from the ACNWR migrating to southern foraging sites remained primarily within 20 m depth (Schroeder *et al.* 2008; B. Schroeder, NMFS unpublished data 2022) and always in waters of less than 50 m depth (D. Bagley, University of Central Florida unpublished data 2016). Sloan *et al*. (2022) tracked eight females from nesting beaches at Sanibel and Keewaydin Islands (SW Florida) to southern foraging areas; on average, they spent 4 days migrating (range = 1-18) and remained in shallow waters, with a mean depth of 14.6, 8.3, and 8.0 m in 2017, 2018, and 2019, respectively (Sloan *et al*. 2022). Post-nesting females (n = 9) tracked from Casey Key migrated to southern foraging areas using waters of less than 20 m depth (K. Mazzarella, Mote Marine Laboratory unpublished data 2022). We conclude that during post-nesting migrations, adults generally remain in neritic waters and depths of less than 20 m.

4.2.2.2 Special Management Considerations or Protection

The migratory corridor may require special management considerations or protection to ensure that the passage of reproductive individuals is not obstructed, deterred, or disturbed. During migration, sea turtles that are otherwise spread out over many, and often distant, foraging sites become concentrated into relatively narrow corridors, making them particularly vulnerable to anthropogenic threats (Foley *et al.* 2013). While green turtles' foraging areas are less spread out compared to loggerhead foraging areas, their migratory corridors are similarly constrained. The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the degradation of habitats due to offshore structures, dredging, pollution, oil and gas, fishing, aquaculture, and vessel activities. In addition, energy generation activities may block passage or generate anomalous magnetic fields altering cues used by green turtles for navigation (Lohmann *et al.* 2004) and cause turtles to deviate from their course. Large structures or excessive noise from seismic surveys (Nelms *et al.* 2016), military, or vessel activities may force turtles off the most direct route, requiring longer migrations and using more energy.

4.2.2.3 Area Containing the Migratory EFs

To identify areas containing the migratory EFs essential to the conservation of the DPS, we reviewed available published and unpublished satellite tracking data. Of 15 turtles (nine females and six males) satellite tracked from the Archie Carr NWR between 2013 and 2015, 14 migrated to foraging areas in the Florida Keys/Florida Bay region; the other turtle was tracked to a foraging area in SE Florida (Chabot *et al*. 2021; D. Bagley, University of Central Florida unpublished data 2016). Sloan *et al*. (2022) tracked eight post-nesting females from Sanibel and Keewaydin Islands in SW Florida to foraging areas in the waters off Cape Sable, the Everglades, Marquesas Keys, Dry Tortugas, Florida Bay, and Brevard County (Figure 6). Eight of 11 post-nesting females tracked from Dry Tortugas National Park by Hart *et al*. (2013) migrated an average straight-line distance of 128.4 ± 74.2 km to the Florida Keys, Marquesas Keys, Biscayne Bay, Everglades, and waters off Cape Sable; however, three individuals remained resident, within 8.0 km of their nesting sites (Hart *et al.* 2013). An additional 13 females and two males tracked from Dry Tortugas National Park migrated to similar locations (K. Hart, USGS unpublished data 2014 and 2015).

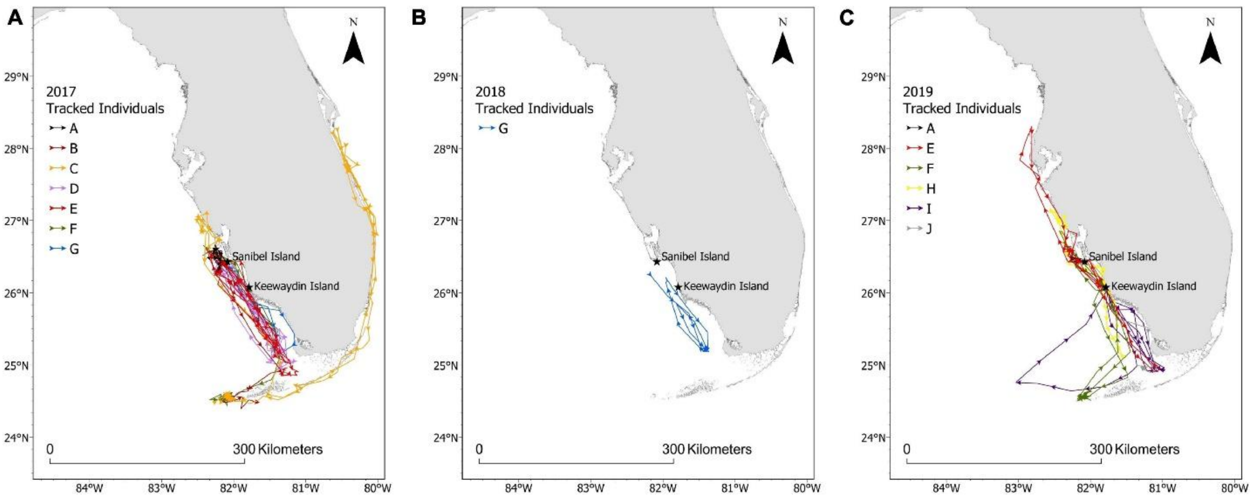


Figure 6. Migratory tracks of eight females tracked from Sanibel and Keewaydin Islands
Females migrated to foraging areas in southern Florida, including waters off Cape Sable, the Everglades, Florida Bay, and the Marquesas Keys (Sloan *et al*. 2022).

Available unpublished data demonstrate that most adults migrate from reproductive areas to these southern foraging areas (Figure 7). To identify areas containing the migratory EF, we compiled available unpublished tracking data:

- Post-nesting females (n = 19) tracked from Archie Carr NWR and two males tracked from St. Lucie County, Florida (Schroeder *et al.* 2008; B. Schroeder, NMFS unpublished data 2022)
- Post-nesting females (n = 6) and adult males (n = 8) tracked from Melbourne Beach and Archie Carr NWR (D. Bagley, University of Central Florida unpublished data 2016) and cited by Chabot (2018).
- Post-nesting females (n = 17) tracked from Casey Key (K. Mazzarella, Mote Marine Laboratory unpublished data 2022)
- Post-nesting females (n = 14) tracked from NW Florida (M. Lamont, USGS unpublished data 2022)
- Post-nesting females (n = 12; 2 in US waters) tracked from nesting beaches of the Yucatan Peninsula, Mexico (M. Lopez, ProNatura unpublished data 2022).

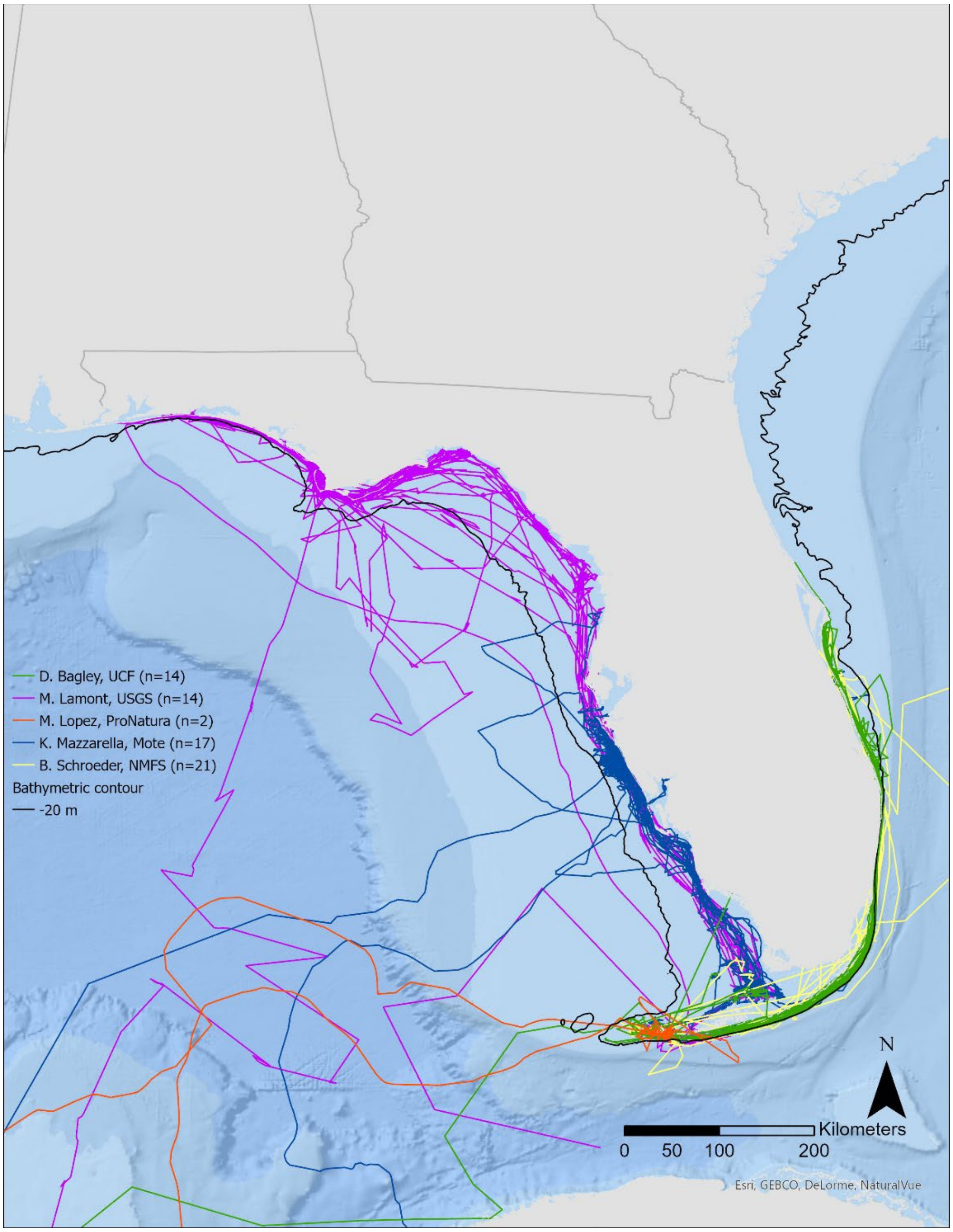


Figure 7. Migratory tracks from Florida reproductive areas to foraging areas

Purple lines represent movement of 14 post-nesting females tracked from NW Florida (M. Lamont, USGS unpublished data 2022); blue lines represent movement of 17 post-nesting females tracked from Casey Key (K. Mazzarella, Mote Marine Laboratory unpublished data 2022); orange lines represent movement of 2 post-nesting females tracked from the Yucatan Peninsula, Mexico (M. Lopez, ProNatura unpublished data 2022); yellow lines represent movement of 19 post-nesting females tracked from Archie Carr NWR and two males tracked from St. Lucie County, Florida (Schroeder *et al.* 2008; B. Schroeder, NMFS unpublished data 2022); and green lines represent movement of six post-nesting females and eight adult males tracked from Melbourne Beach and Archie Carr NWR (D. Bagley, University of Central Florida unpublished data 2016). Black line represents the 20 m bathymetric contour.

Based on these data, we determined that the entire Florida coast, in depths up to 20 m, contain the migratory EF, connecting reproductive areas along the east and west coast of Florida to foraging areas in Monroe County, Florida. On the eastern coast, they likely avoid the northward flowing Gulf Stream and possibly use southward flow, nearshore counter currents, similar to loggerhead turtles (Foley *et al.* 2013). We conclude that these areas contain the migratory EFs essential to the conservation of the DPS that may require special management considerations or protections.

Unlike adult green turtles in Florida, adults originating in Puerto Rico do not appear to use constricted migratory corridors to move between nesting and foraging areas. Long-distance captures of adults tagged at Culebra reveal the use of multiple pathways. Therefore, we are unable to identify any areas containing the migratory EFs in Puerto Rico.

4.2.3 Foraging/Resting (post hatchlings and surface-pelagic juveniles)

The recovery of the DPS requires successful survival, growth, and development of early life stages. After their swim frenzy and early dispersal, post-hatchlings of the North Atlantic DPS are transported via ocean currents to habitats that provide adequate food resources and cover, such as *Sargassum*-dominated drift communities. Green turtles likely remain in such habitats throughout their surface-pelagic juvenile stage.

<u>4.2.3.1 Foraging and Resting EFs Essential to the Conservation of the North Atlantic DPS</u>

The following foraging and resting EFs are essential to the conservation of the North Atlantic DPS: Convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, and other areas that result in concentrated components of the *Sargassum*-dominated drift community, as well as the currents which carry turtles to *Sargassum*-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements.

To identify the surface-pelagic foraging and resting EFs, we used information on the life history of the species (Section 3). In addition, we used the following information to provide additional specificity. After their swim frenzy and early dispersal, post-hatchling turtles become associated with *Sargassum* mats, which are carried (along with the turtles) to surface-pelagic areas with high concentrations of *Sargassum* spp. For this reason, it was important for us to capture the Sargassum habitats that occur nearshore (i.e., easily accessed by post-hatchling turtles), which we defined as areas starting at 10 m depth (to avoid the Sargassum mats that wash up on shore and would not be carried by currents to appropriate surface-pelagic habitats).

Post-hatchling and surface-pelagic juvenile green turtles of the North Atlantic DPS appear to occupy and move with the surface currents for several years before recruiting to neritic habitats for benthic-foraging habitats (Carr and Meylan 1980). For example, some post-hatchlings from eastern Florida beaches likely move into the Gulf Stream, are transported into the North Atlantic gyre, and may be returned to neritic areas by the North Equatorial Current (Witham 1980; Bass *et al.* 2006). Others depart the gyre, such that the Gulf Stream is an initial mode of dispersal but does not necessarily move post-hatchlings across the Atlantic Ocean, but instead inhabit the Sargasso Sea (Mansfield *et al*. 2021). Within the Gulf of Mexico, green turtle recruitment along the West Florida Shelf may fluctuate depending upon the state of the Loop Current and hatchling production at distant nesting sites (Putman *et al.* 2020). In all scenarios, surface-pelagic foraging and resting EFs are associated with *Sargassum* habitats, which provide structured habitat, rich food supply, refugia for rest and predator protection, and thermal benefits promoting growth and feeding (Mansfield *et al*. 2021).

A growing number of studies provide information on the location, diet, and behavior of post-hatchlings and surface-pelagic juveniles of the North Atlantic DPS (Putman and Mansfield 2015; Hardy *et al.* 2018; Mansfield *et al.* 2021). Post-hatchlings and surface-pelagic juveniles associate with *Sargassum*-dominated drift communities within the western North Atlantic, Caribbean Sea, and Gulf of Mexico between the latitudes of 20° and 40° N (Carr and Meylan 1980; Butler *et al.* 1983; Butler and Stoner 1984; Carr 1987; Witherington *et al.* 2012). Pelagic *Sargassum* (mainly *S. natans* and *S. fluitans)* is a rugged, highly branched macroalgae buoyed by pneumatocysts and lacking holdfasts (Witherington *et al.* 2012). *Sargassum* and other flotsam can be arranged within long linear or meandering rows collectively termed "windrows," a result of Langmuir circulations, internal waves, and convergence zones along fronts. When currents and winds are negligible, *Sargassum* is also found in broad irregular mats or scattered patches (Comyns *et al.* 2002; SAFMC 2002). Mats, scattered patches, and drift lines of *Sargassum* provide habitat for early life-stage green turtles and their prey items (Witherington *et al.* 2012). *Sargassum* that occurs in the surf zone or close to shore may not provide the essential EFs; whereas *Sargassum*-dominated drift communities occurring in depths of 10 m and greater provide sufficient food resources and refugia and aids in offshore transport. Such depths overlap with benthic foraging areas to facilitate the developmental transition from surface-pelagic to benthic foraging.

Post-hatchling and surface-pelagic green turtles forage primarily on the animals within the *Sargassum*-dominated drift communities, including invertebrates, fish eggs, and insects (Witherington *et al.* 2012). In their surveys of *Sargassum*-dominated drift communities, Witherington *et al*. (2012; FWC, unpublished data 2019) observed 17 post-hatchling green turtles and 195 surface-pelagic juvenile green turtles, 1 or 2 years of age, within one meter of *Sargassum.* Of those for which behavior data were available in the published survey (13 post-hatchlings and 67 surface-pelagic juveniles), all post-hatchlings and many (57 percent) surface-pelagic juveniles were performing activities (i.e., breathing, swimming, or moving their front flippers) consistent with foraging (Witherington *et al.* 2012). The turtles appeared to use the *Sargassum* itself principally as habitat (i.e., although they consume *Sargassum*, this may be incidental to their targeting of animals located within the plant material; Witherington *et al.* 2012). In addition to providing a rich food supply and structured habitat, *Sargassum* provides predator protection and thermal benefits that promote growth, i.e., exposure to direct sunlight and/or localized warming facilitates temperature-dependent processes including digestion and growth (Mansfield *et al.* 2021). Post-hatchling green turtles selectively use and burrow into *Sargassum* for these purposes (Smith and Salmon 2009).

4.2.3.2 Special Management Considerations or Protection

The foraging and resting EFs used by post-hatchling and surface-pelagic juvenile green turtles may require special management considerations or protection to maintain the food resources and refugia provided by the *Sargassum*-dominated drift community. The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the degradation of habitats from oil and gas activities and pollution. In addition, the EFs may require special management considerations for the commercial harvest of *Sargassum,* anthropogenic marine debris (including debris removal activities), and impacts due to climate change.

The surface convergence zones that aggregate *Sargassum*-dominated drift communities also aggregate pollutants (Wallace *et al.* 2020; Shigenaka *et al.* 2021). Witherington *et al*. (2012) found that at least 67 percent of surveyed post-hatchling and surface-pelagic juvenile turtles ingest plastic material, which can cause blockage in the gut, dilutes the nutritional contribution of the diet, and/or increase the risk of entanglement. Rice *et al*. (2021) examined 380 post-hatchling turtles that were beachcast along Florida's central Atlantic coast during periods of strong shoreward winds; 78.7 percent of turtles had ingested plastics. They also observed a negative correlation between turtle body condition and plastic load suggesting that plastic ingestion results in diminished nutrition which may have population-level impacts (Rice *et al.* 2021). The frequent co-occurrence of *Sargassum* and marine debris within the pelagic environment may require special consideration when planning marine debris removal activities. At-sea marine debris removal often focuses on collection of materials at or near the sea surface. Such activity could negatively impact *Sargassum* habitat used by sea turtles.

Oil exploration, production, and associated spills are major concerns because post-hatchling and surface-pelagic juvenile sea turtles within *Sargassum*-dominated drift communities become fouled in oil or exposed to oil through inhalation or ingestion (McDonald *et al*. 2017; Wallace *et al.* 2020; Shigenaka *et al.* 2021). The cleanup of oil spills may also introduce toxic chemicals (Ylitalo *et al.* 2017). Powers *et al*. (2013) described direct and indirect effects of the *Deepwater Horizon* oil spill on the *Sargassum*-dominated drift communities as follows: (1) the *Sargassum* accumulated oil on the surface exposing animals to high concentrations of contaminants; (2) application of a dispersant sank the *Sargassum*, thus removing the habitat and potentially transporting oil and dispersant vertically; and (3) low oxygen surrounded the habitat potentially stressing animals that reside in the algae. This oil spill was estimated to impact 148,000 surface-pelagic turtles (McDonald *et al.* 2017). Other sources of pollution include ocean dumping, vessel discharges, and dredging (e.g., from disruption of contaminated sediment). In addition, hull fouling and ballast water exchange may result in the introduction or transfer of non-native species, which may outcompete native species within *Sargassum*-dominated drift communities.

The commercial harvest of *Sargassum* would directly reduce the availability of *Sargassum*-dominated drift communities. The Fishery Management Plan for Pelagic *Sargassum* Habitat of the South Atlantic Region provides guidelines for the harvest of pelagic *Sargassum* (68 FR 57375, October 3, 2003). The guidelines restrict the total allowable harvest of *Sargassum* to 5,000 pounds per year, collected during the months of November to June and from areas 100 miles off the shores of States north of South Carolina. At the time of the Fishery Management Plan development, a *Sargassum* fishery was proposed; however, establishment of the fishery did not occur, and no such fishery currently exists.

The impacts of climate change (including temperature increases and ocean acidification) are likely to alter the conditions (such as currents and other oceanographic features) that allow *Sargassum*-dominated drift communities to thrive and support green turtle development (Koch *et al.* 2013). The impacts of climate change are not easily ameliorated; however, there is a global effort to limit future greenhouse gas emissions (e.g., the Paris Agreement; UNFCCC, December 12, 2015).

4.2.3.3 Area Containing the Foraging and Resting EFs

Sargassum-dominated drift communities occur where surface waters converge to form local downwelling (Wallace *et al.* 2020; Shigenaka *et al.* 2021). They are common in the Gulf of Mexico and the northwest Atlantic Ocean. As post-hatchlings and surface-pelagic juveniles, green turtles occupy the same *Sargassum*-dominated drift communities as other species, including the loggerhead sea turtle (Witherington *et al*. 2012). Therefore, we incorporated by reference the information on the abundance, distribution, and persistence of *Sargassum*-dominated drift communities as described in the Biological Report on the Designation of Marine Critical Habitat for the Loggerhead Sea Turtle, *Caretta caretta* (NMFS 2013). During that report's preparation, the extent of *Sargassum* habitat was guided by contemporary synoptic estimates of its distribution (Gower and King 2011). Loggerhead *Sargassum* critical habitat was designated for two areas containing the EFs: the Atlantic Ocean from the Gulf of Mexico along the northern/western boundary of the Gulf Stream and east to the outer edge of the U.S. EEZ; and the western Gulf of Mexico to the eastern edge of the Loop Current (71 FR 39856, July 10, 2014; Figure 8). At the time that loggerhead critical habitat was designated, limited data were available on loggerhead EFs in the eastern Gulf of Mexico. Data available since then indicate that surface-pelagic foraging/resting EFs for green turtles occur throughout the Gulf, including waters of the eastern Gulf of Mexico (Figure 9; Hardy *et al*. 2018) and in particular along the West Florida Shelf (Putman and Mansfield 2015).

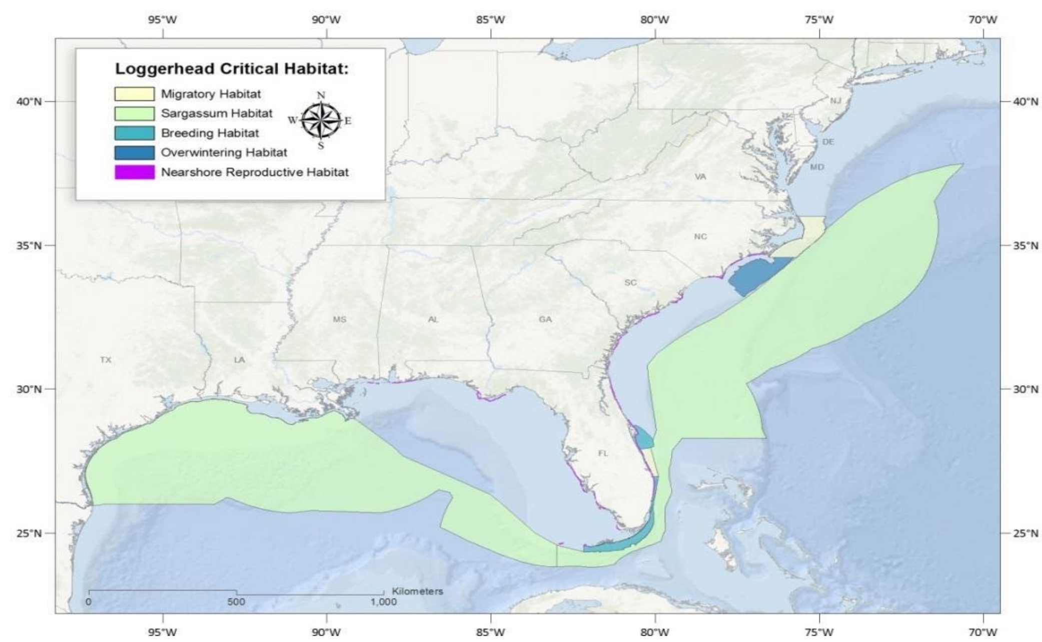
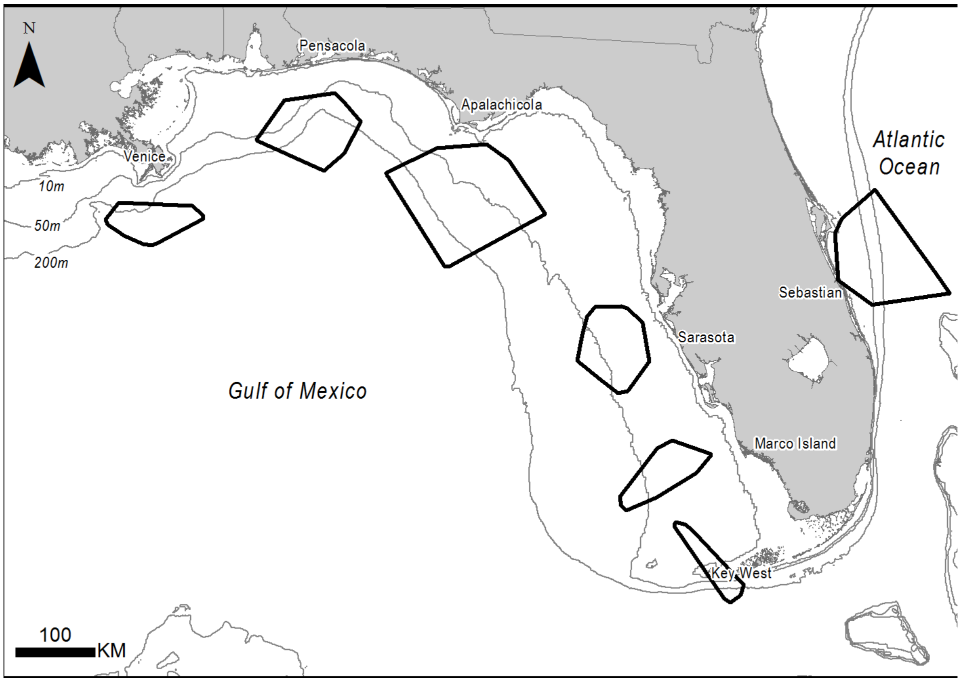


Figure 8. Sargassum critical habitat for the loggerhead sea turtle
Light green indicates *Sargassum* habitat (71 FR 39856, July 10 2014)



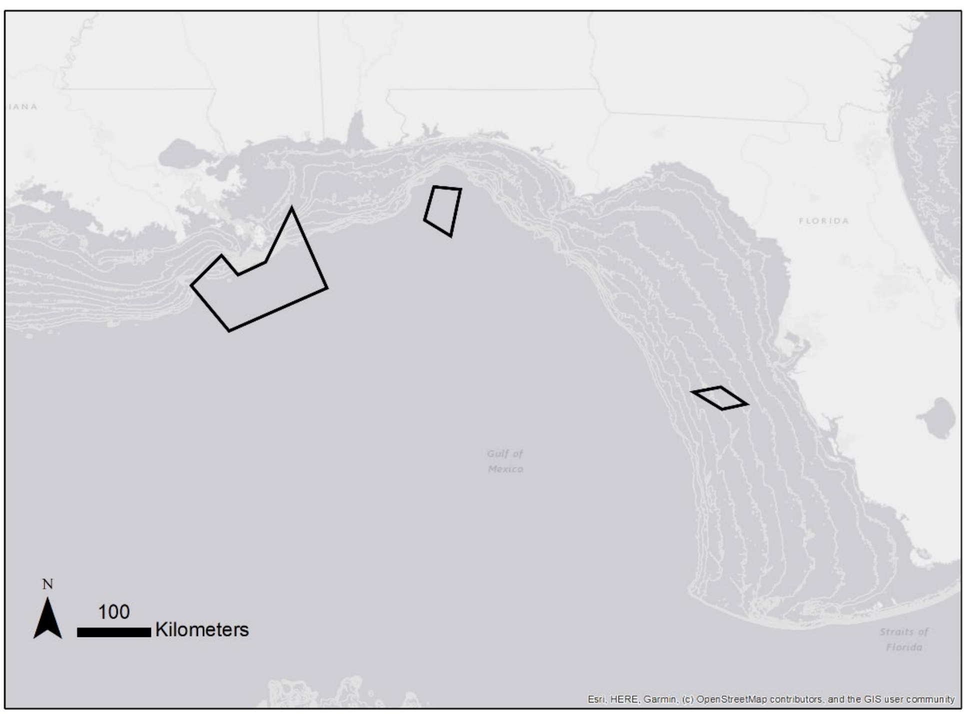


Figure 9. Surface-pelagic juvenile green turtle observations

Top figure: black outlines show study areas in the Gulf of Mexico and Atlantic Ocean where surface-pelagic green turtles have been observed (Witherington *et al.* 2012a; Hardy *et al.* 2018); bottom figure: black outlines show study areas in the Gulf of Mexico where surface-pelagic green turtles have been captured and sampled; light gray lines show bathymetry < 100m (Mansfield and Putman 2015; Phillips *et al*., University of Central Florida unpublished data 2022).

As shown above, the eastern Gulf of Mexico contains the EFs, as demonstrated by the presence of surface-pelagic juvenile green turtles (Witherington *et al*. 2012a) and *Sargassum* habitat (Putman and Mansfield 2015; Hardy *et al.* 2018). Witherington *et al*. (2012a; unpublished data 2019) observed 195 surface-pelagic juvenile green turtles associated with *Sargassum*-dominated drift communities in the eastern Gulf of Mexico, 18 of which were tracked via satellite transmitters. A majority of those individuals remained within the northeastern Gulf of Mexico, while five individuals departed the Gulf of Mexico and followed the Gulf Stream System into North Atlantic waters (FWC, unpublished data 2019). Putman and Mansfield (2015) captured 24 surface-pelagic juvenile green turtles in the offshore northern and eastern Gulf of Mexico: Cortez, Sarasota, Panama City, and Pensacola, Florida; Orange Beach, Alabama; and Venice, Louisiana. Other studies have identified increasing numbers of surface-pelagic juveniles throughout the northern and eastern Gulf of Mexico and Atlantic Ocean (Hardy *et al*. 2018; Mansfield and Phillips in review); some of these juveniles are carried via the Loop Current, Straits of Florida, and Gulf Stream into the North Atlantic (Mansfield and Phillips in review).

Green turtles are also found in *Sargassum*-dominated drift communities of the northwest Atlantic Ocean, where Witherington *et al*. (2012a; Witherington and FWC unpublished data 2019) observed 17 post-hatchlings. Mansfield *et al*. (2021) satellite-tracked 21 surface-pelagic green turtles (3 to 9 months old) from Boca Raton, FL, to waters associated with the Sargasso Sea, via the Gulf Stream (Figure 10). Prior to exiting the U.S. EEZ, most turtles remained in oceanic waters, off the Continental Shelf (greater than 200 m depth; Mansfield *et al*. 2021), within the *Sargassum* critical habitat designated for loggerheads. Therefore, the "*Sargassum*" area in the Atlantic, designated for loggerheads, also contains the EFs essential to the conservation of green turtles.

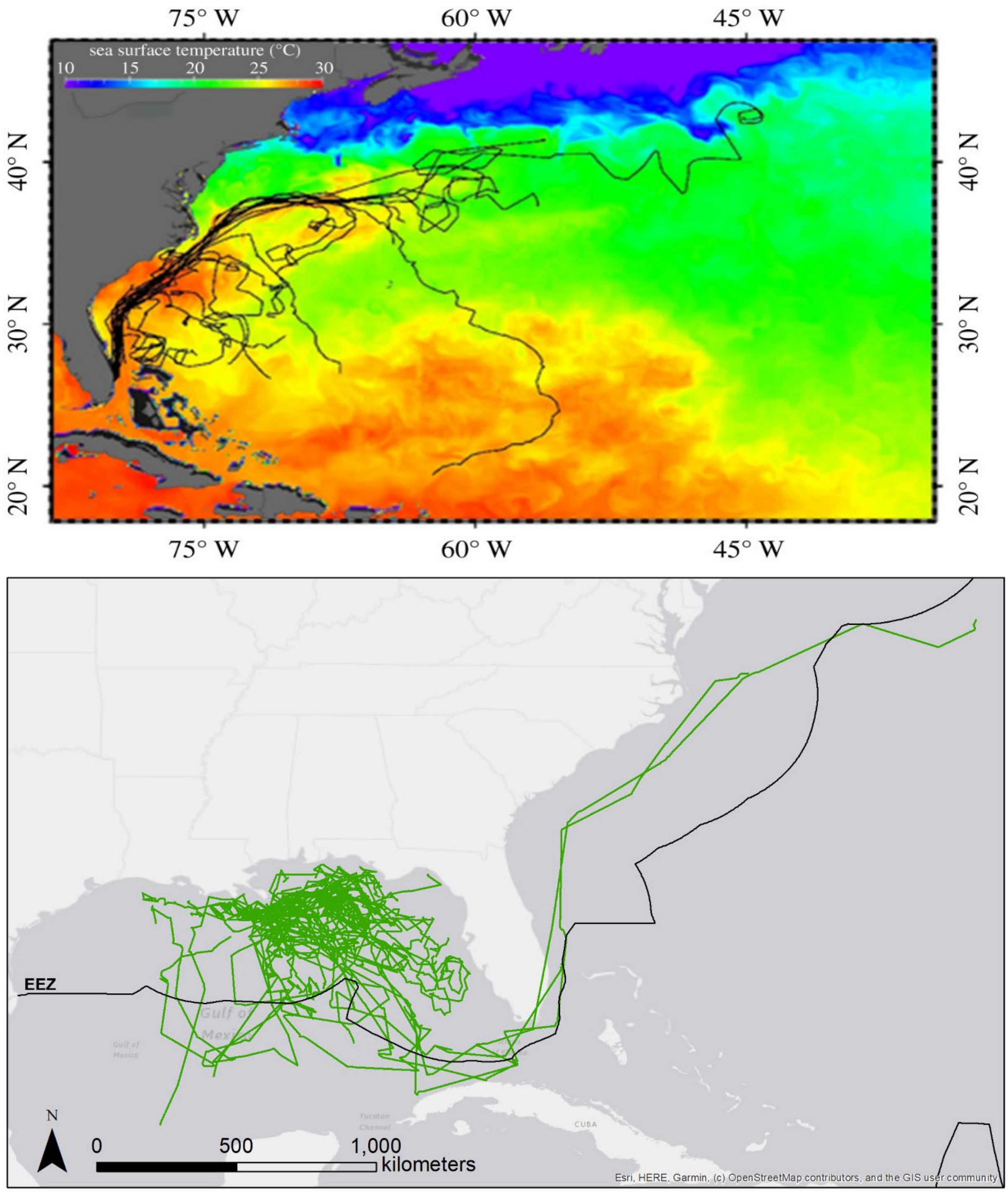


Figure 10. Satellite tracking of surface-pelagic juveniles in the Atlantic Ocean

Top figure shows black lines representing 21 tracked green turtles, reared in the laboratory and released in the western Atlantic ([Mansfield *et al*. 2021]); bottom figure shows green lines representing tracks from 70 wild-caught green turtles, captured and released in the Gulf of Mexico from 2012 to 2021; black line represents the US EEZ (Mansfield and Putman 2015, Phillips *et al*., University of Central Florida unpublished data 2022).

U.S. waters of the Gulf of Mexico and Northwest Atlantic Ocean lie downstream of or adjacent to major sea turtle rookeries in the region. The Caribbean, Loop, and Gulf Stream currents transport *Sargassum* and sea turtles from nesting beaches through the Gulf of Mexico and NW Atlantic. Major green turtle rookeries are found upstream, within this current system, at Tortuguero, Costa Rica, the Bay of Campeche, Mexico, Yucatan Peninsula, Mexico, and Aves Island, Venezuela. Genetic mixed stock analyses of surface-pelagic juvenile green turtles from the northeast Gulf of Mexico found that turtles in the area originated from Bay of Campeche and Caribbean nesting beaches (Shamblin *et al.* 2018). Phillips *et al*. (in review) found similar results but also demonstrated higher connectivity between the Bay of Campeche and surface-pelagic areas off Louisiana and between Quintana Roo and areas off Cortez, Florida. Direct observations of green turtles, genetic findings, the position of the eastern Gulf of Mexico within the Gulf Stream System relative to green turtle rookeries and the year-round presence of *Sargassum* in the area suggests that green turtles use the northeastern Gulf of Mexico during their surface-pelagic juvenile developmental stage (Hardy *et al*. 2018).

Based on these data, which we considered to be the best available scientific data, we concluded that the Atlantic and Gulf of Mexico *Sargassum*-dominated drift communities in greater than 10 m depth contain the surface-pelagic foraging and resting EFs essential to the conservation of the North Atlantic DPS that may require special management considerations or protection.

4.2.4 Foraging and Resting EFs (benthic juveniles, subadults, and adults)

The recovery of the DPS requires the success of multiple life stages, including benthic-foraging juveniles, subadults, and adults. After their surface-pelagic juvenile stage, green turtles recruit to benthic-foraging habitats that provide adequate food resources and cover from predators, which allow successful survival, growth and development to maturity. Adults require adequate long-term residence areas, which include food resources and adjacent refugia, to provide the energy needed to survive, migrate to nesting beaches, and reproduce.

4.2.4.1 Foraging and Resting EFs Essential to the Conservation of the North Atlantic DPS

The following foraging and resting EFs are essential to the conservation of the North Atlantic DPS: In waters up to 20 m depth, underwater refugia (such as sandy troughs, hard-bottom substrates, and Sabellariid worm reefs) and food resources (i.e., seagrass, marine algae, and/or invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, and growth of benthic-foraging juveniles and survival and reproduction of adults.

To identify the benthic foraging and resting EFs, we used the natural history summary for the species (Section 3), satellite tracking data, in-water data, and the following additional information. After recruiting from *Sargassum*-dominated drift communities, juvenile green turtles of the North Atlantic DPS forage in benthic developmental habitats, including coral and nearshore reefs, seagrass beds, inshore bays, estuaries (Ehrhart 1983; Guseman and Ehrhart 1990; Wershoven and Wershoven 1992; Bresette *et al.* 1998; Ehrhart *et al.* 2007; Meylan and Meylan 2011), man-made embayments (Redfoot and Ehrhart 2000), and passes (Shaver 1994). Benthic-foraging juveniles may use shallower foraging and resting areas than adults (Witherington *et al.* 2006; Meylan and Meylan 2011) and move to deeper habitats as they mature

(Bagley *et al.* 2008; Reich *et al.* 2008; Vander Zanden *et al.* 2013). During this stage of development, juveniles feed primarily on seagrass (e.g., *Thalassia testudinum, Syringodium filiforme*, *Halodule wrightii,* and *Zostera marina*; Mendonça 1983), benthic macroalgae (e.g., *Gracilaria mammillaris*, *Bryothamnion seaforthii, Laurencia poiteau*, *Ulva* spp., and *Hypnea* spp.; (Bjorndal 1980; Mortimer 1981; Bellmund *et al.* 1987; Coyne 1994; Shaver 1994; Redfoot 1997; Makowski *et al.* 2006; Kubis *et al.* 2009; Vander Zanden *et al.* 2013), and/or invertebrates (Mendonça 1983; Bjorndal 1990; Makowski *et al.* 2006; Stringell *et al.* 2016; Holloway-Adkins *et al*. 2017). Turtles generally occur where there are sufficient food resources (Witherington *et al.* 2006); however, there is a complex relationship between food availability and juvenile abundance and growth rates (Long *et al.* 2021). An 18-year study of juvenile green turtles in the Indian River Lagoon revealed: 1) a sharp decline in seagrass cover; 2) varying trends in macroalgae cover; and 3) a decline in juvenile green turtle abundance but stable growth rates. Long *et al*. (2021) concluded that additional factors, such as nutrient pollution and predation, may be impacting juvenile foraging in this area. Some turtles forage on multispecies assemblages of turf algae, which likely provide a diverse, abundant, and stable food source (Stadler *et al.* 2015). Individuals may specialize on a particular forage item and develop specialized fermentive gut microflora that are able to efficiently digest either the cellulose of seagrasses or the complex carbohydrates of macroalgae (Bjorndal 1980). In addition to their herbivorous diet, green turtles appear to forage on invertebrates. Stringell *et al*. (2016) report that 28 percent of green turtles sampled (n = 91) ingested 8 different species of sponges that are found in relatively small proportions (i.e., biomass) in the foraging habitat. In addition, three percent of green turtles in the study also ingested cnidarians and "other invertebrates" (Stringell *et al.* 2016). Holloway-Adkins and Hanisak (2017) found that juveniles commonly foraged on benthic invertebrates, including polychaetes, hydrozoa, and gastropods.

Juveniles of the North Atlantic DPS preferably forage on stable reefs (i.e., uncovered by sand) located in shallow water, exposed to bright ambient light, where algae and seagrass are abundant and include many species (Stadler *et al.* 2015). Juveniles also forage on smaller patches of marine algae and seagrass, and some may prefer low or medium-density seagrass beds (Dawes *et al.* 2004; A. Meylan, FWC pers. comm. 2016). They appear to maintain “grazing plots” by consistently recropping seagrass to create more digestible forage that is higher in protein and lower in lignin than that found in ungrazed seagrass beds (Bjorndal 1980); Moran and Bjorndal 2007; Bresette *et al.* 2010). Juvenile green turtles occupy small, stable home ranges, where they forage and rest in one or two exclusive sites (Mendonça 1983; Makowski *et al.* 2006). The depths at which juveniles forage and rest differs throughout their range and is dependent on the depth of available food resources. Seagrasses, for example, need light and are generally limited to depths where at least 20 percent of surface irradiance reaches the seafloor; this depth varies among sites as a function of water clarity (Dixon 1999; P. Carlson, FWC, pers. comm. 2016).

The EFs may include algae or seagrass growing on manmade structures, such as docks, seawalls, piers, pipelines, boat ramps, platforms, ramparts, pilings, and jetties. This includes algae in the Trident Submarine Basin (Kubis *et al.* 2009; Holloway-Adkins and Hanisak 2017) and on jetties in southeast Texas (Shaver 1994; Metz and Landry 2013; Shaver *et al.* 2013), where studies have shown that food resources are in sufficient condition, abundance, and density to support survival, development, and growth of benthic-foraging juveniles.

In addition to productive foraging grounds, green turtles need access to protective resting areas. Because they are vulnerable to predation and tidal exposure, they seek refugia in Sabellariid worm reefs (Stadler *et al.* 2015), nearshore reef ledges (Guseman and Ehrhart 1990; Ehrhart and Witherington 1992; Wershoven and Wershoven 1992), or other shallow-water areas that are inaccessible to sharks (Bresette *et al.* 2010). When resting, turtles often wedge their head and body under ledges along the reef (Makowski *et al.* 2006; Mott and Salmon 2011; Stadler *et al.* 2015). Hart *et al*. (2016) found that six of 11 juvenile turtles equipped with tri-axial acceleration data loggers near the Dry Tortugas made excursions to deep waters (4 to 27 m) for rest, often at night. Makowski *et al*. (2006) found that turtles rested only during nocturnal hours, avoiding marine predators and sleeping underneath the same patch reefs upon which they actively foraged. Renaud *et al.* (1995) also reported daytime foraging and nocturnal resting. However, Mendonça (1983) observed juvenile green turtles within Mosquito Lagoon, Florida, actively feeding on shallow (0.5 to 1.0 m) seagrass flats in mid-morning and mid-afternoon, with resting occurring in deeper waters (2.0 to 2.5 m) during the mid-day hours. Mott and Salmon (2011) suggest that turtles use solar cues to move offshore toward deep water reefs to escape threats; they return to shallow foraging areas after several hours.

As juveniles mature, they forage in deeper waters (3 to 27.3 m; In-water Research Group 2008; Bresette *et al.* 2010; FWC and NMFS unpublished data 2016) and may occupy a more narrow range in southern Florida, including the Florida Keys, Marquesas Keys, and Dry Tortugas (Witherington *et al.* 2006; Bresette *et al.* 2010). Adult and subadult turtles may forage in herds to provide increased vigilance of large predators, such as sharks that also forage at these depths, or to increase grazing maintenance of seagrasses, which provides food resources that are higher in nutrition and easier to digest (Bjorndal 1980; Moran and Bjorndal 2007; Bresette *et al.* 2010).

4.2.4.2 Special Management Considerations or Protection

The foraging and resting EFs may require special management considerations or protection to maintain the food resources and refugia in neritic waters. The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the degradation of habitats due to dredging, pollution, oil and gas, fishing, and vessel activities. The Recovery Plan specifically highlights the need to restore and limit further development in important foraging habitats (e.g., seagrass beds, which are relatively fragile habitats requiring low energy and low turbidity waters; NMFS and USFWS 1991).

Seagrass habitats are among the most threatened ecosystems on earth (Waycott *et al.* 2009). Since 1980, seagrass beds have disappeared at a rate of 110 km^2/year (Waycott *et al.* 2009). The reductions are mainly due to declines in water quality and other human impacts (Orth *et al.* 2006). Between 2011 and 2019, ~19,000 hectare or ~58 percent of seagrasses were lost from the Indian River Lagoon, coinciding with intense blooms of phytoplankton (Morris *et al.* 2022). Field *et al.* (2021) observed a net seagrass loss of 5.6 percent (34.2 percent decrease in continuous but 18.4 percent increase in patchy seagrass) in the Albemarle-Pamlico Estuarine System, NC, between 2006 and 2013. Substantial reductions of seagrass beds have also occurred in Tampa Bay (Morrison and Greening 2011) and throughout the Gulf of Mexico (Handley *et al.* 2007), as a result of climate and water-level variations, physical removal or damage, smothering with sediments, light extinction resulting from turbidity or phytoplankton, and inputs of excess nutrients and storm events (Fourqurean *et al.* 2001; Dawes *et al.* 2004)(Fourqurean *et al.* 2001; Dawes *et al.* 2004). However, recent improvements in water quality have resulted in more than 45,295 acres of seagrass beds in Tampa Bay (Southwest Florida Water Management District 2022). Climate change is likely to alter seagrass habitat distribution, reproduction, and growth rates (Short and Neckles 1999; Morrison and Greening 2011; Zimmerman 2021).

Dredging activities (including channelization, sand mining, and dredge fisheries) may remove, bury, or inhibit the growth of important food resources and destroy or disrupt resting areas. In Texas, turtles using jetties and channel entrances are likely to be affected by dredging activities that remove foraging resources and alter refugia (Renaud *et al.* 1995). Landry *et al.* (1992) indicate that maintenance dredging around South Padre Island, Texas poses a direct threat to green turtles through destruction of their foraging and resting areas.

Beach nourishment may reduce the availability of food resources (especially seagrass) and destroy underwater refugia (especially Sabellariid worm rock reefs) by covering these nearshore hard bottom areas in sand (NMFS 2008). For example, sand placement projects along parts of the Florida coastline bury the reef habitat and food resources required by green turtles (Lindeman and Snyder 1999). These alterations may have lasting effects because turtle abundance is linked to reef stability. Foraging and resting turtles are most abundant on nearshore worm rock reefs with little change in reef area (and rarely covered by sand) over a decade (Stadler *et al.* 2015).

Vessel activities may also reduce or interfere with the availability of food resources. For example, propellers scar seagrass beds throughout the coastal waters of Florida. The most severe scarring occurs in areas where green turtles are known to forage, such as the Florida Keys and north Indian River Lagoon (Sargent *et al.* 1995).

Pollution also reduces the quality and availability of food resources. Oil and gas activities may reduce the quality and quantity of food resources, especially if an oil spill occurs. Other sources of pollution include construction, runoff, dumping, and aquaculture waste. For example, coastal lagoons in Florida, such as the Indian River Lagoon, may expose green turtles to high levels of pollutants as a result of agricultural and residential runoff (Hirama and Ehrhart 2007). Pollution can also diminish water clarity and light availability, which may reduce the growth and availability of seagrass and algae and reduce turtles' visibility for turtles, which impacts their ability to forage and avoid predators (Long *et al.* 2021). Increased nutrient load in these coastal waters causes eutrophication, which is linked to harmful algal blooms that result in the loss of seagrass beds and macroalgae cover (Milton and Lutz 2003; Long 2021), resulting in changes to green turtle foraging ecology that last beyond the harmful algal bloom event (Long 2021). Such environmental degradation is also linked to increased incidence of fibropapillomatosis (Borrowman 2008), which was one of the factors identified in the listing of the North Atlantic DPS (81 FR 20057, April 6, 2016). In a study of green turtles in the Indian River Lagoon, Florida, which has poor water quality due to runoff and attenuation of pollutants, Florida, nearly every individual becomes infrected with fibropapillomatosis upon recruitment to the area; however, most recover as they mature (Kelley *et al.* 2022).

Finally, fishing and other activities within the vicinity of foraging and resting areas may alter the behavior of green turtles. For example, scallop recreational fisheries appear to temporarily reduce the core and home range of green turtles in response to increased human and boat presence (Wildermann *et al.* 2020).

4.2.4.3 Areas Containing the Foraging and Resting EFs

To identify areas containing the foraging and resting EFs, we considered the best available data by State(s) or Territory. We first identified areas containing refugia and food resources, especially seagrass cover (Figure 11), which has been mapped (maps of algae and invertebrates are not available).

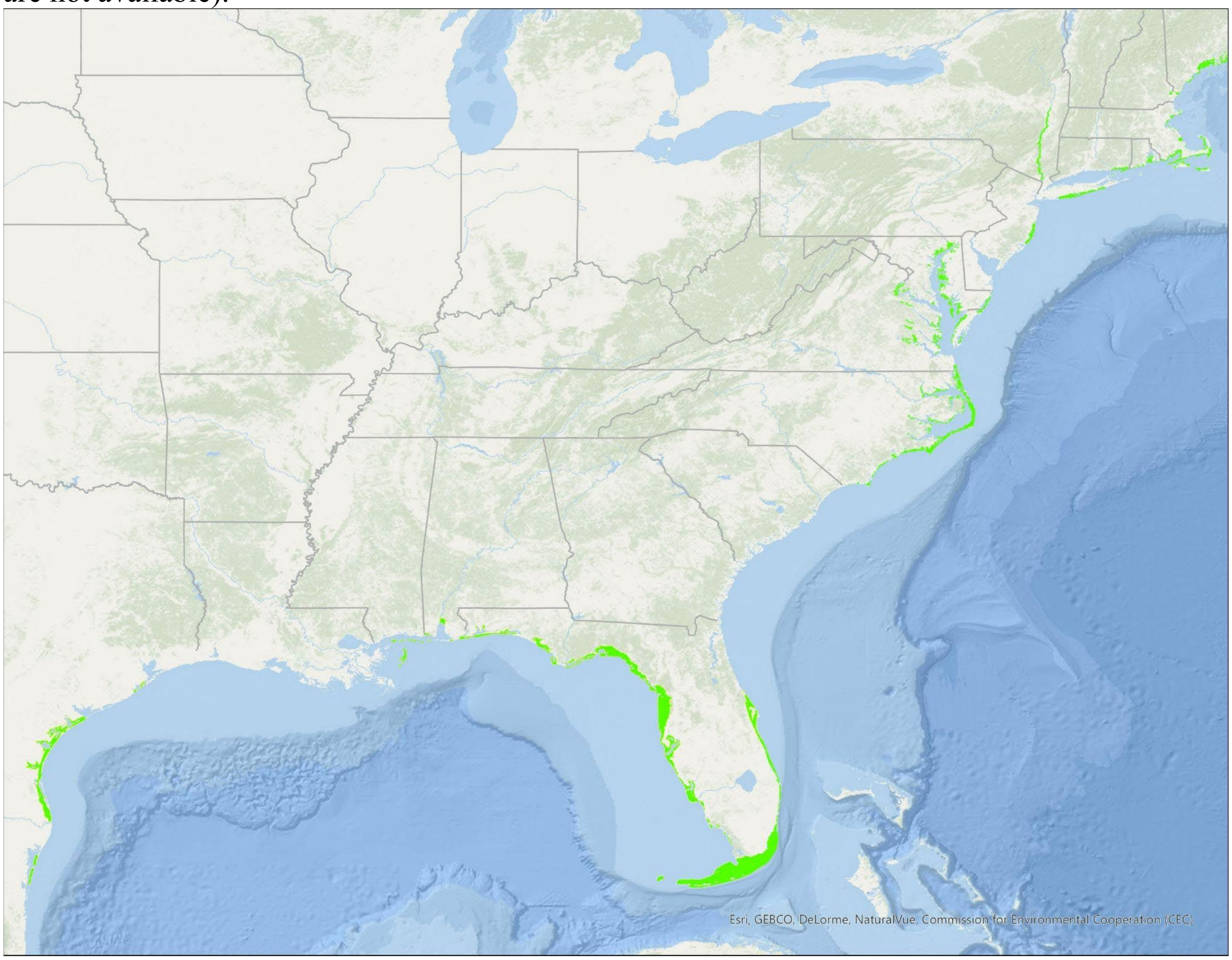


Figure 11. Seagrass coverage within the U.S. range of the North Atlantic DPS
Light green polygons represent seagrass cover (Commission for Environmental Cooperation CEC 2021).

Because many areas within the range of the North Atlantic DPS contain seagrass, we relied on the best available scientific data on the occurrence of benthic-foraging and resting green turtles to determine which of these areas contain sufficient resources to support juvenile green turtles' survival, development, and growth and adults' survival, migration, and reproduction. We considered published and unpublished studies on green turtles to be the best available data; these include satellite tracking, tagging, and in-water observation data. We also considered data derived from fisheries bycatch, incidental capture in power plants, and dredging relocation projects. To rate the conservation value of each area, we evaluated the data to compare the relative abundances or densities of green turtles within areas.

For this DPS, we do not have a standardized consistent dataset with which to compare relative abundances or densities. Instead, most data on this DPS focus on one State or area of interest. However, aerial survey data are available throughout much of the Atlantic and Gulf of Mexico. These data were provided by the Atlantic and Gulf of Mexico Marine Assessment Programs for Protected Species (AMAPPS and GoMAPPS) and the Virginia Aquarium (Figure 12). Despite the broad coverage of these data, we were unable to use these data to compare abundances and densities for three reasons: 1) Effort was not standardized across the regions, such that more effort would likely result in more observed turtles; 2) Aerial surveys are only able to reliably detect larger turtles (> 40 cm SCL) and miss smaller turtles; 3) The aerial survey data does not account for potential sightability differences between the areas based on variations in environmental conditions and turtle behavior; 4) These surveys do not occur in inshore bays or lagoons, where many green turtles forage; and 5) Aerial surveys do not allow insight into the behavior of green turtles such that we were unable to confirm that turtles were foraging and resting. These concerns are clearly demonstrated by what appears to be the greatest abundance of green turtles on the continental shelf from Virginia to New York. Our best available data (focused in-water research studies including bycatch analyses) do not corroborate these data, nor do stranding and cold stun data, which show that abundance is far greater in waters of Florida, North Carolina, and Texas. Furthermore, the majority of observations on the continental shelf from Virginia to New York occur in depths of 20 to 60 m, which exceeds the depth of the benthic foraging and resting EFs. We based the EFs on the best available data demonstrating that green turtles use waters of less than 20 m depth for resting and foraging on seagrass, macroalgae, and benthic invertebrates. While some individual green turtles may forage or rest at deeper depths, we are unaware of any data indicating if or why the EFs would extend to 60 m depth north of Virginia. Thus, this area does not appear to contain the foraging/resting EFs, and we were unable to explain the relatively large number of sightings in this area. For these reasons, we did not base our conservation value ratings on the aerial data.

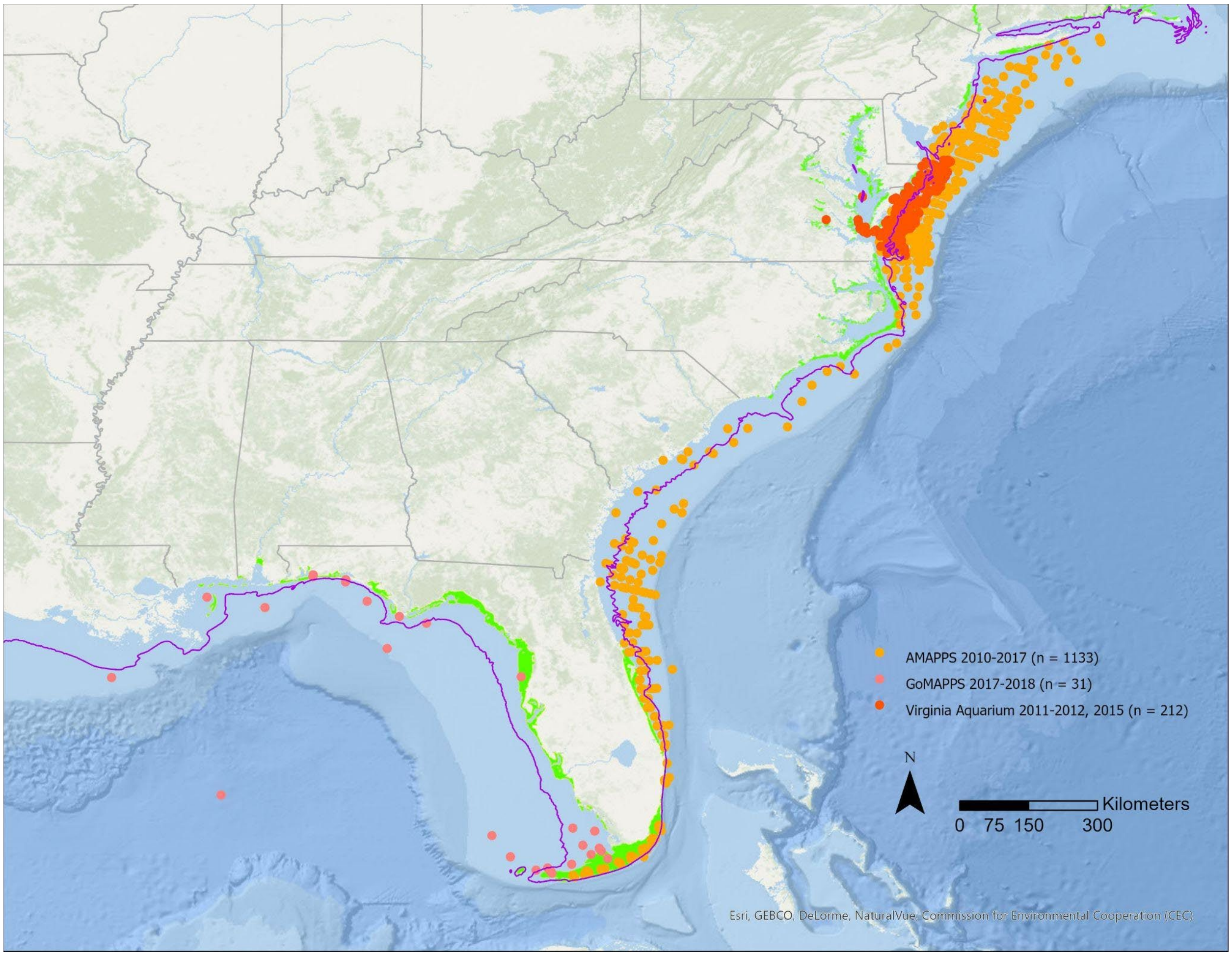


Figure 12. Green turtles observed during aerial surveys
Dots represent green turtles observed by AMAPPS (orange; unpublished data 2022); GoMAPPS (pink; unpublished data 2022); and S. Barco, Virginia Aquarium (red; unpublished data 2022). Purple line represents the 20 m bathymetric contour; light green polygons represent seagrass cover (CEC 2021).

Stranding data are another dataset that are available for all Atlantic and Gulf of Mexico States, where green turtles occur. We evaluated available stranding data from 2010 to 2020 (Table 3; Figure 13). Stranding data include cold-stunned turtles; however, there is a difference: cold-stunned turtles are likely healthy turtles that were foraging in an area when temperatures dropped, resulting in cold stunning; whereas, other strandings are more likely to involve injured or sick turtles. Caveats to using stranding data (including cold-stunned turtles) include: 1) Data collection and effort is not standardized throughout the region; 2) Reporting is dependent on observation, creating a bias toward areas of greater human density or greater accessibility (e.g. beach areas vs. marshy shorelines); 3) Stranded turtles may be carried by currents such that reported locations may not accurately represent the area occupied by the turtle (Santos *et al.* 2018a; Santos *et al.* 2018b); and 4) Strandings may be caused by suboptimal habitat use. Given these caveats, we only used stranding data to support areas identified as containing the EFs based on other data sources (such as research studies). We did not base our conservation ratings on the relative amount of strandings; however, stranding data from 2010 to 2020 confirm at least an order of magnitude greater densities of turtles in Florida, Texas, and North Carolina compared to other Atlantic and Gulf of Mexico States. These data corroborate research data that indicate high densities of green turtles foraging and resting in Florida, Texas, and North Carolina.

Table 3. Strandings by State from 2010 to 2020 (includes cold stunned turtles)

State	Strandings	Citation
Florida	11,284	A. Foley, FWC unpublished data 2022
Texas	9,889	D. Shaver, NPS unpublished data 2022
North Carolina	5,365	M. Godfrey, NCWRC unpublished data 2022
South Carolina	267	M. Pate, SCDNR unpublished data 2022
Virginia	234	S. Barco, Virginia Aquarium unpublished data 2022
Massachusetts	228	A. Kennedy, New England Aquarium, and R. Prescott, MA Audubon Society unpublished data 2022
Georgia	192	M. Dodd, GADNR unpublished data 2022
New York	168	K. Durham, Atlantic Marine Conservation Society, and M. Montello, New York Marine Rescue Center unpublished data 2022
Louisiana	141	L. Howell, STSSN unpublished data 2022
Mississippi	70	L. Howell, STSSN unpublished data 2022
New Jersey	58	R. Schoelkopf, Marine Mammal Stranding Center unpublished data 2022
Alabama	56	L. Howell, STSSN unpublished data 2022

State	Strandings	Citation
Delaware	9	S. Thurman, MERR Institute unpublished data 2022
Maryland	3	J. Dittmar, National Aquarium, and A. Weschler, Maryland Department of Natural Resources unpublished data 2022
Connecticut	3	S. Callan, Mystic Aquarium unpublished data 2022
Rhode Island	1	S. Callan, Mystic Aquarium unpublished data 2022

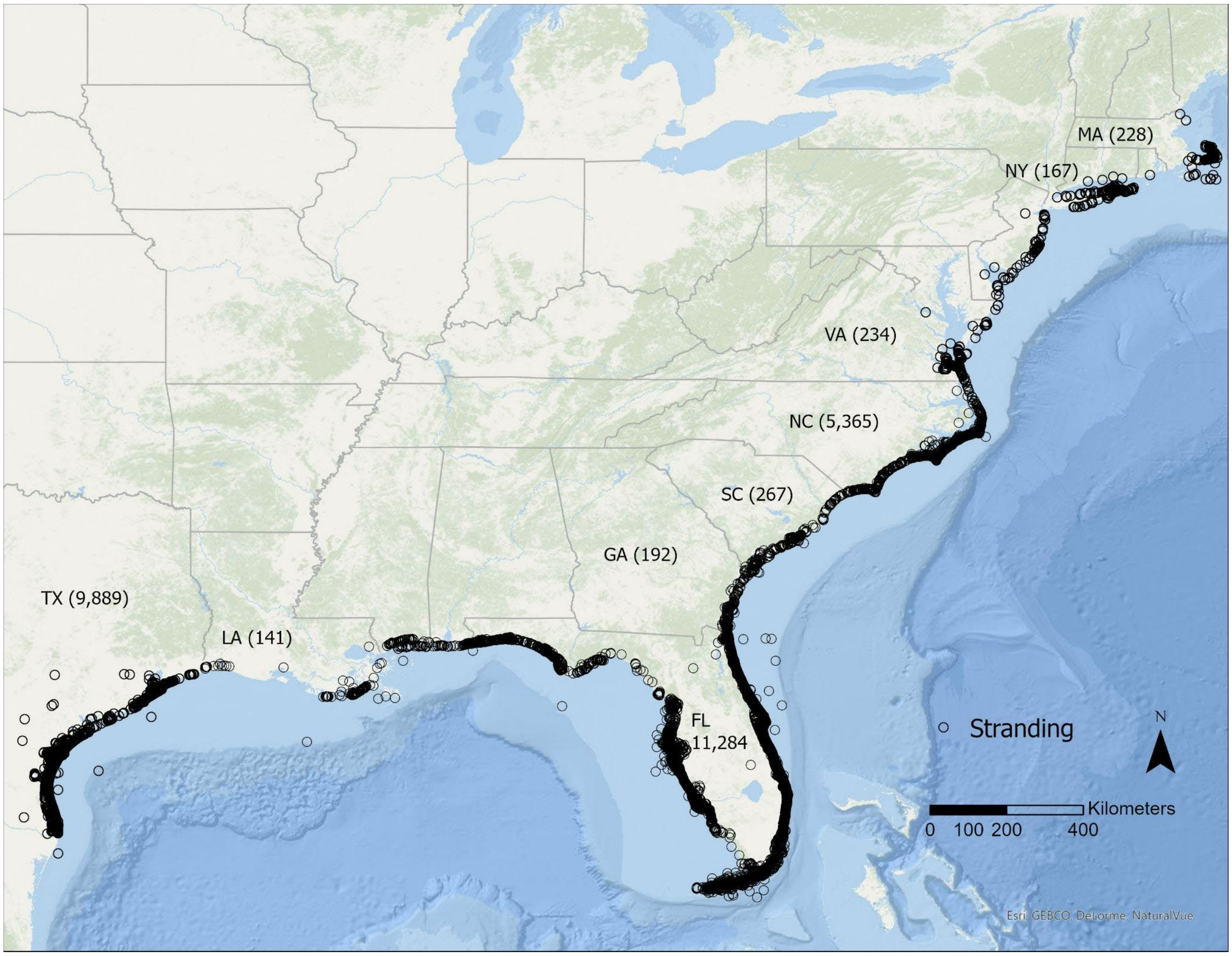


Figure 13. Stranding data for the North Atlantic DPS from 2010 to 2020

Circles represent strandings. Data provided by: A. Foley, FWC unpublished data 2022; D. Shaver, NPS unpublished data 2022; M. Godfrey, NCWRC unpublished data 2022; M. Pate, SCDNR unpublished data 2022; M. Dodd, GADNR unpublished data 2022; S. Barco, Virginia Aquarium unpublished data 2022; A. Kennedy and R. Prescott, New England Aquarium and MA Audubon Society unpublished data 2022; K. Durham and M. Montello, Atlantic Marine Conservation Society and New York Marine Rescue Center unpublished data 2022; R. Schoelkopf, Marine Mammal Stranding Center unpublished data 2022; L. Howell, STSSN unpublished data 2022; S. Thurman, MERR Institute unpublished data 2022; J. Dittmar and A. Weschler, National Aquarium and Maryland Department of Natural Resources unpublished data 2022; S. Callan, Mystic Aquarium unpublished data 2022.

4.2.4.3.1 Texas

In Texas, juvenile and subadult turtles forage in depths of up to 20 m on macroalgae, seagrass, and invertebrates (Howell *et al.* 2016; Howell and Shaver 2021; P. Plotkin and N. Wilderman, Texas A&M University unpublished data 2022). Texas waters provide one of the most important developmental and foraging habitats for juvenile green turtles in the western Gulf of Mexico (Shaver *et al.* 2017), i.e., those originating from Mexico nesting beaches (Shamblin *et al.* 2017). Turtles forage on seagrass (Figure 14) and macroalgae in natural habitats and on jetty rocks and other artificial structures (fishing piers, docks, oil and gas platforms, and bridge support structures) that occur in the bays and passes of nearshore Gulf of Mexico waters (Shaver *et al*. 2017). They also consume animal matter and are best described as omnivores (Howell and Shaver 2021). These jettied passes also provide refugia for resting turtles and quick access to deeper, warmer waters to avoid cold-stunning (Shaver 1994; Shaver *et al*. 2013; Shaver *et al*. 2017). In recent years, cold stunning is a frequent occurrence in Texas.

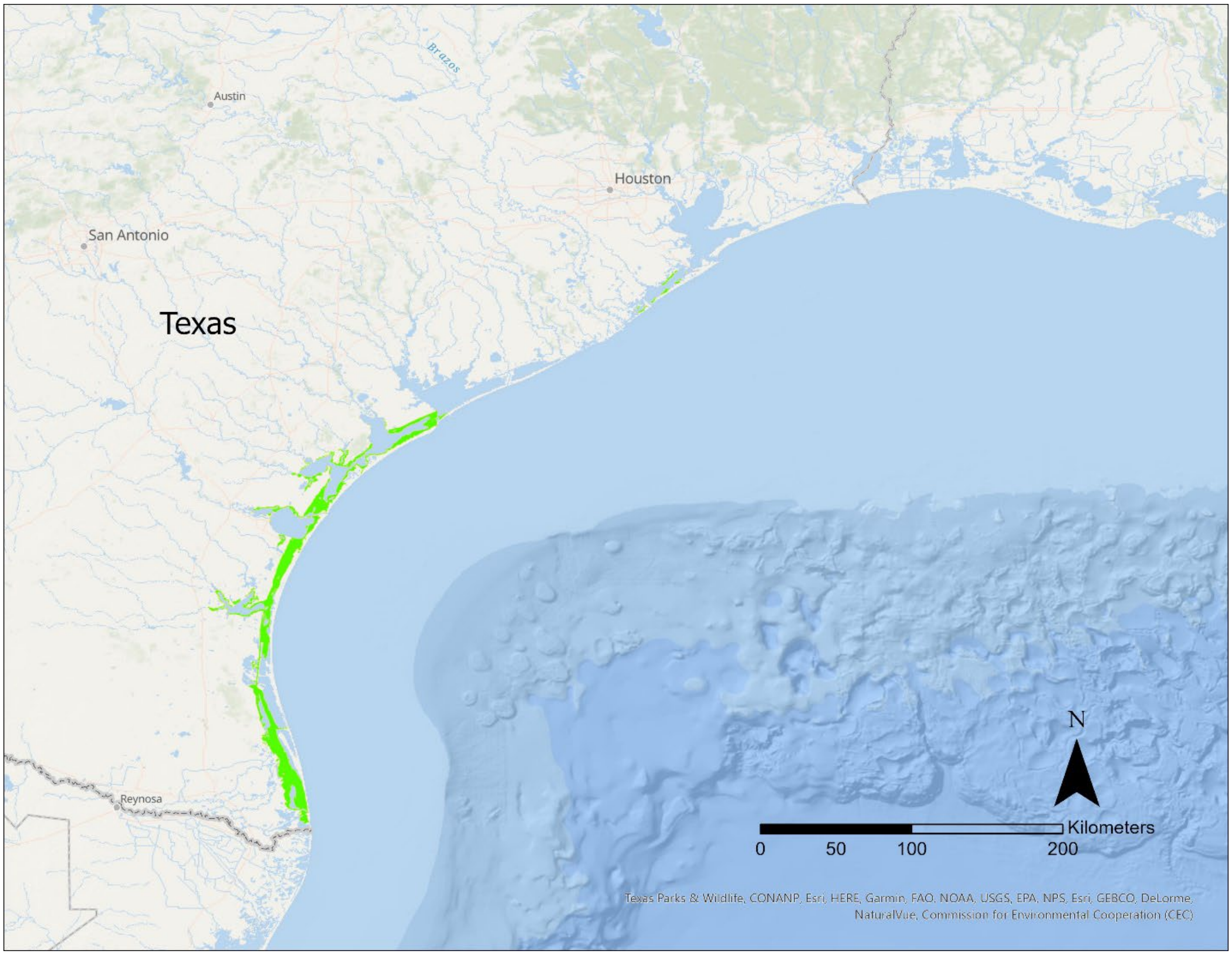


Figure 14. Seagrass coverage in Texas
Light green polygons represent seagrass cover (CEC 2021).

The February 2021 cold stunning event in Texas was the largest on record, with approximately 13,300 turtles documented. Approximately 6,600 green turtles were found in the inshore waters of the Upper Laguna Madre, 5,700 in the Lower Laguna Madre, and 1,200 along the Upper Texas Coast. Nearly all were juvenile green turtles, but small numbers of larger sub-adult and adult sized green turtles, and a few loggerheads were also documented. Around 4,300 turtles were rehabilitated and released. While cold stunning events in Texas occur nearly every year and the number of turtles affected has increased each year, the magnitude of the 2021 event was unprecedented and reinforces the importance of Texas inshore waters as green turtle habitat.

As stated above, green turtles foraging and resting in Texas waters likely originate from

Mexican rookeries in the western Gulf of Mexico (Shamblin *et al*. 2017). As post-hatchlings and small juveniles, they reside and feed within Sargassum mats, which break apart and wash ashore in Texas during the spring and summer (Gheskiere *et al.* 2006; Gower *et al.* 2006; Gower and King 2011; Webster and Linton 2013), leading to large recruitment pulses (Shaver *et al.* 2017). Recruits have been documented foraging and resting at granite rock jetties and inhabiting jetty channels for up to 1,100 days (Shaver 2000). At 25 to 45 cm SCL, they transition to residency in inshore seagrass beds (Howell *et al.* 2016) which also support macroalgal and invertebrate communities (Howell and Shaver 2021).

Stomach content and stable isotope analyses of live (n = 55) and stranded (n = 114) juvenile green turtles indicate that small juveniles (15 to 25 or 35 cm SCL, depending on the area) forage predominantly on macroalgae but shift to a seagrass-dominated diet as they increase in size (Howell *et al.* 2016). The dietary shift occurs at different sizes in different areas. Juveniles of the lower Texas coasts shifted to inshore seagrass beds before attaining 35 cm SCL; whereas juveniles of middle Texas coasts made the dietary transition at variable sizes (25 to 55 cm SCL; Howell *et al.* 2016). Such foraging preferences are geographically divided as well, with some lower Texas coast juveniles foraging on macroalgae at jetty channel passageways and others foraging on seagrasses within the bay systems (Coyne 1994). Animal matter (i.e., predominantly invertebrates) is also a major prey group, occurring at a frequency of 25 percent or greater in stomach content samples, and is especially important to green turtles greater than 45 cm SCL (Howell *et al.* 2016). Unfortunately, green turtles also ingest plastics, as detected in the stomach contents of 226 of 464 turtles stranded in Texas between 1987 and 2019 (Choi *et al.* 2021).

Green turtles forage and rest throughout the bays, passes, and nearshore waters of Texas from Galveston Bay to the Mexico border, as demonstrated by numerous published studies (described in detail below) and incidental capture of turtles from 2010 to 2020 (Figure 15; D. Shaver, NPS unpublished data 2022). Thousands of stranding and cold stun records further demonstrate the large abundance of foraging and resting green turtles in Texas waters (Shaver et al. 2017). Such wide-spread habitat is consistent with historical records of green turtle harvest: Green turtles were once abundant along the coasts of Texas, with approximately 490,000 pounds landed throughout the State in 1890; fishers caught green turtles in Aransas Bay and Laguna Madre; and green turtle canneries were located in Galveston, Fulton, and Corpus Christi (Doughty 1984).

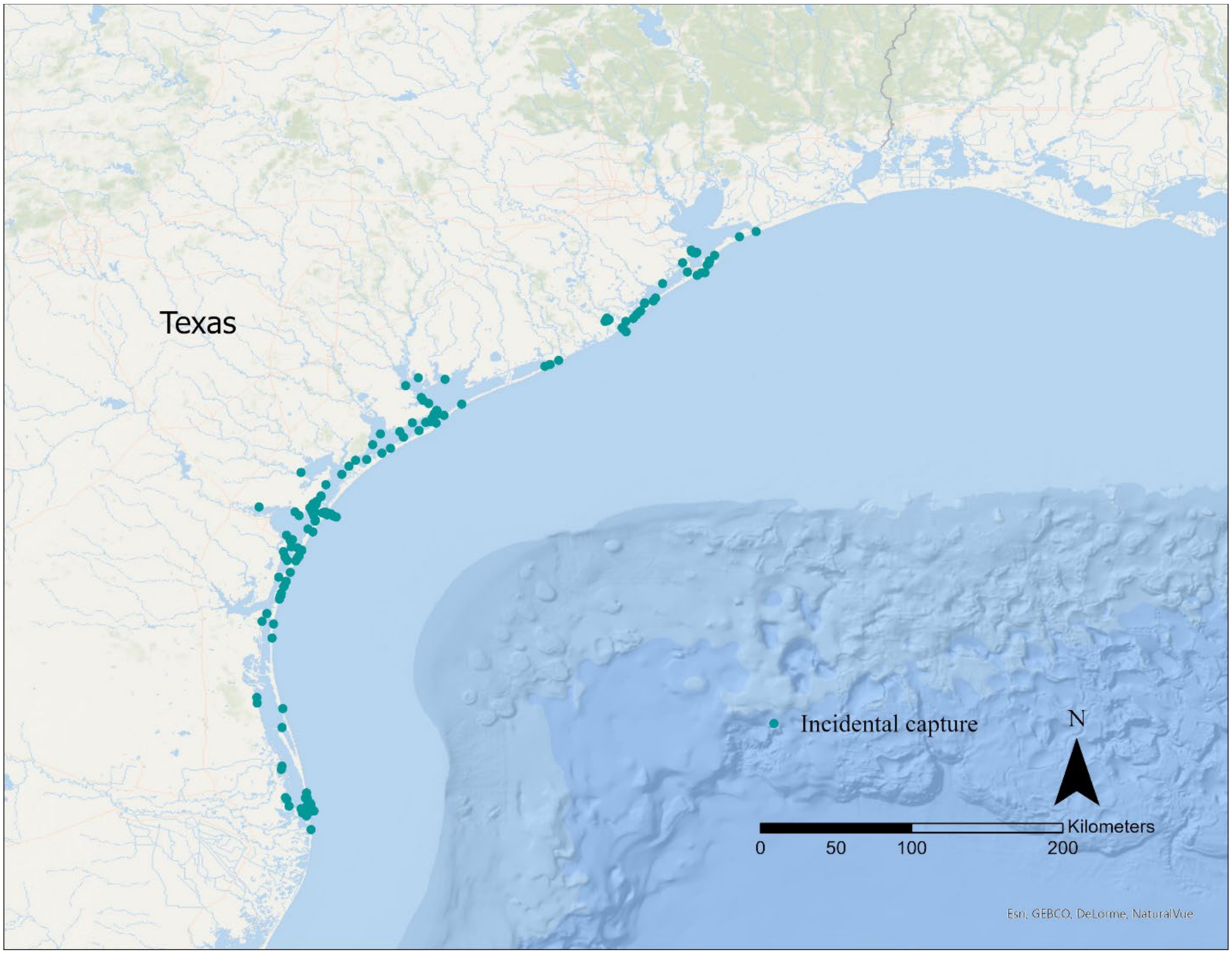


Figure 15. Incidental captures
Incidental captures (n = 239) between 2010 and 2020 in Texas waters (D. Shaver and S. Walker, NPS unpublished data 2022).

The abundance of juveniles in these areas appears to be increasing over time (Shaver 1994; Metz and Landry 2013). Juveniles establish residency in the bays but also southward into Mexican waters (Shaver *et al.* 2013; Metz *et al.* 2020). Most travel between the connected bays and the Gulf of Mexico using the jettied passes (Shaver *et al.* 2013), with the exception of Galveston Bay. Galveston Bay supports a resident green turtle population that feeds on seagrass beds and heavy algal growth (L. Howell, NMFS pers. comm., 2015). Green turtles in Galveston Bay have been studied for the prevalence of FP (Shaver *et al.* 2019). Otherwise, the bays are connected via an intercoastal waterway, which turtles use to move up and down the coast from Lavaca-Matagorda Bay through Laguna Madre and into Mexico.

Lavaca-Matagorda and Aransas Bays are hotspots for foraging and resting juvenile green turtles, especially in May and June (Metz *et al*. 2020). Recent satellite tracking of 18 green turtles captured in Matagorda Bay demonstrated use of most coastal areas within the Bay with some turtles moving south to Corpus Christi Bay, Laguna Madre, and into Mexico (Figure 16; P. Plotkin and N. Wilderman, Texas A&M University unpublished data 2022). They appear to use waters less than 20 m depth for foraging and resting but use waters of greater depths for southern migration (P. Plotkin and N. Wilderman, Texas A&M University unpublished data 2022). An additional 15 juveniles demonstrated different use of the Bays, depending on season (Figure 17; Metz *et al*. 2020). Two radio-tracked turtles increased their movements during November and December, moving south to warmer waters (Renaud *et al.* 1995). Their home range encompassed 19.5 km^2 of the bay (Renaud *et al.* 1995). In 2006 and 2007, 11 juveniles were captured in Lavaca-Matagorda Bay in areas with patchy shoal grass (*Halodule wrightii*), and 11 juveniles were captured in Aransas Bay, which hosts turtle grass, *Thalassia testudinum* (Metz and Landry 2013). These bays appear to be important juvenile developmental areas (Metz *et al.* 2020).

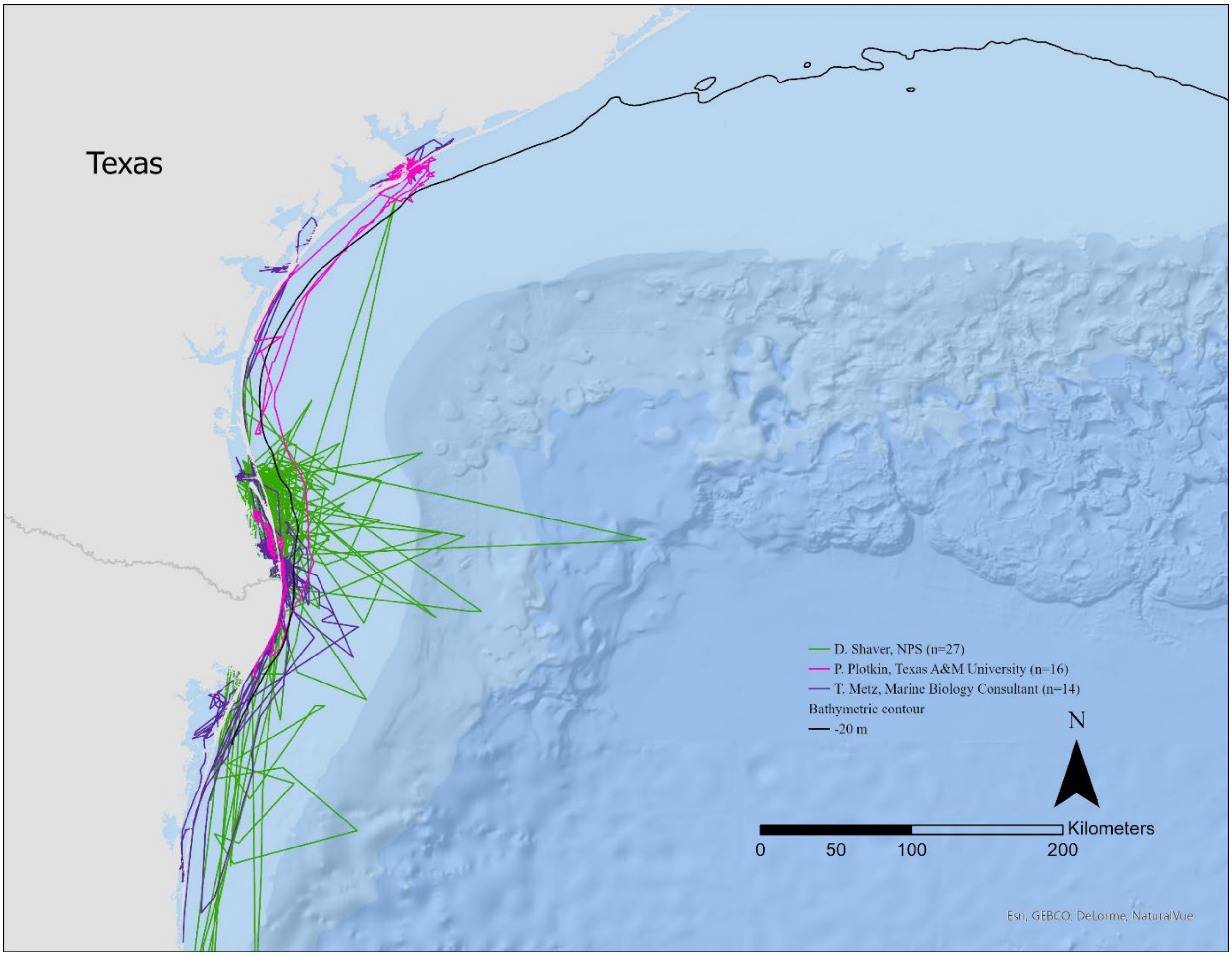


Figure 16. Satellite tracking of green turtles from Matagorda Bay and Laguna Madre, Texas
Purple tracks represent 15 juvniles tracked in Texas waters (Metz *et al*. 2020; T. Metz, Marine Biology Consultant data 2022); pink tracks represent 16 juveniles in Matagorda Bay, Texas (P. Plotkin and N. Wilderman, Texas A&M University unpublished data 2022); green tracks represent 27 green turtles tracked from Laguna Madre, Texas (D. Shaver, NPS unpublished data 2022).

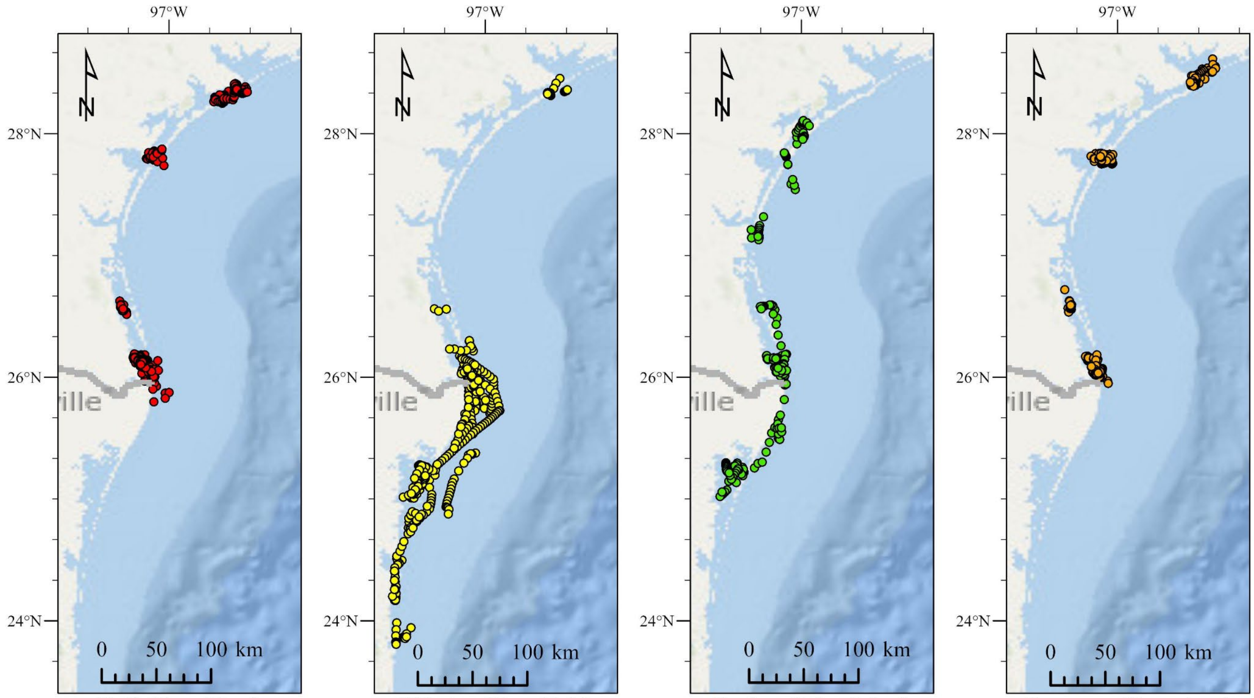


Figure 17. Satellite tracking of green turtles in Texas
Juveniles (n = 15) tracked by season in Texas waters (Metz *et al*. 2020).

The most important juvenile developmental area in Texas is Laguna Madre, which hosts the greatest amount of seagrass coverage (81 percent) and the greatest abundance of green turtles in Texas (Figures 16-19; Shaver *et al*. 2013; Howell and Shaver 2021; D. Shaver, NPS unpublished data 2022). Green turtle densities appear to be highest in the areas of greatest seagrass coverage (Weatherall 2010). Juveniles are concentrated near the Mansfield Channel and appear to use it for foraging, resting, and for passage between Laguna Madre and the Gulf of Mexico (Shaver 1994; Shaver 2000; Shaver *et al*. 2013). Shaver (2000) netted 258 green turtles in the Mansfield Channel from 1989 to 1997 (3.63 turtles/km-h). Juveniles also forage on macroalgae at the Brazos Santiago Pass near South Padre Island (Renaud *et al*. 1995). Core and home range analyses show foraging and resting hotpots year round in this area (Figure 18; Figure 19; Metz and Landry 2013; Metz *et al*. 2020). Metz and Landry (2013) tagged 247 juveniles between 1991 and 2010; they found significant increases in abundance during that time and a significantly higher CPUE compared to Matagorda and Aransas Bays. Green turtles use Laguna Madre for foraging and resting and also for overwintering behavior (Arms 1996). Cold stunning has the highest prevalence at Laguna Madre (Shaver *et al*. 2017). FP prevalence has also been studied in Laguna Madre (Shaver *et al*. 2019). Larger green turtles forage on the seagrass beds at South Bay, Mexiquita Flats, and Laguna Madre (Landry *et al.* 1992; Coyne 1994). Females nesting at PAIS travel south to Mexico to forage and rest (D. Shaver, NPS unpublished data 2022).

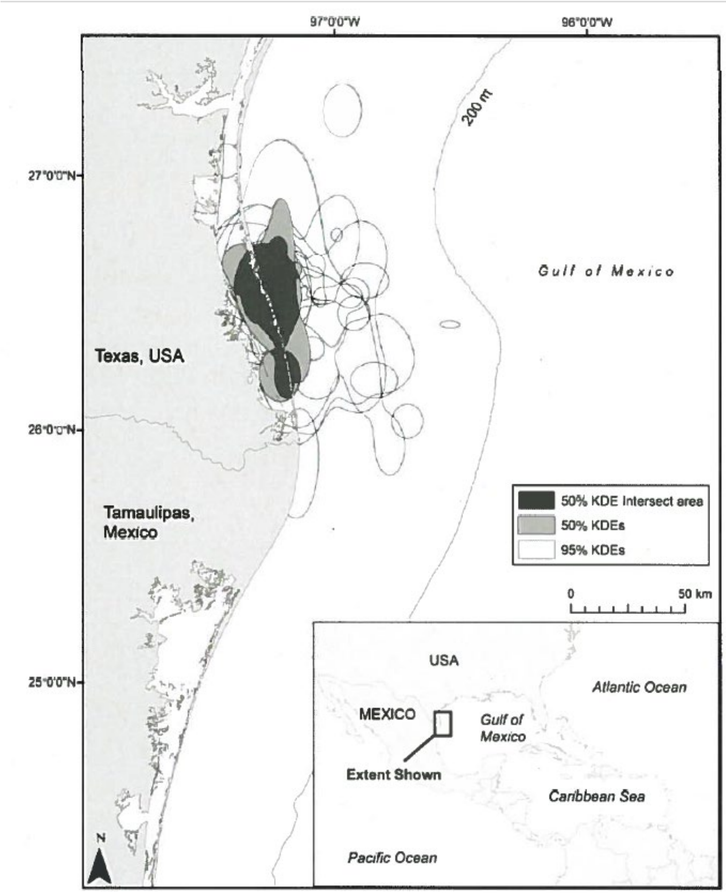


Figure 18. Juvenile green turtle in Laguna Madre

Core use and home range areas for 11 juvenile green turtles tagged in Laguna Madre between 1995 and 1997 (Shaver *et al*. 2013).

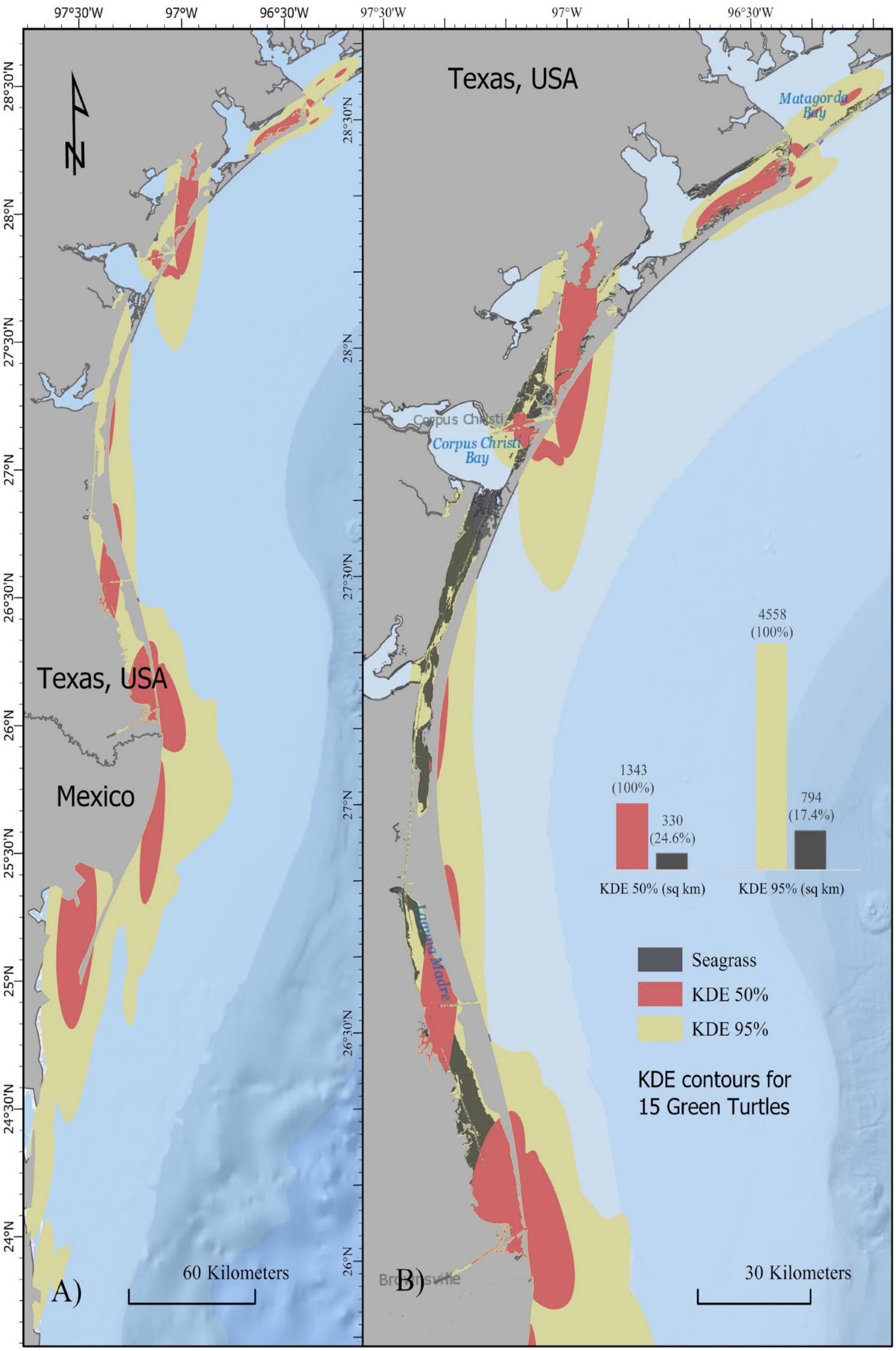


Figure 19. Core and home ranges of foraging and resting turtles in Texas ([Metz *et al*. 2020](#)).

Based on the above data, we conclude that the nearshore waters of Texas (Galveston to the Mexico border), from the shoreline (mean high water) to 20 m depth, contain the benthic-foraging and resting EFs that may require special management considerations or protections.

4.2.4.3.2 Louisiana, Mississippi, and Alabama

To identify areas in Louisiana, Mississippi, and Alabama containing the benthic foraging and resting EFs for green turtles, we first evaluated maps of seagrass cover and other submerged vegetation (Figure 20). Seagrass cover occurs throughout the Chandeleur Islands. Benthic macroalgae grows in abundance on and around jetties at Belle Pass (USGS and LDWF, unpublished data 2016). Thus, these areas have the potential to support foraging and resting green turtles. Although we are not aware of current population surveys or estimates, historical data indicate that waters of Louisiana once supported a large green turtle fishery, second only to that of Florida (Doughty 1984). In 1880, 30,000 pounds of green turtle were landed in Louisiana; the combined total from Florida and Louisiana was 42,100 pounds in 1940 and 26,000 pounds in 1960 (Doughty 1984).

In the Mississippi Delta, surveys in nearshore water revealed only one green turtle (Welsh *et al.* 2023). In Louisiana, K. Hart (USGS unpublished data 2022) has documented the occurrence of green turtles at Belle Pass (Figure 20), Ship Shoal, and the Chandeleur Islands (Figure 21). Since 2014, 131 juvenile green turtles (25.6 to 44.2 cm SCL) have been tagged while foraging on algae on and around jetties at Belle Pass (K. Hart, USGS and LDWF unpublished data 2022). These turtles appear to be year-round residents, as demonstrated by 31 recaptures (K. Hart, USGS and LDWF unpublished data 2022). Individuals tracked from Belle Pass (n = 6) generally remained within 40 km of Belle Pass, but one visited Ship Shoal (K. Hart, USGS and LDWF unpublished data 2022). Juvenile green turtles were also observed foraging at seagrass beds of the Chandeleur Islands during a scientific rapid assessment conducted by the USGS and LDWF in April 2015 (K. Hart, USGS pers. comm. 2015). In both areas, juveniles were observed foraging and resting close to the jetties and islands, though these observations may reflect sampling bias (i.e., small boat surveys conducted close to shore and jetties). Inwater Research Group (IRG 2014) conducted vessel-based sea turtle surveys in the nearshore coastal waters (out to three nautical miles offshore) of Terrebonne, Lafourche, Jefferson, Plaquemines, St. Bernard, and Orleans Parishes in eastern Louisiana; they observed one juvenile green turtle, at the surface near the Chandeleur Islands, in Plaquemines Parish (IRG 2014). Although aerial survey sightings are sparse (possibly because green turtles in this region are too small to be seen), stranding data indicate use of nearshore waters along Louisiana, Mississippi, and Alabama. Bycatch data are also available for the region. For example, the GoM coast shrimp otter trawl fishery captured 6 green turtles in try nets and 14 green turtles in standard nets between 2007 and 2017, with total bycatch mortality 95% credible intervals estimated from 22 to 81 green turtles (Babcock *et al.* 2018).

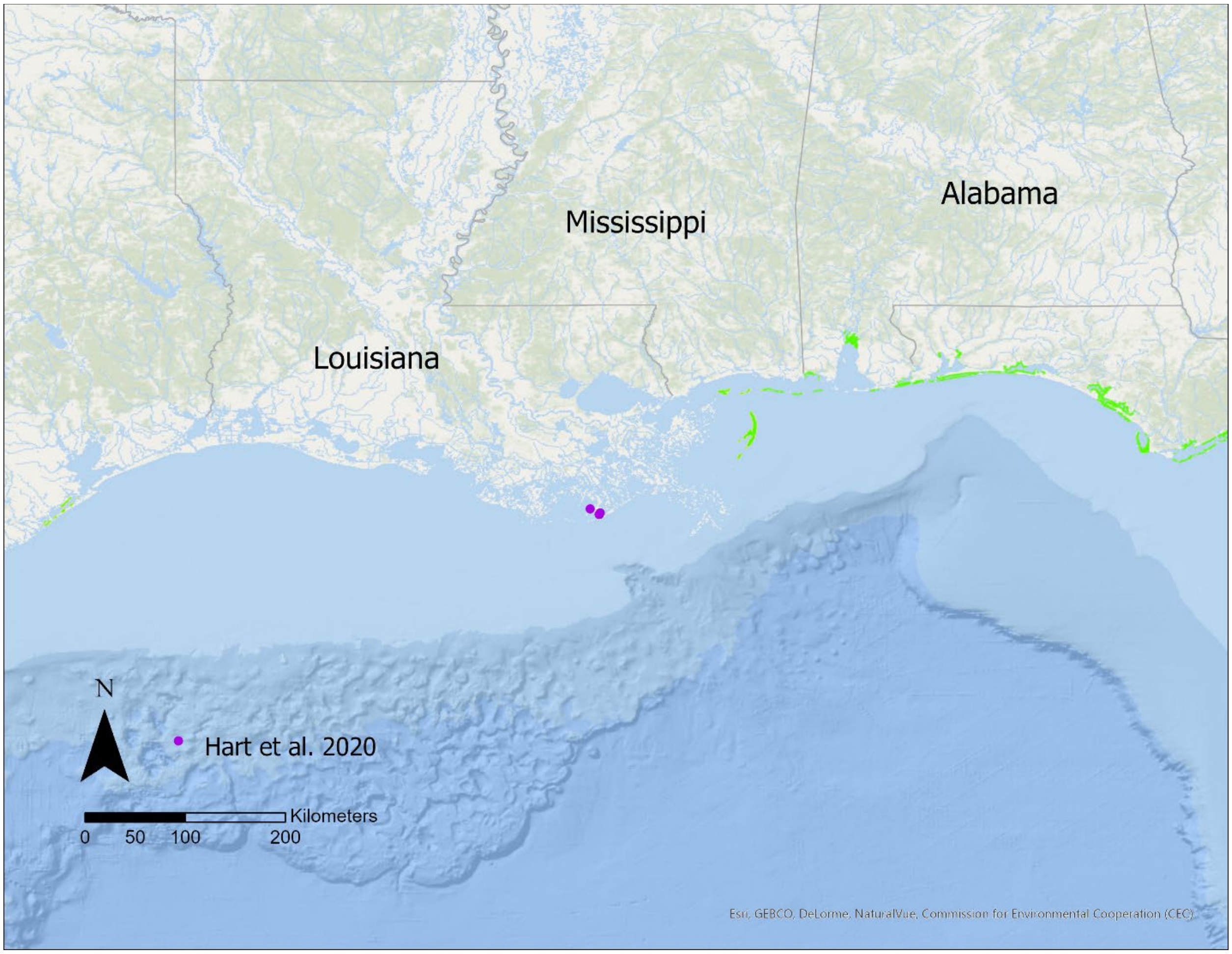
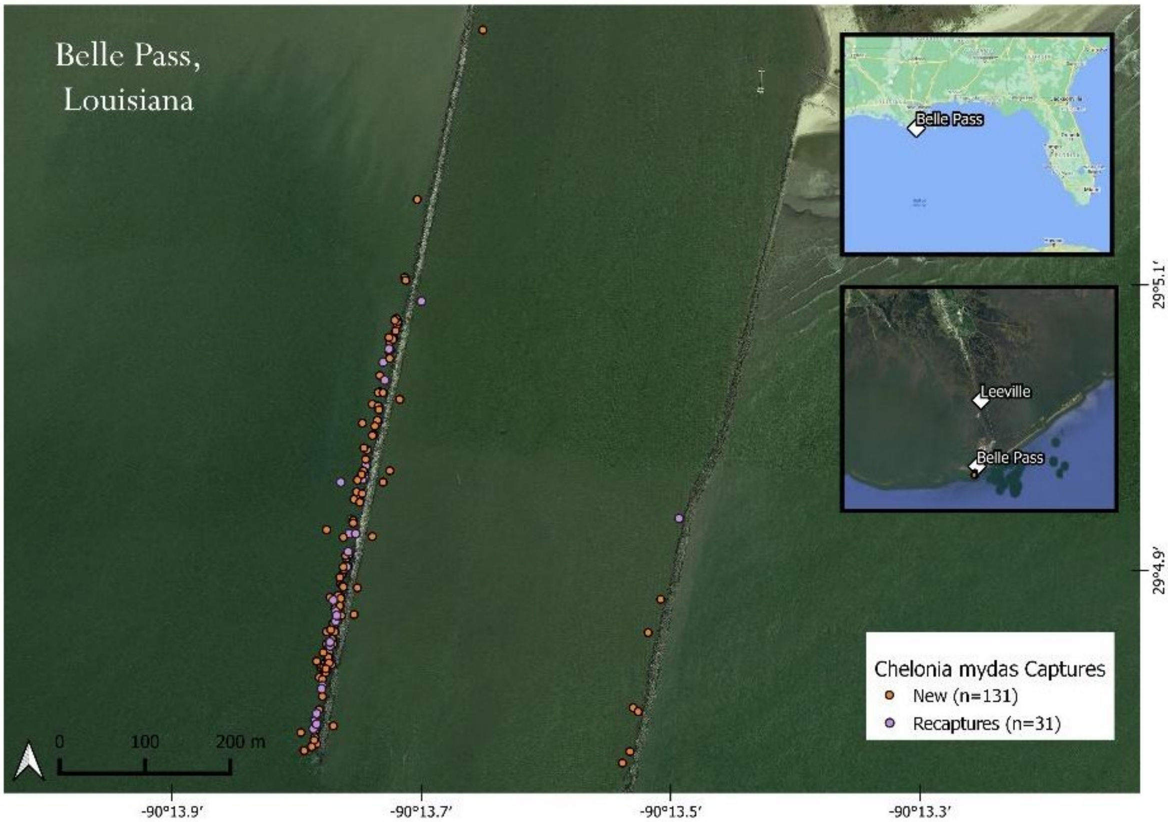


Figure 20. Benthic foraging and resting areas in Louisiana, Mississippi, and Alabama
Available spatial data on green turtle occurrence in neritic waters of Louisiana, Mississippi, and Alabama. Purple dots represent study sites at Belle Pass and Ship Shoal, Louisiana (Hart *et al*. 2020); light green polygons represent seagrass cover (CEC 2021).


Belle Pass,
Louisiana
Belle Pass
Leeville
Belle Pass
Chelonia mydas Captures
New (n=131)
Recaptures (n=31)
0 100 200 m
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29°4.9′
-90°13.9′
-90°13.7′
-90°13.5′
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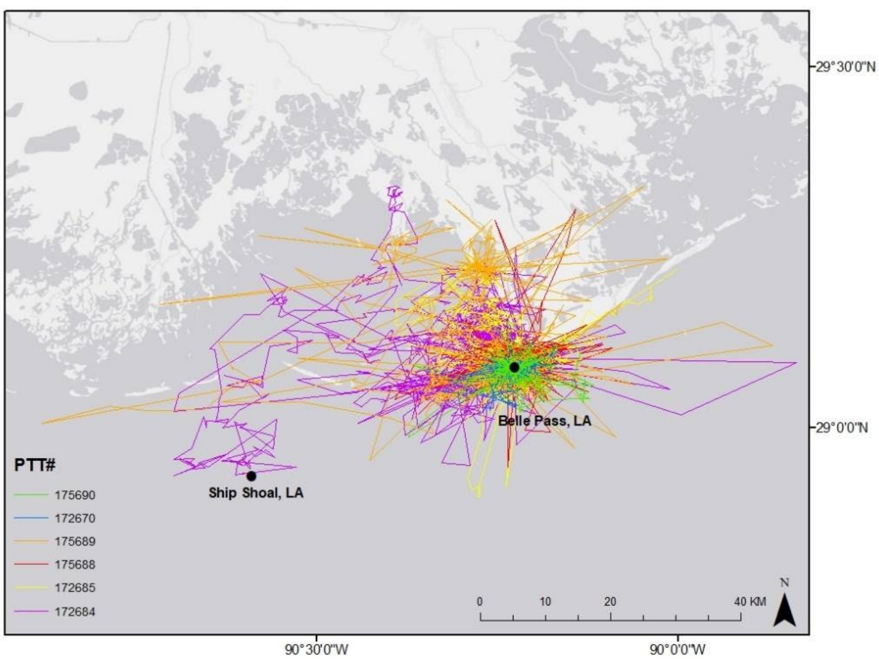
29°30'0"N
29°0'0"N
Belle Pass, LA
Ship Shoal, LA
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175690
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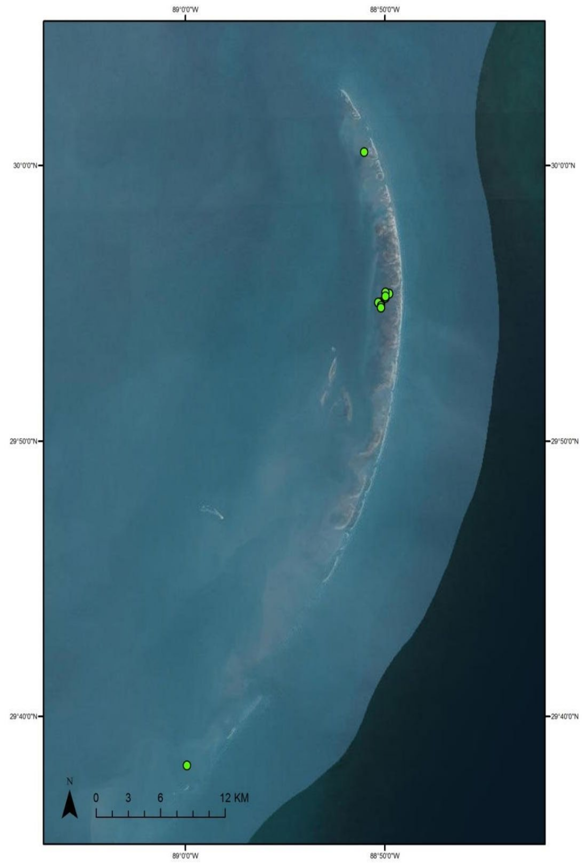


Figure 21. Foraging and resting areas in Louisiana
Green turtle occurrences at Belle Pass (top), Ship Shoal (center), and Chandeleur Islands (bottom) in Louisiana (K. Hart, USGS and LDWF unpublished data 2022).

4.2.4.3.3 Florida

Seagrass habitat is ubiquitous throughout much of the Florida coastline (Figure 22). Both continuous and patchy seagrass beds provide food resources and shelter (Dawes *et al.* 2004). Seagrass beds are especially abundant in the shallow marine waters surrounding the southern tip of the peninsula from Biscayne Bay, through Florida Bay and the Florida Keys, and north to Cape Romano (Fourqurean *et al.* 2001). Sabellariid worm reefs stretch from Indian River County to Key Biscayne and appear to be important developmental habitats for juvenile green turtles (Figure 22; Guseman and Ehrhart 1990; FWC unpublished data 2022).

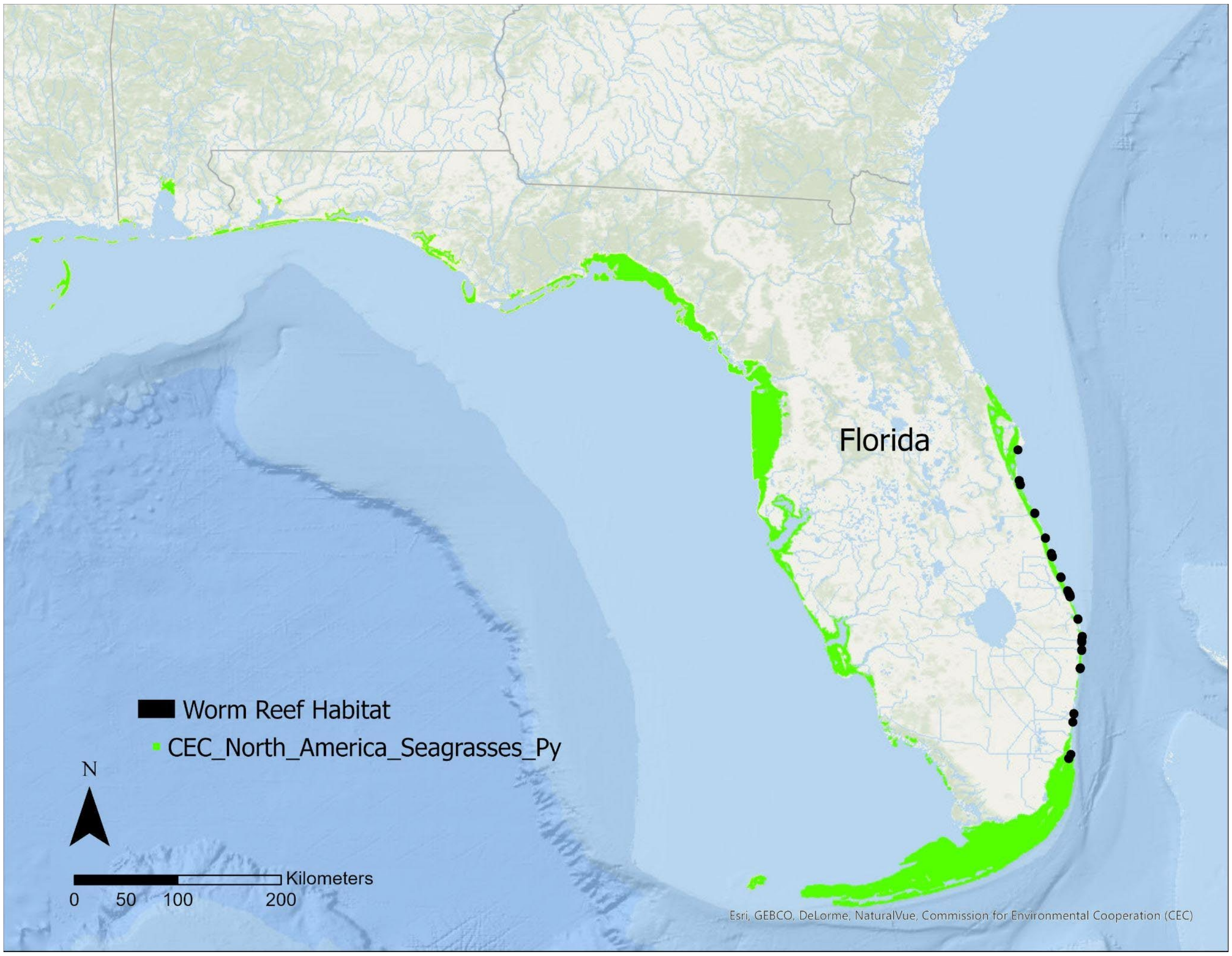


Figure 22. Foraging and resting habitats in Florida
Seagrass cover shown in green (CEC 2021); worm reef habitat locations shown in black (FWC 2022).

The benthic foraging and resting EFs are found throughout nearshore waters of Florida, where studies on green turtles demonstrate their widespread occurrence. Figure 23 illustrates available spatial data from a small sample of studies on foraging green turtles and areas where these studies have occurred. We cite many additional studies in the paragraphs below and, during the public comment period, we will likely receive additional information on studies we inadvertently missed. For this report, we organized data geographically as five regions in Florida: NW, SW, SE, NE, and Monroe County, which includes the Florida Keys, Dry Tortugas, Marquesas Keys, Biscayne Bay, and Everglades (Figure 23). We added Monroe County to the Eaton *et al.* (2008) regional divisions because of its importance to foraging adults and subadults. Eaton *et al*. (2008) and FWC (unpublished data 2015) provided an extensive list of areas where green turtles have been observed in Florida during in-water research projects (published and unpublished), cold-stunning events, and confirmed observations:

- Apalachee Bay
- Banana River
- Big Bend Seagrasses/St. Martins Marsh Aquatic Preserve
- Big Sable Creek Complex

- Biscayne Bay
- Broward County Reefs
- Brevard County Reefs
- Cape Sable
- Cape Canaveral and Northeast Coast
- Cedar Key
- Charlotte Harbor
- Chassahowitzka NWR (C. Sasso, NMFS unpublished data 2016)
- Collier County
- Crystal River Energy Complex
- Deadman Bay
- Dry Tortugas
- Everglades
- Fernandina Harbor
- Florida Bay
- Florida Reef Tract
- Florida Keys
- Ft. Pierce
- Galt Ocean Mile, Lauderdale-by-the-Sea
- Hutchinson Island
- Indian River County, Lagoon, and Reefs
- Intracoastal at the south end of Indian River County (near the Moorings development)
- Jenning's Cove
- Key West NWR
- Lake Worth Lagoon
- Longboat Key Relocation Trawling
- Marquesas Keys (including Eastern Quicksands)
- Mayport/Huguenot Park
- Mosquito Lagoon
- Northeast Coast
- Palm Beach County
- Port Canaveral Ship Channel
- Sewall's Point at the south end of Hutchinson Island
- St Joseph Bay
- St. Augustine Inlet (inshore area)
- St. Lucie County
- St. Lucie Power Plant
- SW Peninsular Florida
- Tampa Bay Entrance Channel
- Ten Thousand Islands
- The Breakers Central Reef Tract
- Trident Submarine Basin
- West-central Florida including Tampa Bay and nearshore waters of Pinellas and Hernando Counties

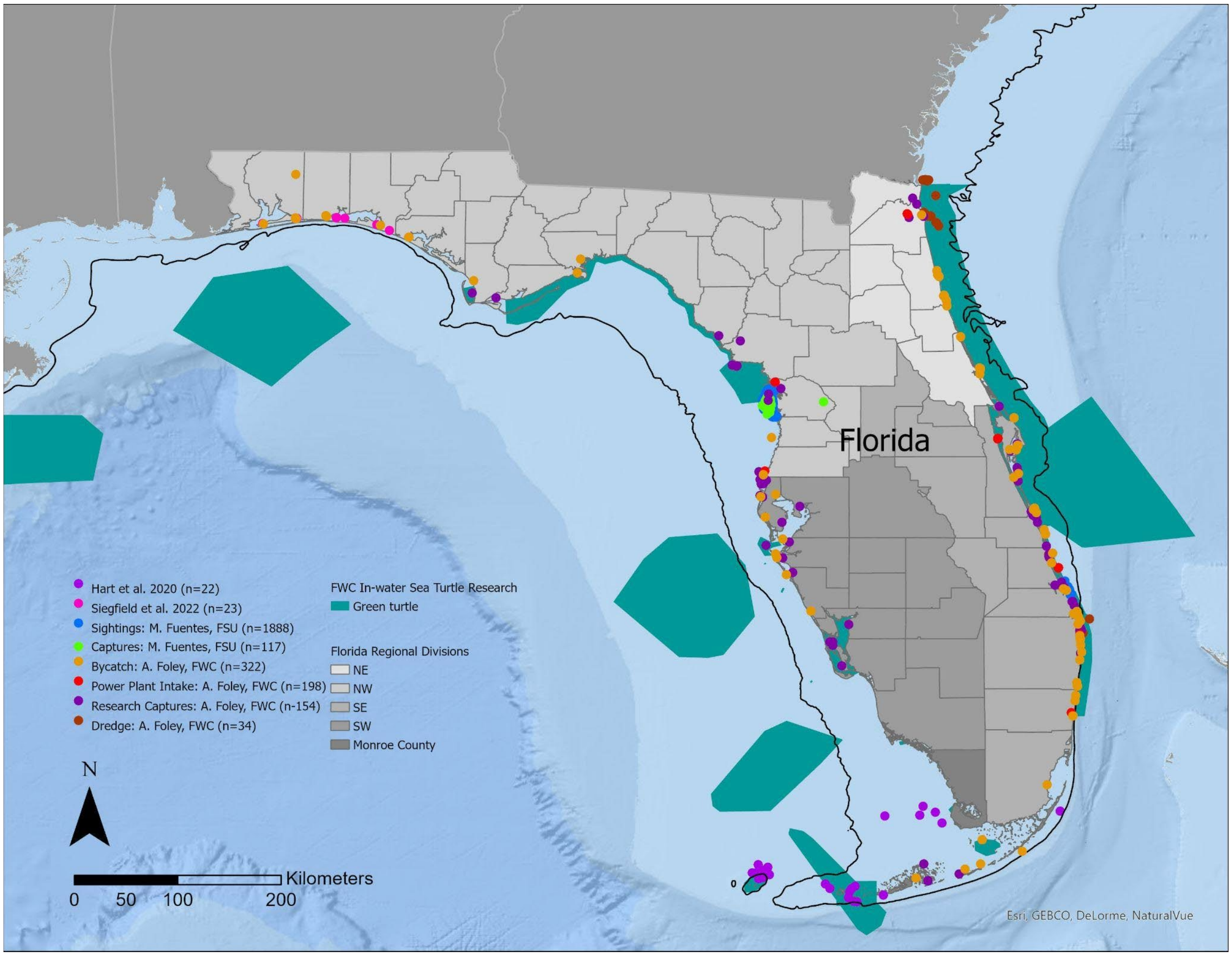


Figure 23. Benthic foraging and resting areas in Florida
Available published and unpublished spatial data on green turtle occurrence in neritic waters of Florida. Violet dots represent foraging/resting destinations of 22 post-nesting females between 2009 and 2019 (Hart *et al*. 2020); pink dots represent foraging/resting locations of 23 green turtles in 2019 and 2020 (Siegfried *et al*. 2022); blue and lime dots represent green turtles sighted (n = 1888) or captured (n = 117) during research studies from 2016 to 2021 by M. Fuentes, Florida State University unpublished data 2022); FWC data from 2010 to 2020 on research captures (purple; n = 154), power plant intakes (red; n = 198), dredge incidental captures (brown; n = 34), and hook and line bycatch (orange; n = 322) were provided by A. Foley, FWC unpublished data 2022); dark green shading represents areas where green turtles were observed during in-water research (FWC Online Sea Turtle Research and Monitoring Information System 2022); gray shading represents regional divisions (Eaton *et al.* 2008) plus Monroe County; black line represents the 20 m isobath (USGS 2013).

In addition to the available spatial data on foraging and resting turtles, numerous studies describe their occurrence and behavior throughout Florida. In the following paragraphs, we review these studies, based on location, starting in NW Florida, which includes the Florida Panhandle and Big Bend areas. In the Florida panhandle, a “reasonable high density” of juvenile green turtles forage in nearshore habitats (artificial reefs, piers, and jetties) from Escambia to South Walton Counties, as demonstrated by video footage of 23 turtles (Siegfried *et al.* 2021). Rock jetties may serve as an important foraging and refugia areas for small juveniles as they recruit to nearshore areas. Juvenile green turtles were observed year-round at these areas, indicating site fidelity, residency, and overwintering (Lamont and Iverson 2018; Lamont *et al.* 2018; Siegfried *et al.* 2021). Numerous juveniles forage in St. Joseph Bay, St. Andrew Bay (including Crooked Island Sound), and in nearshore waters off Eglin Air Force Base and Santa Rosa Island, where they exhibit strong site fidelity and small home ranges (Lamont *et al.* 2015; Lamont and Iverson 2018; Lamont and Johnson 2021; Lamont *et al.* 2021). St. Joseph Bay is an especially important foraging/resting area for juvenile turtles because of the quality and density of seagrass habitat and its proximity to deep, sandy-bottom channels for rest (Lamont *et al.* 2015; Rodriguez and Heck 2020; Lamont and Johnson 2021). Between 2011 and 2019, 175 juvenile green turtles were captured in shallow waters (less than 4 m depth) of St. Joseph Bay (Lamont and Johnson 2021). Satellite tracking of seven juvenile green turtles in St. Andrew and St. Joseph Bays indicates shallow (mean 4.3 m depth), near-shore (mean 0.9 km) core use areas and home ranges of 4.2 ± 5.2 and 15.8 ± 19.4 km^2 respectively (Lamont and Iverson 2018). In response to seasonally cooler temperatures, juveniles remained inside the Bays, which may provide gelatinous prey (e.g., tunicates); however, some moved to deeper waters within the Bays for winter residency (Lamont *et al.* 2015; Lamont and Iverson 2018). Northwest of these Bays, in waters off Santa Rosa Island (which is owned by Eglin Air Force Base), 91 juvenile green turtles were net-captured in shallow waters (less than 4 m depth) by researchers between 2014 and 2019 (Lamont and Johnson 2021); during that time, another 12 juvenile green turtles were incidentally caught in hook and line gear off a Navarre Beach Marine Sanctuary fishing pier also on Santa Rosa Island (Lamont *et al*. 2021). Long-term recaptures (max = 388 days) off Santa Rosa Island may demonstrate multi-year fidelity in this sand-bottom habitat (where turtles appear to forage on algae), or juveniles may move between this area and seagrass habitat in Choctawhatchee Bay (Lamont and Johnson 2021).

Coastal waters of Florida's Big Bend once supported one of the largest sea turtle fisheries in the United States, and continue to be a hotspot for foraging green turtles (Chabot *et al.* 2021). Chabot *et al*. (2021) recorded 624 green turtles near the St. Martins Marsh Aquatic Preserve between 2012 and 2018; juvenile densities ranged from 57 to 221 turtles/km^2; however, larger turtles (>60 cm SCL) were primarily limited to the southern section of their study area; mtDNA analyses indicated that these foraging turtles originated from the western Gulf of Mexico, Mexican Caribbean, and Costa Rica. Another important area for foraging/resting turtles is the Crystal River Region, including St. Martins Marsh and Chassahowitzka Bay (Wildermann *et al.* 2019; Wildermann *et al.* 2020). Based on turtle fishery landings data from the late 1800s, Homosassa appears to have hosted one of two of "the most abundant in-water populations of green turtles in the entire Gulf of Mexico" (Valverde and Holzwart 2017). Florida's Big Bend provides shallow seagrass habitats and other resources critical to the growth and survival of juvenile and subadult green turtles from Anclote Key in Pinellas County and Ochlockonee Bay in Wakulla County (IRG 2013). During vessels surveys between 2012 and 2014, one subadult and 27 juvenile green turtles (up to 0.93 turtles/km) were observed in the Big Bend Seagrasses Aquatic Preserve, and 14 juveniles green turtles (up to 1.33 turtles/km) were obsersed in the St. Martins Marsh Aquatic Preserve (IRG 2013). In Florida's Big Bend, green turtles have been observed and captured around Pepperfish Keys, between Pepperfish Keys and Horseshoe Beach, near Big Grass Island, and Fisherman's Rest (C. Campbell, University of Florida, pers. comm., 2016).

Green turtles also occur from Yankeetown to Tarpon Springs. Unpublished data from scientific studies provide evidence for additional juvenile foraging/resting areas. In 2021, IRG (unpublished data 2022) observed 164 juvenile green turtles during exploratory vessel surveys (90.3 km) of Pasco County. Although current, systematic survey data are not available for the Homosassa region, incidental sightings to the south near Chassahowitzka National Wildlife Refuge indicate high levels of green turtle abundance. For example, sightings from a vessel traveling at ~5 knots documented 65 green turtles over a 20 minutes observation effort (C. Sasso, SEFSC, pers. comm. 2022). Juvenile green turtles of multiple size classes were present, with small juveniles ~20-30 cm carapace length sighted in shallow water (to ~3 m depth), while large juveniles and sub-adults are found in deeper water (C. Sasso, SEFSC, pers. comm. 2022). Numerous sub-adult (Chabot *et al.* 2021) and possibly adult-sized green turtles have also been sighted in the Homosassa Shipping Channel, where the water depth is ~4 m (M. Bresette, IRG, pers. comm. 2022). The Gulf Specimen Marine Laboratory has tagged and released several green turtles; one turtle caught and tagged off Piney Island near Panacea, Florida was caught in the same seagrass bed several years later (J. Rudloe, pers. comm., August 31, 2016). Between 1995 and 1997, 11 green turtles were captured in nets set in narrow channels or over shallow seagrass beds in Apalachee Bay (FWC online data 2022).

In SW Florida, one to 12 green turtles have been sighted in waters of Charlotte Harbor, or captured in waters off Collier County, Siesta Key, Longboat Key, and Tampa Bay during dredging relocation projects (FWC online data 2022). In a pier study, over 1,000 fishers were interviewed over three years; 7.7 percent reported catching sea turtles within the past 12 months, and 4.4 percent reported catching sea turtles within Tampa Bay (M. Flint, University of Florida and Florida Aquarium, unpublished data 2016). This area appears to host a low density of foraging/resting green turtles.

Many green turtles forage on seagrass beds found in waters of Monroe County, which includes Florida Bay, Florida Keys, Marquesas Keys, Dry Tortugas, Everglades, and Cape Sable. These areas appear to be especially important foraging/resting areas for subadults and adults, who migrate to these areas after mating and nesting (Bagley and Welsh 2022). Analyzing transect survey data (i.e., 187 green turtles observed over 364 km), Bagley and Welsh (2022) found increasing green turtle density, as they surveyed further south and west through the Florida and Marquesas Keys, with an estimated 15,957 adults and subadults and 4,655 juvenile green turtles in the 1,500 km^2 area surveyed. Eastern Quicksands, located west of Marquesas Keys, hosts one of the densest aggregations of foraging adults (47.3 turtles/km^2) and subadults (72.5 turtles/km^2) in Florida and worldwide (Welsh and Mansfield 2022). At eastern Quicksands and other locations around Marquesas Keys, 1,087 green turtles were sighted foraging on seagrass beds (*T. testudinum*, *S. filiforme*, and *H. wrighti*): adults and subadults were found in depths of 3 to 5 m, and smaller turtles foraged in shallower waters of less than 3 m (Herren *et al.* 2018). Bresette *et al*. (2010) describe juvenile green turtles foraging in shallow seagrass habitat (i.e., less than 2 m) in Mooney Harbor of the Marquesas Keys. Large juvenile (and adult) green turtles exhibited extended site fidelity to foraging sites in Dry Tortugas National Park, primarily in areas with submerged rooted vascular plants (Fujisaki *et al.* 2016), where the turtles appear to primarily consume seagrass and macroalgae, with some incidence of omnivory (Roche 2016). Hart (unpublished data 2015) identified 205 juveniles foraging in the Dry Tortugas from 2008 to 2015. In the Lower Florida Keys (from Big Pine Key to Boca Chica Key just east of Key West), IRG (unpublished data 2022) observed 108 green turtles (up to 1.86 turtles/km) over 268 kilometers of vessel based visual transects; IRG also captured 64 of these turtles, ranging in size ranged in size from 29.7 – 91.9 cm SCL. An area ~30 km off Cape Sable appears to be another important adult resident foraging/resting area, as demonstrated by tracking data of 10 post-nesting females in SW Florida (Sloan *et al*. 2022). Their 50 percent core use resident areas ranged from 8 to 904 km^2, with a mean of 296 ± 309.3 km^2 (Sloan *et al*. 2022). The Everglades National Park may represent an important developmental habitat and foraging/resting area in shallow waters to 10 m depth (Hart and Fujisaki 2010). Schroeder (NMFS unpublished data 2022) documented 595 sightings of juvenile green turtles over a 19-year period (2000 to 2018) in a relatively small area of the western portion of Florida Bay (within the boundaries of Everglades National Park), in waters generally less than 3m depth. Additionally, green turtles forage near Ten Thousand Islands, western Everglades (Witzell and Schmid 2004). Hart *et al.* (2013) and Hart *et al.* (2021) tracked 22 females from their nesting beaches in the Dry Tortugas to foraging/resting areas in the Florida Keys National Marine Sanctuary, the Dry Tortugas, the Marquesas Keys, Biscayne National Park (part of SE Florida), and Everglades National Park. FWC and NMFS (unpublished data 2016) tracked 12 post-reproductive individuals to these same locations, where they foraged in depths of 4.1 to 27.3 m (with an average of 12.8 m and a standard deviation of 6.9 m) near patchy or continuous seagrass habitat. Of 15 turtles satellite tracked from the Archie Carr NWR between 2013 and 2015, 14 migrated to foraging areas in the Florida Keys/Florida Bay region (Figure 24; Chabot 2018; D. Bagley, University of Central Florida unpublished data 2016). The other turtle was tracked to a foraging area in SE Florida.

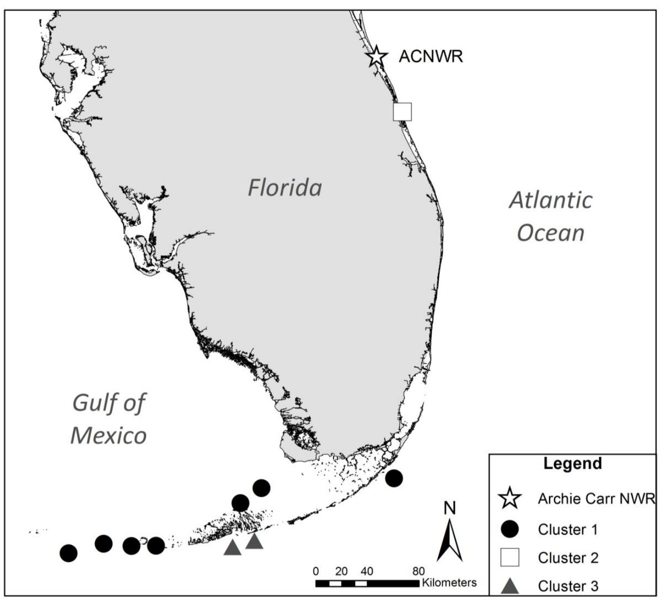


Figure 24. Foraging areas in Monroe County, Florida
Symbols represent foraging areas identified by tracking nine females and six males from the Archie Carr NWR between 2013 and 2015 (Chabot 2018; D. Bagley, University of Central Florida unpublished data 2016).

SE Florida is another important foraging/resting area for green turtles (Redfoot and Ehrhart 2000; Hirama and Ehrhart 2007; Kubis *et al.* 2009; Long *et al.* 2021; Kelley *et al.* 2022). As summarized by Witherington *et al*. (2006), green turtles forage through the winter in Mosquito

Lagoon and the Indian River Lagoon Complex (Ehrhart 1983; Ehrhart *et al.* 2007; Long 2021; Kelley *et al.* 2022); within Port Canaveral (Redfoot and Ehrhart 2000); on nearshore Atlantic reefs from Brevard to Broward counties (Guseman and Ehrhart 1990; Wershoven and Wershoven 1992; Bresette *et al.* 1998); and juveniles forage in nearshore, hardbottom habitats in St. Lucie County (Bresette *et al.* 1998; Foley 2005). A large green turtle fishery flourished in the Indian River during the 19th century (Ehrhart 1983). Now, the Indian River Lagoon Complex is an important foraging/resting area for green turtles; however, from 2000 to 2018, juvenile green turtle abundance has declined, concurrent with declines in seagrass and, since 2011, macroalgae (Long 2021). Green turtles also forage in the Banana River and adjacent Mosquito Lagoon, off Brevard and Volusia Counties on the east central coast of Florida, where shallow depths (i.e., 1.5 m average depth) support extensive seagrass beds, including *S. filiforme* (manatee grass) and *H. wrightii* (shoal grass) (Ehrhart 1983; Mendonça 1983). Juveniles forage on algae along the rock riprap-lined embayment of the Trident Submarine Basin (i.e., Turning Basin) at Port Canaveral (Redfoot and Ehrhart 2013) and the Cape Canaveral Shipping Channel (Henwood 1987; Holloway-Adkins and Hanisak 2017), indicating that man-made environments may also contain the foraging/resting EFs. Juveniles also forage in water depths of 2.0 to 6.0 m at a hard-bottom, nearshore reef segment in Broward and Palm Beach Counties. This is an especially important foraging and resting area because of the worm rock reef that provides refugia habitat (Guseman and Ehrhart 1990) and supports macroalgae species, including *G. mammillaris* (Makowski *et al.* 2006).

In 2021 and 2022, IRG conducted 23 5-km surveys between West Palm Inlet and approximately 20 kilometers north of Sebastian Inlet, in Palm Beach, Martin, St. Lucie, Indian River, and Brevard Counties; they observed 44 adult females, 43 adult males, 80 sex-unidentified adults, and 14 juveniles (Welsh and Witherington 2023). From 1994 to 2018, 4,215 green turtles were drawn into the intake canal of the St. Lucie Power Plan (Bentley *et al.* 2021). Between September 1998 and January 2000, 73 green turtles were captured at Jennings Cove, also in St. Lucie County (Perrault *et al.* 2021). From 2017 to 2022, IRG captured 50 juvenile green turtles foraging on sandy seagrass beds in Jupiter Inlet and the Intracoastal Waterway in Palm Beach County Florida (IRG unpublished data 2022).

Between 2010 and 2012, Stadler *et al*. (2015) observed 351 juvenile green turtles (including resightings) swimming, breathing at the surface, or resting on the bottom of nearshore reef habitat in Palm Beach County (Breakers = 29 turtles/km and Boca Raton reefs = 44 turtles/km) and Broward County (Broward North, Middle, and South reefs = 77 turtles/km); the greatest abundance occurred at the Boca Raton reef (n = 85). From 2005 to 2013, Gorham *et al.* (2016) observed 719 juvenile green turtles (0.80 observations per transect kilometer) foraging on seagrass in the urbanized Lake Worth Lagoon, Palm Beach. K. Hart (USGS, pers. comm. 2022) captured 16 adult green turtles in Biscayne Bay National Park. Biscayne Bay historically hosted green turtles in sufficient abundance to support a fishery (Witzell and Schmid 2004). Although the salinity of the Bay increased over the 20th century due to decreased freshwater input, Biscayne Bay currently contains extensive seagrass beds, and sightings and captures have revealed the presence of numerous green turtles ranging from approximately 20 to 60 cm carapace length (C. Sasso, SEFSC, pers. comm. 2022).

In NE Florida, from Cape Canaveral to Georgia, NMFS (SEFSC unpublished data 2022) captured 41 juvenile green turtles in trawls between 1986 and 1991. This area appears to host a moderate density of foraging/resting green turtles (A. Foley, FWC pers. comm. 2022).

In addition to these scientific studies, stranding data (including thousands of records of cold-stunned turtles) demonstrate green turtle use of foraging and refugia areas throughout Florida estuarine and marine habitats (FWC unpublished data 2022). Based on the above data, we conclude that the nearshore waters of Florida, from the shoreline (mean high water) to 20 m depth, contain the benthic-foraging and resting EFs that may require special management considerations or protections.

4.2.4.3.4 Georgia and South Carolina

Seagrass cover is very low in Georgia and South Carolina and few studies have focused on green turtle presence and habitat use in this region.

In Georgia, juveniles are anecdotally reported to forage on macroalgae (e.g., *Ulva* spp.) on docks and rock pilings, and necropsies of stranded turtles indicate that they also consume invasive red algae (*Graciliaria vermiculophylla)* and *Spartina alterniflora* (M. Dodd, GA DNR, pers. comm. 2022). A study of live-bottom reefs within Grays' Reef National Marine Sanctuary found that three green turtles wedged themselves into sandstone ledges for rest (Auster *et al.* 2020).

In South Carolina, green turtles were historically reported as being present at low population levels. During the late 1800s, small juvenile green turtles were infrequently captured incidental to other fisheries and sold commercially, with maximum annual take estimated at ~150 individuals (True 1884). Since 2019, SCDNR satellite tracked eight turtles (for a total of 625 standardized observation days), all of which remained in waters off southern Georgia and NE Florida (Figure 25; M. Arendt, SCDNR; C. Eastman, University of FL Whitney Sea Turtle Hospital; D. Evans, Sea Turtle Conservancy; T. Norton, Jekyll Island Georgia Sea Turtle Center; unpublished data 2022). Aerial surveys and strandings data (seen Section 4.2.4.3) and fisheries bycatch data provide additional information about sea turtle occurrence in South Carolina waters. Between 1992 and 2014, a total of 330 turtles were incidentally captured by inshore fisheries in Port Royal Sound, St. Helena Sound, Charleston Harbor, Cape Romain, and Winyah Bay (M. Pate, SCDNR unpublished data 2016). The majority of these captures comprise bycatch in trammel net fisheries (n > 300 from 1992 to 2012; M. Arendt, SCDNR pers. comm. 2015). SCDNR captured 21 green turtles in trawl surveys between 2000 and 2021(SCDNR unpublished data 2022). Additional bycatch data are available for the region. For example, the southeastern U.S. Atlantic coast shrimp otter trawl fishery captured 1 green turtle in try nets and 1 green turtle in standard nets in shelf waters between 2007 and 2017, with total bycatch mortality 95% credible intervals estimated from 2 to 86 green turtles (Babcock *et al.* 2018).

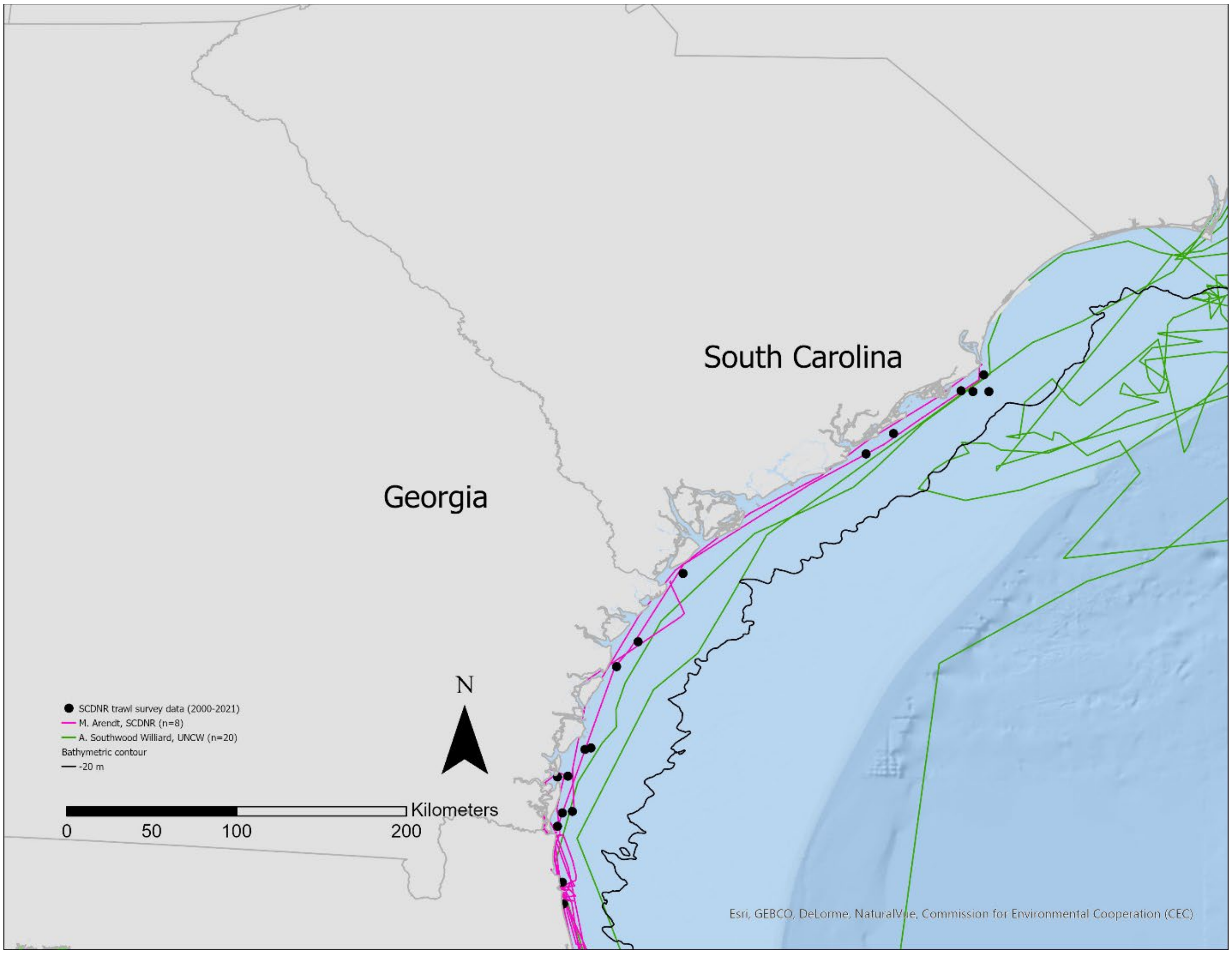


Figure 25. Benthic foraging and resting areas in Georgia and South Carolina
Black dots represent green turtles (21) captured during trawl surveys from 2000 to 2021. Pink lines represent eight satellite tagged turtles (M. Arendt, SCDNR; C. Eastman, University of FL Whitney Sea Turtle Hospital; D. Evans, Sea Turtle Conservancy; T. Norton, Jekyll Island Georgia Sea Turtle Center; unpublished data 2022); green lines represented 20 turtles tracked from North Carolina (A. Southwood Williard, University of North Carolina Wilmington unpublished data 2022); black line represents the 20 m isobath (USGS 2013); light green polygons (none present) represent seagrass cover (CEC 2021).

4.2.4.3.5 North Carolina

Seagrass and other submerged aquatic vegetation are found throughout nearshore waters of North Carolina (Figure 26; *http://portal.ncdenr.org/web/mf/habitat/SAV*). Juvenile green turtles forage on seagrass beds in shallow water in Core, Pamlico, Bogue, and Albemarle Sounds (Epperly *et al.* 1995; Bass *et al.* 2006; Epperly *et al.* 2007b; McClellan and Read 2009; McClellan *et al.* 2009). Juveniles also forage in Back Sound and the Cape Fear, New, and White Oak River estuaries from April through November (Avens *et al.* 2003; Avens and Lohmann 2004; Snoddy *et al.* 2009; Snoddy and Southwood Williard 2010) or December (Southwood Williard *et al.* 2017). Within the Albemarle-Pamlico Estuarine System, a comprehensive survey conducted during 2006 and 2007 documented an areal extent of 100,843 acres of seagrass beds.

A subsequent survey during 2013 demonstrated an overall decrease of 5.6 percent in this areal extent, with a decrease in continuous seagrass extent of 34.2 percent, but an increase in patchy seagrass extent of 18.4 percent (Field *et al.* 2021).

Figure 26. Submerged aquatic vegetation in North Carolina
(*http://portal.ncdenr.org/web/mf/habitat/SAV*; accessed July 7 2016; NC Division of Marine Fisheries; Earthstar Geographics, Esri, HERE, DeLorme)

Green turtles were documented to commonly occur in North Carolina's inshore waters as early as 1884, prior to which the population had been sufficient to support a small-scale fishery both for individual fisher consumption and commercial sale (True 1884). These green turtles were reported to be small (about 8 lb each; True 1884), with maximum reported weights of 80 and 150 lb (Coker 1906), suggesting that the majority of green turtles inhabiting these waters were juveniles. At the peak of the fishery as many as 100 green turtles might be caught at one time and turtles would be "shipped by the barrel" for sale (Coker 1906). However, by the early 1920s, green turtles were rarely encountered and their scarcity was attributed to overfishing and egg collection from southern nesting beaches (Coker 1906).

During characterization of inshore sea turtle populations from 1988 to 1992, collaborating commercial fishers in Core and Pamlico Sounds reported that juvenile green turtles comprised 4 to 16 percent of the annual sea turtle bycatch (total n = 21; Epperly et al. 1995). Subsequent standardized fishery-dependent sampling conducted in Core and Pamlico Sounds from September through November, 1997 to 2009, demonstrated a significant increase in green turtle CPUE of 4,250 percent and an increased proportion of green turtles in the species distribution from 19 to 42 percent (Epperly *et al.* 2007a; Braun McNeill *et al.* 2018). This increase in the number of green turtles captured corresponded with a significant decrease in size distribution, with the predominant SCL size class shifting from 30-35 cm to 25-30 cm (Braun McNeill et al. 2018). Furthermore, analysis of green turtle bycatch in the NC inshore gillnet fishery indicated an increase in CPUE of more than 650 percent between 2001 and 2016 (Putman *et al.* 2020). These published data demonstrating green turtle presence in NC waters are further supported by data on incidental captures collected by the NC Division of Marine Fisheries and the NMFS Beaufort Laboratory (n = 1,485; Figure 27), stranding records (n = 2,969; Figure 13), and necropsy data indicating that at least 43.5 percent of necropsied turtles (n = 485) had seagrass or other vegetation in their gut (NCWRC unpublished data 2015). Analyzing a subset of incidental captures (n = 757) indicates that most individuals are juveniles, with an average SCL of 32.4 cm, a minimum SCL of 20.6 cm, and a maximum SCL of 94.5 cm (SEFSC unpublished data 2022). Incidental captures (Figure 27) confirm that the EFs extend westward into the Pamlico and Albemarle Sound estuaries and northward into the Cape Fear, New, and White Oak Rivers (Epperly *et al*. 2007; SEFSC unpublished data 2015). Seven juveniles that survived capture in gillnets in the lower Cape Fear River remained there (within a 3 km radius of the capture site) after release for up to 42 days (Snoddy and Williard 2010). Similarly, 10 juveniles (27.9 to 42.5 cm SCL) captured in Core, Back, and Pamlico Sounds were found to inhabit areas from Bogue Sound to Pamlico Sound. These turtles were strongly associated with seagrass habitat (most frequently at the edge of seagrass beds) and retreated into the beds when disturbed by natural and anthropogenic activities, including vessel and fishing activities (McClellan and Read 2009). In general, each turtle used a restricted area and showed little movement during the summer, followed by an increase in movement during the fall, consistent with an onset of migratory behavior (McClellan and Read 2009). Generally, turtles occupied mean temperatures between 26 and 28 °C in water depths of generally less than one meter (but up to depths of four meters) and in areas close to the shoreline, near seagrass meadows (McClellan and Read 2009). During winter months when water temperatures fall below habitable levels, juveniles typically move out of shallow estuarine waters to deeper waters on the North Carolina shelf south of Cape Hatteras, migrate south along the continental shelf to waters off the coast of Florida, or migrate east to oceanic waters in the North Atlantic (Epperly *et al.* 1995; Read *et al.* 2004; Southwood Williard *et al.* 2017). Barden Inlet and the Cape Lookout Bight appear to be important transit routes, although other nearby inlets are also used by green sea turtles to move in and out of NC estuarine waters (McClellan and Read 2009; Southwood Williard *et al.* 2017). During rapid drops in water temperatures in NC estuarine waters in fall and winter months, juvenile green sea turtles may be susceptible to cold-stunning (Niemuth *et al.* 2020). In early 2016, more than 1,800 hypothermic green sea turtles were documented in eastern Pamlico and southern Core Sounds in a 4-week period, documenting the importance of these foraging/resting areas (NCWRC unpublished data 2016).

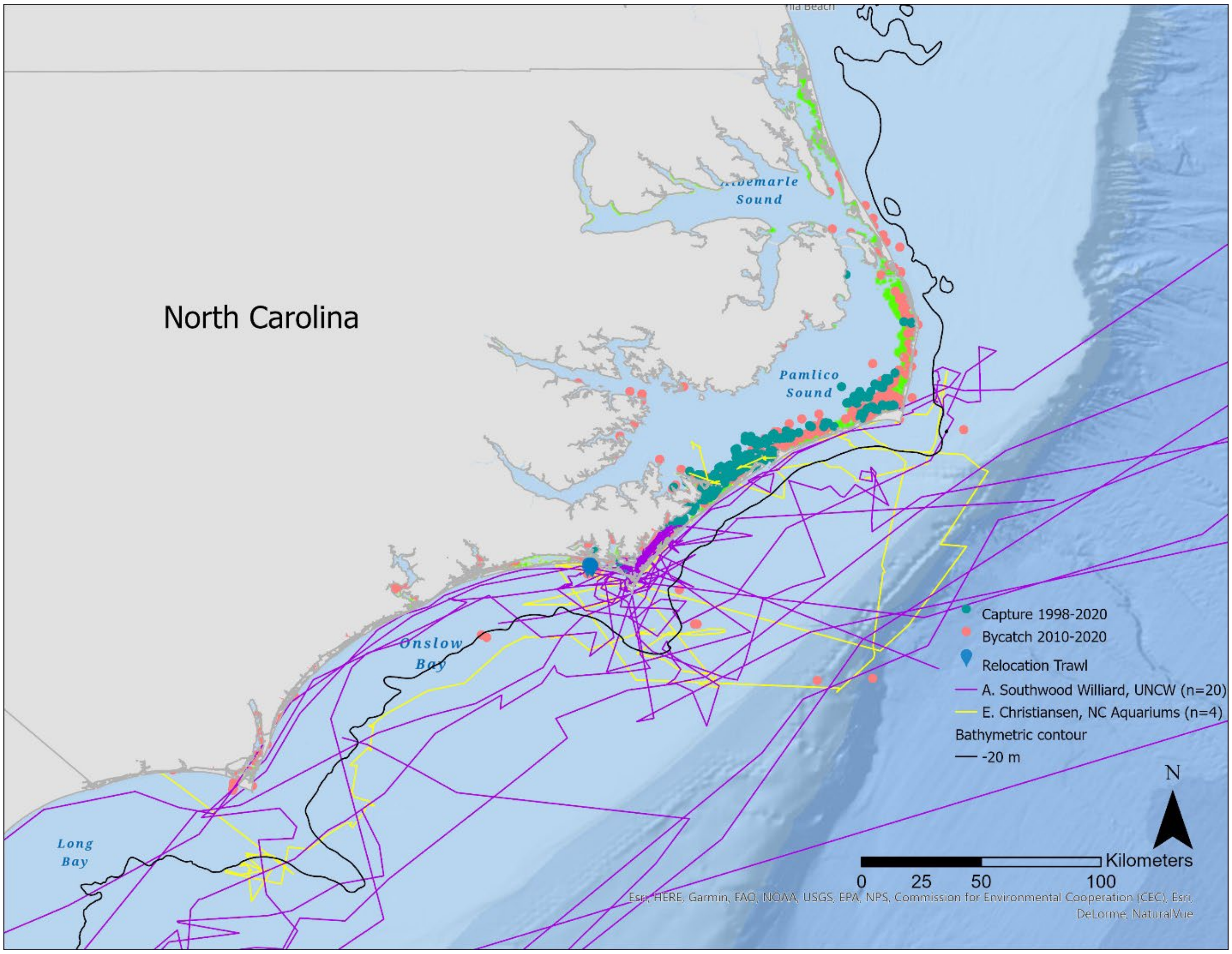


Figure 27. Benthic foraging and resting areas in North Carolina

Green dots represent turtles captured during research studies (L. Avens, SEFSC unpublished data 2022); red dots represent incidentally captured turtles (NC Division of Marine Fisheries, and NMFS Beaufort Laboratory, unpublished data 2016); blue markers represent areas where relocation trawls occurred. Purple lines represent 20 satellite-tracked turtles (A. Southwood Williard, University of North Carolina Wilmington unpublished data 2022); yellow lines represent four satellite tracked turtles (E. Christiansen, H. Broadhurst, NC Aquariums, and M. Godfrey, NC Wildlife Resources Commission unpublished data 2022). Light green polygons represent seagrass cover (CEC 2021); black line represents the 20 m isobath (USGS 2013).

4.2.4.3.6 Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, and Massachusetts

Seagrass beds are found throughout inshore and nearshore waters from Virginia through Massachusetts (Figure 28). Green turtles occur in this area, but there are few published studies. Aerial survey data indicate the presence of green turtles in neritic waters from Virginia to New York (Figure 12; S. Barco, Virginia Aquarium unpublished data 2022 and AMAPPS unpublished data 2022). Schwartz (1960) published the first record of a green turtle in Maryland's Chincoteague Bay, along the Atlantic coast. Green turtles occur in the Chesapeake Bay (Hardy 1972; Barnard *et al.* 1989) and in parts of the Potomac River, where they graze on underwater grasses (Carter and Rybicki 1985). Analyses of stomach contents of turtles stranded in Virginia and Maryland suggest that these turtles are foraging on eelgrass and macroalgae, including *Ulva* spp. (Bellmund *et al.* 1987; Barco *et al.* 2015). In a research study, four green turtles were captured alive in pound nets set in Maryland Chesapeake Bay waters (around Fishing Bay) from 2004 through 2006, one of which was a recapture (Kimmel 2006, 2007). These occurrence data are corroborated by S. Barco (Virginia Aquarium & Marine Science Center unpublished data 2022), who acoustically tagged and monitored seven green turtles using a Navy acoustic receiver array in the Virginia Chesapeake Bay, James River tributary, and coastal ocean waters (Figure 28). Evaluating stranding data and drift scenarios, Santos *et al.* (2018a) identified mortality hotspots off southeastern Virginia and within the lower Chesapeake Bay, including the Bay mouth and the lower James River. Stranding, cold stun, and incidental capture data also demonstrate the presence of green turtles from Virginia to Massachusetts (Figure 28). Twelve cold stunned green turtles were rehabilitated and released with satellite tags by the New England Aquarium; most exhibited normal migratory behaviors, moving south or offshore as water temperatures dropped; however, one remained in Long Island Sound (Figure 28; Robinson *et al.* 2020).

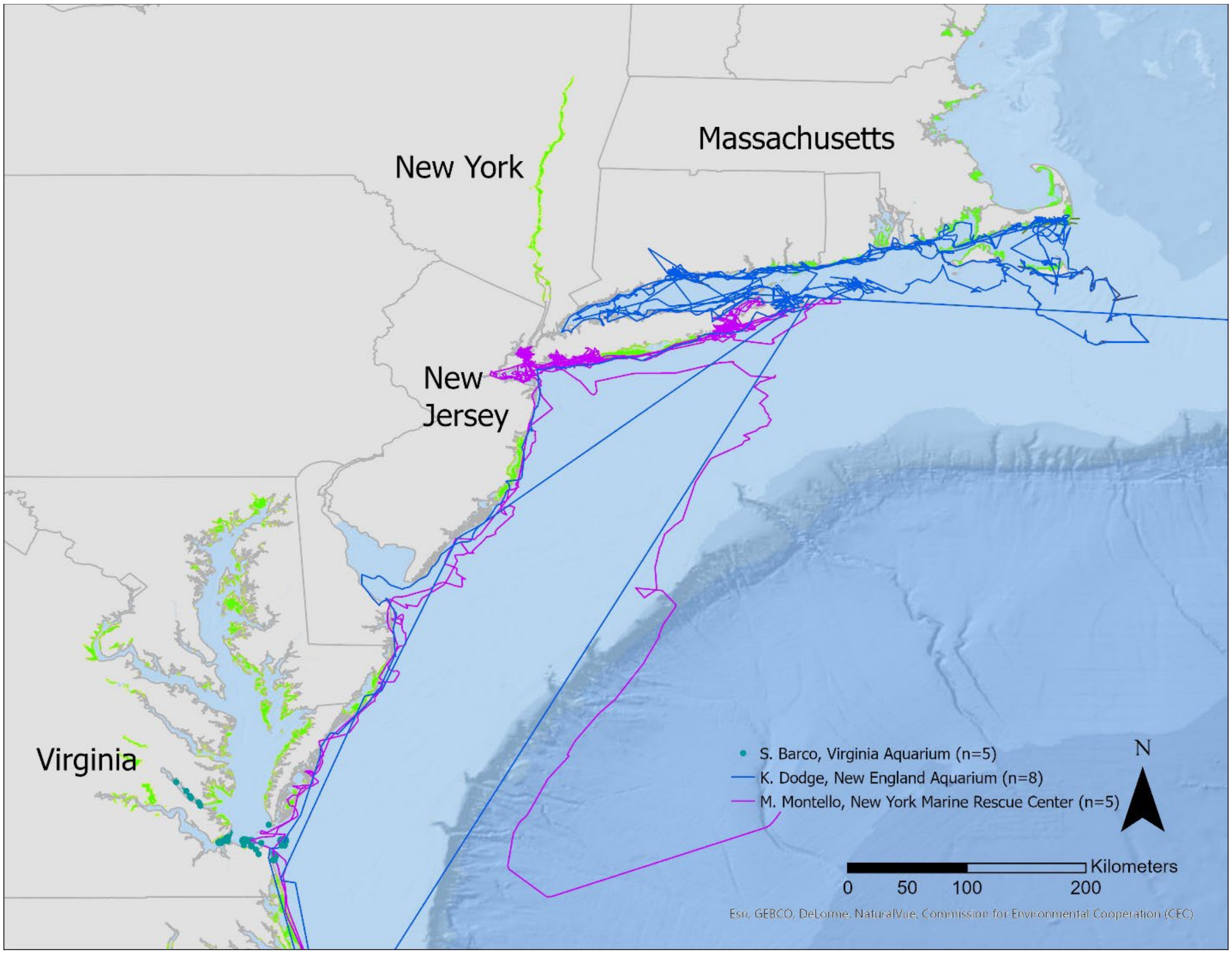


Figure 28. Benthic foraging and resting green turtles between Virginia and Massachusetts
Green dots represent acoustic data (S. Barco, Virginia Aquarium unpublished data 2022); blue lines represent eight satellite tagged rehabilitated green turtles (K. Dodge, New England Aquarium unpublished data 2022); purple lines represent five green turtles satellite tracked after rehabilitation and release in New York waters (M. Montello, New York Marine Rescue Center unpublished data 2021); light green polygons represent seagrass cover (CEC 2021).

In New York, juvenile green turtles forage on seagrass and algae throughout the eastern Peconic Bay Estuary system, Long Island Sound, and in Shinnecock Bay on Long Island's southern shore (Montello *et al.* 2022). Since 1998, 174 cold-stunned green turtles have beIn these areas, 35 green turtles were incidentally captured in pound nets between 2002 and 2004 (Figure 29; Morreale *et al.* 2005). Between 1988 and 1992, 30 green turtles were captured and tagged in New York waters. Seven individuals were recaptured, indicating residency, with one 38 cm green recaptured approximately a year after initial encounter 13 km distant from its original tagging site in Gardiners Bay (Morreale and Standora 1998). Based on the annual timing of encounters, green sea turtles appear to reside in these waters seasonally, arriving in early July and departing in October. Evaluation of gut contents during necropsy demonstrated that these green turtles in this area are foraging on algae and eelgrass (*Zostera marina*) (Burke *et al.* 1992). Growth rates calculated for the 7 recaptures (ranging from 20 to 40 cm SCL) demonstrated significant positive somatic growth and rates of growth comparable to those observed in other regions. Two green turtles were recovered in North Carolina within 180 days after originally being tagged during the foraging season in New York, indicating capacity for seasonal migration to avoid lethally cold water temperatures. Since 2019, five green turtles were rehabilitated, satellite tagged, and released by the New York Marine Rescue Center (M. Montello, New York Marine Rescue Center unpublished data 2021). Several turtles remained in New York waters before transmissions ceased, two migrated south along the coast, and one moved south in more offshore waters (Figure 28).

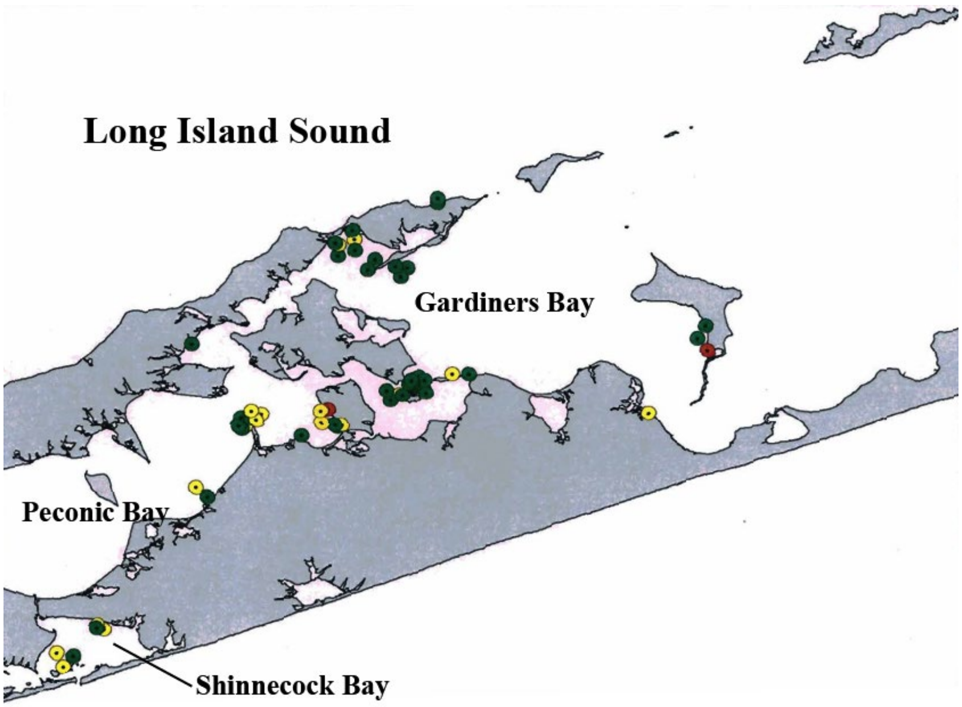


Figure 29. Juvenile green turtles (n = 35) captured in pound nets from 2002 to 2004
Green dots represent juvenile green turtles (Morreale *et al.* 2005)

4.2.4.3.7 Puerto Rico

In Puerto Rico, green turtles forage on seagrasses, macroalgae, and invertebrates and rest on coral reefs. Seagrass is especially abundant around Culebra and Vieques Islands (Figure 30).

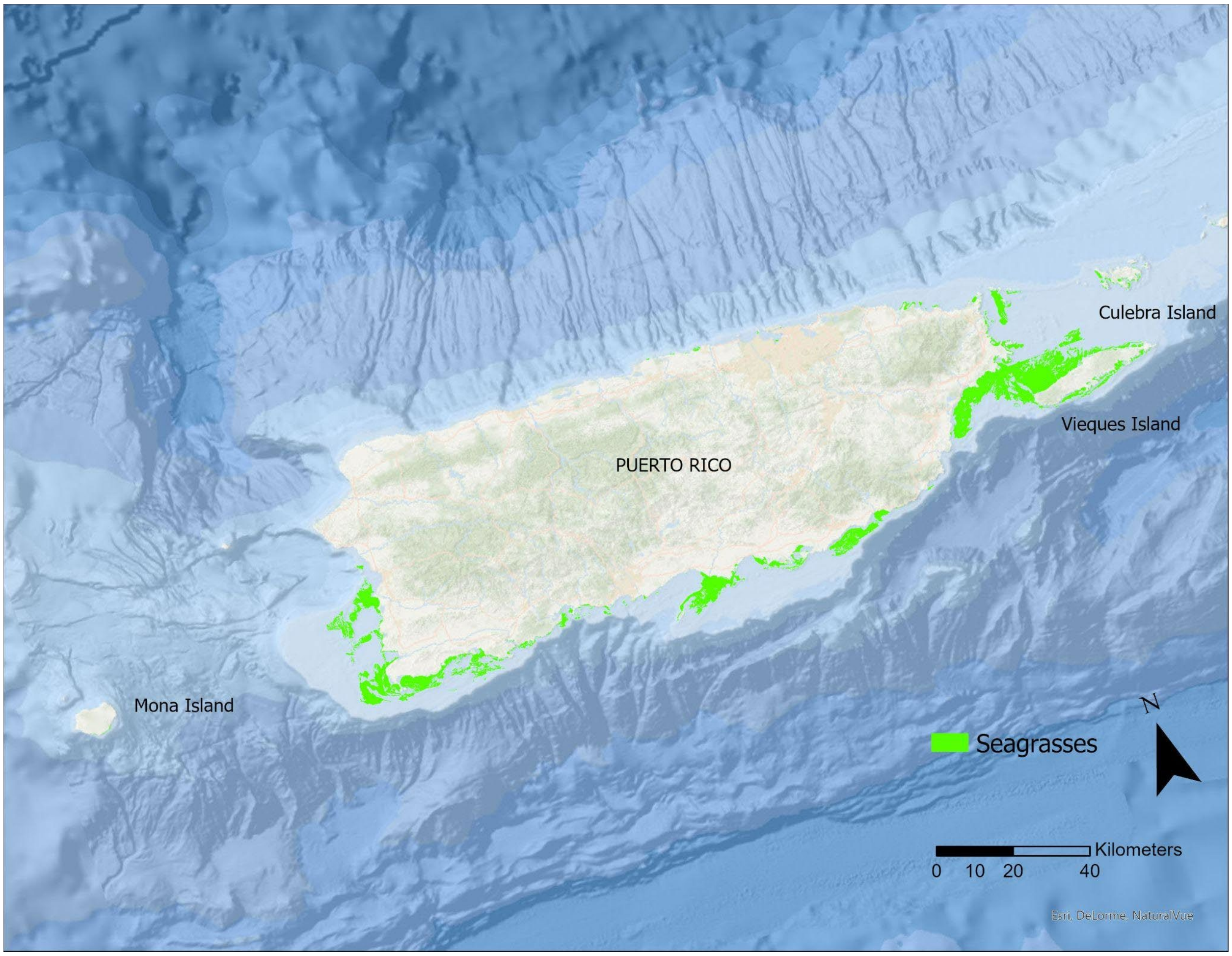


Figure 30. Seagrass coverage around Puerto Rico
Seagrass is shown in green (https://marinecadastre.gov/data/).

In Puerto Rico, juveniles forage throughout shallow, nearshore areas of Culebra Island, in inshore bays around Mona Island, and on the northern coast of the main island of Puerto Rico. From 1985 to 2021, 840 green turtles, mainly juveniles, have stranded in Puerto Rico (C. Diez, PRDRNA, unpublished data 2022). The existing critical habitat designation (63 FR 46693, September 2 1998) identifies the marine areas around Culebra Island, from the mean high water line extending seaward 5.6 km (3 nautical miles), as essential to the conservation of the species. These waters include Culebra's outlying Keys including Cayo Norte, Cayo Ballena, Cayos Geniquí, Isla Culebrita, Arrecife Culebrita, Cayo de Luis Peña, Las Hermanas, El Mono, Cayo Lobo, Cayo Lobito, Cayo Botijuela, Alcarraza, Los Gemelos, and Piedra Steven. This is the only designated critical habitat for green turtles at the time of this analysis.

Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This designation was based largely on 165 green turtles captured at Culebra between 1987 and 1989 in depths of 9.1 m or less (Collazo *et al.* 1992). Collazo *et al*. (1992) found that juveniles foraged on seagrass beds at Culebrita Island, Mosquito Bay, Puerto Manglar, and Tamarindo Grande. Patrício *et al.* (2014) and Patrício *et al.* (2017)

confirmed that Culebra areas continue to contain foraging and resting EFs and serve as an important juvenile developmental habitat for juvenile green turtles. Griffin *et al.* (2017) recommended continued protection of this critical habitat unit to ensure recruitment into the adult life stage. A mitochondrial DNA mixed stock analysis of 103 juvenile green turtles foraging around Culebra Island indicates origin from four stocks: Costa Rica, Mexico, Florida, and Suriname (Patrício *et al.* 2017). Capture data (n = 665) over 13 years of surveys at Culebra Island indicate that juvenile turtles reside in Tortuga Bay (n = 122 turtles; Patrício *et al.* 2014) and Manglar Bay (n = 187 turtles; Patrício *et al.* 2014), where juveniles forage on the seagrasses, *S. filiforme* and *H. wrightii*, and the algae *T. testudinum*. There is little movement between the two areas, and each bay appears to represent a distinct foraging ground with a unique aggregation of juveniles (Patrício *et al.* 2011). Acoustic tracking of 21 green turtles (38 to 70 cm SCL) confirmed high site fidelity within each Bay, with little connectivity between the Bays (Griffin *et al*. 2019). Green turtles were also captured in Mosquito Bay, where seagrass beds are abundant (Patricio *et al.* 2014).

These data support the designation of waters around Culebra as areas containing the foraging and resting EFs; however, we are not aware of any data to support the designation to 5.6 km (3 nautical miles). The original designation was based largely on the data presented by Collazo *et al*. (1992), but these data described turtles foraging and resting in 9.1 m or less (Collazo *et al*. 1992). Studies of green turtles conducted over 20 years at Culebra further support foraging and resting EFs in depths of 20 m or less (C. Diez, PRDRNA pers. comm. 2022).

Recent rapid assessments identified high-density foraging and resting areas off the main island of Puerto Rico, where juvenile turtles aggregate at Punta Salinas, Escambron-Normandy, and Arrecifes Isla Verde (Figure 31; C. Diez, PRDRNA unpublished data 2022). While Culebra supports a greater overall abundance of green turtles, these small areas host especially high densities of green turtles (C. Diez, PRDRNA pers. comm. 2022). For example, 30 green turtles were captured off Punta Salinas in 2 days, and another 10 green turtles were sighted in 2 hours (C. Diez, PRDRNA unpublished data 2022). Additional rapid assessment surveys have identified green turtles in seagrass and coral reef habitats throughout the northern coast of the main island of Puerto Rico (Diez 2022). Green turtles were observed foraging and resting in “urban” sites, including: Escambron (San Juan; n = 45), Rompeolas (n = 33), Tres Palmas (Rincon; n =25), Isla Verde (Carolina; n = 40), and Pt. Salinas (n = 26) in the municipality of Toa Baja (Diez 2022). An estimated 80 to 90 percent of these turtles exhibit FP (C. Diez, PRDRNA pers. comm. 2022). The presence of green turtles during these rapid assessments indicates that the area supports EFs in sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, and growth.

Figure 31. Benthic foraging and resting areas in Puerto Rico identified during rapid assessments (Diez 2022)

Around Mona Island, turtles are most commonly observed off the southern coast, in Sectors 1 and 5 (Figure 32; C. Diez and R. vanDam, DRNA-PR unpublished data 2021). All size classes have been observed, but most are juveniles and sub-adults (30 to 50 cm), especially in Sector 5 (C. Diez and R. vanDam, DRNA-PR unpublished data 2021). In Sector 1, which is adjacent to one of the higher density green turtle nesting beaches, more adults (males and females) have been observed in recent years (C. Diez and R. vanDam, DRNA-PR unpublished data 2021). Turtles feed on Thalassia and Halodule seagrass beds off Pajargos, Brava, Coco, and Caigo no Caigo beaches (C. Diez, PRDRNA pers. comm., April 27 2016).

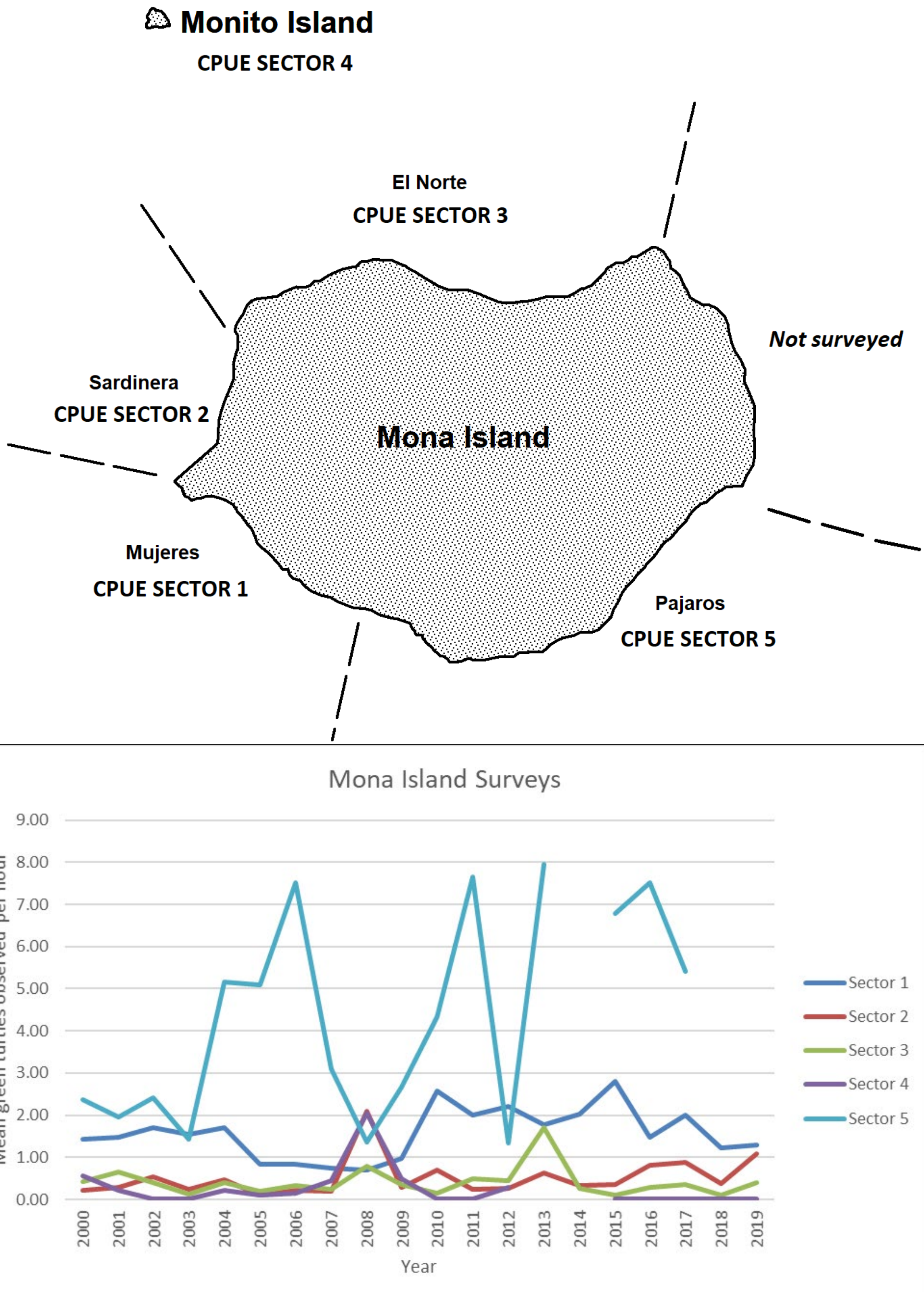


Figure 32. Green turtles observed during surveys around Mona Island
Map of Mona Island, with sectors identified; mean number of green turtles observed per hour in each sector annually (C. Diez and R. vanDam, DRNA-PR unpublished data 2021).

In addition, green turtles were identified foraging on the north central beach on Vieques Island (i.e., Mosquito Cay). To evaluate possible important foraging areas for sea turtles, DRNA-PR evaluated coastal marine habitats around Vieques (Diez 2003). They surveyed from Mosquito Cay through Bahia Esperanza to the southwest; turtles were observed along the north coast at Mosquito Cay and between Isable and Punta Goleta, at Pocito Reef in the Federal Reserve, and in lagoons in the south (including Puerto Mosquito; Diez 2003).

4.2.5 Migration (developmental)

Green turtles of the North Atlantic DPS may pass through multiple developmental habitats in coastal waters during their maturation from benthic-foraging juveniles to adults (Bolten 2003; Bresette *et al.* 2010; Meylan *et al.* 2011). In addition, some juveniles appear to use deeper waters as they mature (M. Lamont, USGS, and M. Bresette, In-water Research Group, pers. comm. 2022). As juvenile green turtles approach 70 cm SCL, they leave northern embayments and migrate south to open grazing habitats in more tropical waters or start using deeper waters (Witherington *et al.* 2006). Of 16 juvenile turtles tagged in the Indian River Lagoon system of east-central Florida, seven were recovered as sub-adults or adults at foraging grounds in Cuba, seven in Nicaragua, one in Belize, and one in the Dominican Republic (L. Ehrhart unpublished data, cited in Witherington *et al.* 2006; Ehrhart *et al.* 2007). Bresette *et al*. (2010) also encountered a large number of sub-adults foraging at the eastern Quicksands, in the Marquesas Keys, Florida. Welsh and Mansfield (2022) found spatial segregation of large juvenile and adult green turtles, which may reflect differences in benthic habitat preferences and predator detection/avoidance. We have accounted for these movements during our analysis of benthic foraging and resting EFs because we included waters to 20 m depth, which includes the waters used to move from shallow to deeper depths. Furthermore, we included all benthic foraging and resting EFs, including those that apply to juveniles and adults (which includes the intermediate life stage of sub-adult). Finally, when gathering data on green turtles, we focused on the *occurrence* of green turtles within this DPS because we could not distinguish between turtles that were actively foraging/resting and those that were moving to other foraging/resting areas. For these reasons, we concluded that developmental migratory behavior is addressed under the foraging and resting EFs.

4.3 Benefit to the North Atlantic DPS

In Figure 33, we summarize the areas containing EFs essential to the conservation of the North Atlantic DPS that may require special management considerations or protection. Where we had sufficient data to do so, we also include a qualitative measure (high, medium, or low) of the benefit that these areas provide to the DPS (Table 4). We did not rate areas where there were data deficiencies or a high degree of uncertainty. All areas containing reproductive and migratory EFs are of high conservation value because they are directly linked to population growth and recovery. Females must use reproductive areas to reach the nesting beaches considered for proposed critical habitat designation by USFWS and for internesting. These areas are also essential for successful mating and post-hatchling swim frenzy. The migratory corridor is also of high benefit to the DPS because adult males and females use it to migrate between reproductive and foraging/resting areas. The area containing foraging and resting EFs for surface-pelagic individuals is of high benefit because it is the only area that provides the EFs required for their survival, growth, and development. For all other foraging/resting areas, we rated areas based on available data on green turtle usage, abundance, and density.

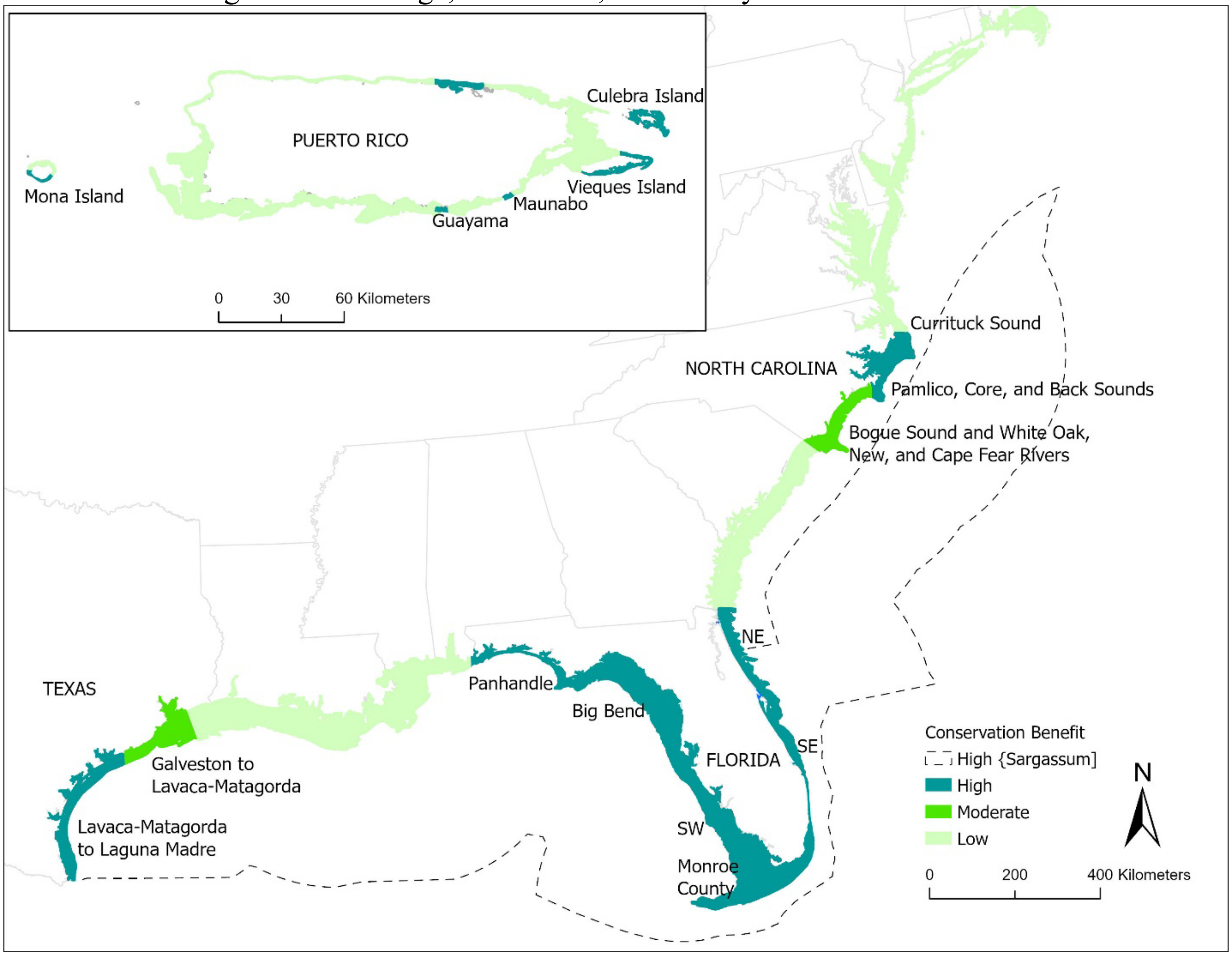


Figure 33. Areas containing the EFs essential to the conservation of the North Atlantic DPS

Dark green represents high conservation value areas from mean high water to 20 m depth; medium green represents moderate conservation value areas from mean high water to 20 m depth; light green represents low conservation value areas from mean high water to 20 m depth; dashed black line represents high conservation value areas containing the surface-pelagic foraging/resting EFs from 10 m depth to the outer boundary of the loggerhead Atlantic and Gulf of Mexico Sargassum critical habitat designation.

Table 4. Areas containing the EFs and their relative value to the North Atlantic DPS

Area	Value	Rationale
Sargassum	High	Surface-pelagic foraging/resting EFs; essential for early development and only area that provides the EFs required for the survival, growth, and development of the surface-pelagic juveniles; high density of foraging and resting post-hatchlings and surface-pelagic juveniles (Witherington *et al*. 2012; Hardy *et al*. 2018; Mansfield *et al*. 2021).
Texas		

Area	Value	Rationale
Laguna Madre to Lavaca-Matagorda Bay (including Lavaca-Matagorda Bay)	High	Foraging/resting EFs; high density foraging (Shaver *et al*. 2013; Metz *et al*. 2013; Metz *et al*. 2020; Howell and Shaver 2021; P. Plotkin and N. Wilderman, Texas A&M University unpublished data 2022; D. Shaver and S. Walker, NPS unpublished data 2022)
Lavaca-Matagorda Bay to Galveston Bay	Moderate	Foraging/resting EFs; moderate density foraging (Shaver *et al*. 2019; D. Shaver and S. Walker, NPS unpublished data 2022)
Texas (all other areas)	Low	Foraging/resting EFs;
Louisiana	Low	Foraging/resting EFs; low density overall, despite concentration of foraging turtles at Belle Pass and to a lesser degree at Chandeleur Islands and Ship Shoals (K. Hart, USGS unpublished data 2022)
Mississippi	Low	Foraging/resting EFs; low density of green turtles as demonstrated by stranding data.
Alabama	Low	Foraging/resting EFs; low density of green turtles as demonstrated by stranding data.
Florida		
NW Florida (Panhandle)	High	Reproduction, migratory, and foraging/resting EFs; some high density reproductive areas (M. Lamont, USGS unpublished data 2022); west coast migratory corridor; moderate density foraging (Lamont et al. 2015; Lamont and Iverson 2018; Lamont et al. 2018; Siegfried et al. 2022; Lamont and Johnson 2021a/b; A. Foley, FWC unpublished data 2022)
NW Florida (Big Bend)	High	Foraging/resting EFs; high density juvenile foraging (Wildermann et al. 2019; Wildermann et al. 2020; Chabot et al. 2021; A. Foley, FWC unpublished data 2022; M. Fuentes, Florida State University unpublished data 2022)
SW Florida	High	Reproduction, migratory, and foraging/resting EFs; some high density reproductive areas; west coast migratory corridor (Hart et al. 2020; Sloan et al. 2022; K. Mazzarella, Mote Marine Laboratory unpublished data 2022); moderate density foraging (A. Foley, FWC unpublished data 2022)
Monroe County	High	Reproductive, migratory, and benthic foraging and resting EFs; many high density reproductive areas; destination for east and west coast migratory corridors (Hart et al. 2013; K. Hart, USGS unpublished data 2014 and 2015; M. Lopez, ProNatura unpublished data 2022); high density juvenile and adult foraging areas (Bresette et al. 2010; Fujisaki et al. 2016; Hart et al. 2020; Hart et al. 2021; Welsh and Mansfield 2022)
SE Florida (from Cape Canaveral to Monroe County) including:	High	Reproductive, migratory, and foraging/resting EFs; many high density reproductive areas; east coast migratory corridor (Schroeder et al. 2008; D. Bagley, University of Central Florida unpublished data 2016; B. Schroeder, NMFS unpublished data 2022); high density foraging especially at worm rock reefs (Ehrhart 1983; Guseman and Ehrhart 1990; Wershoven and Wershoven 1992; Bresette et al. 1998; Redfoot and Ehrhart 2000; Bresette et al. 2002; Makowski et al. 2006; Stadler et al. 2015; Gorham et al. 2016; Holloway-Adkins and Hanisak 2017; Long et al. 2021)

Area	Value	Rationale
NE Florida (from Georgia border to Cape Canaveral)	High	Reproduction, migratory, and foraging/resting EFs; some high density reproductive areas; east coast migratory corridor; moderate density foraging (A. Foley, FWC unpublished data 2022)
Georgia	Low	Foraging/resting EFs; low density of green turtles as demonstrated by stranding data.
South Carolina	Low	Foraging/resting EFs; low density of green turtles as demonstrated by stranding and incidental capture data.
North Carolina		
Pamlico Sound	High	Foraging/resting EFs; high density of green turtles (predominantly small juveniles) inhabiting extensive seagrass habitat during the majority of the year, documented by numerous records from satellite tracking, directed captures for research, fishery bycatch, cold stuns, and strandings (McClellan and Read 2009; Braun McNeill et al. 2018; Putman et al. 2020; NCWRC unpublished 2022)
Core Sound	High	Foraging/resting EFs; high density of green turtles (predominantly small juveniles) inhabiting extensive seagrass habitat during the majority of the year, documented by numerous records from satellite tracking, directed captures for research, fishery bycatch, cold stuns, and strandings (McClellan and Read 2009; Braun McNeill et al. 2018; Putman et al. 2020; NCWRC unpublished 2022)
Back Sound	High	Foraging/resting EFs; high density of green turtles (predominantly small juveniles) inhabiting extensive seagrass habitat during the majority of the year, documented by numerous records from satellite tracking, directed captures for research, fishery bycatch, cold stuns, and strandings (McClellan and Read 2009; Braun McNeill et al. 2018; Putman et al. 2020; NCWRC unpublished 2022)
Bogue Sound	Moderate	Foraging/resting EFs; moderate density of green turtles (predominantly small juveniles) inhabiting areas of extensive submerged aquatic vegetation, documented by fishery bycatch and strandings (NCWRC unpublished 2022)
White Oak River	Moderate	Foraging/resting EFs; moderate density of green turtles (predominantly small juveniles) inhabiting areas of extensive submerged aquatic vegetation, documented by fishery bycatch and strandings (NCWRC unpublished 2022)
New River	Moderate	Foraging/resting EFs; moderate density of green turtles (predominantly small juveniles) inhabiting areas of extensive submerged aquatic vegetation, documented by fishery bycatch and strandings (NCWRC unpublished 2022)
Cape Fear River	Moderate	Foraging/resting EFs; moderate density of green turtles (predominantly small juveniles) inhabiting areas of extensive submerged aquatic vegetation, documented by satellite tracking, fishery bycatch, and strandings (Snoddy

Area	Value	Rationale
		and Southwood Williard 2010; NCWRC unpublished 2022)
North Carolina (all other areas)	Low	Foraging/resting EFs; low density of green turtles (predominantly small juveniles) documented by lower numbers of satellite tracking, relocation trawling, fishery bycatch, and stranding observations (Southwood Williard et al. 2017, NCWRC published 2022)
Virginia	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few acoustic tracks, incidental bycatch, and strandings
Maryland	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few incidental captures and strandings
Delaware	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few strandings
New Jersey	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few strandings
New York	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few satellite tracks, incidental bycatch, and strandings
Massachusetts	Low	Foraging/resting EFs; low density of green turtles (predominantly juveniles), as demonstrated by few satellite tracks and strandings
Puerto Rico		
Culebra Island	High	Foraging/resting EFs; existing critical habitat since 1998; high abundance (highest in Puerto Rico) of foraging/resting green turtles as demonstrated by tagging (i.e., 700 turtles in 20 years; C. Diez, PRDRNA unpublished data 2022) and numerous studies (Collazo *et al*. 1992; Diez *et al*. 2010; Patrício *et al*. 2014; Patrício et al. 2017; Griffin *et al*. 2019)
Vieques Island (East and Couth)	High	Reproductive and foraging/resting EFs; high density nesting; density of foraging/resting turtles is unknown because while there is abundant seagrass cover, we have little data on foraging/resting turtles (C. Diez, PRDRNA unpublished data 2022).
Vieques Island (other areas)	Low	Foraging/resting EFs. Density of foraging/resting turtles is unknown because while there is abundant seagrass cover, we have little data on foraging/resting turtles (C. Diez, PRDRNA unpublished data 2022).
Puerto Rico (Maunabo)	High	Reproductive and foraging/resting EFs; high density nesting.
Puerto Rico (Guayama)	High	Reproductive and foraging/resting EFs; high density nesting.
Puerto Rico (north coast including Punta Salinas, Escambron, and Arrecifes Isla Verde Natural Reserve)	High	Foraging/resting EFs; highest density of foraging/resting green turtles (C. Diez, PRDRNA unpublished data 2022)
Mona Island (southern)	High	Reproductive and foraging/resting EFs; high density nesting; low density of foraging/resting turtles (C. Diez, PRDRNA unpublished data 2022).

Area	Value	Rationale
Mona Island (northern)	Low	Foraging/resting EFs; low density of foraging/resting turtles (C. Diez, PRDRNA unpublished data 2022).
Puerto Rico (all other areas)	Low	Reproductive and foraging/resting EFs

5. SOUTH ATLANTIC DPS

5.1 Geographical Area Occupied by the South Atlantic DPS

The South Atlantic DPS is defined as green turtles originating from the South Atlantic Ocean, including those hatching from nests on the beaches of the USVI. The DPS is bounded by the following lines and coordinates: along the northern and eastern coasts of South America (east of 7.5° N., 77° W.); 14° N., 77° W. to 14° N., 65.1° W. to 19° N., 65.1° W. in the north and west; 19° N. Lat. in the northeast; 40° S. 19° E. in the southeast; and 40° S. Lat. in the south. This area includes waters outside of U.S. jurisdiction. If we apply the U.S. EEZ, we are left with the range of the DPS within U.S. jurisdiction (Figure 34); however, the range of this DPS also overlaps with the range of the North Atlantic DPS.

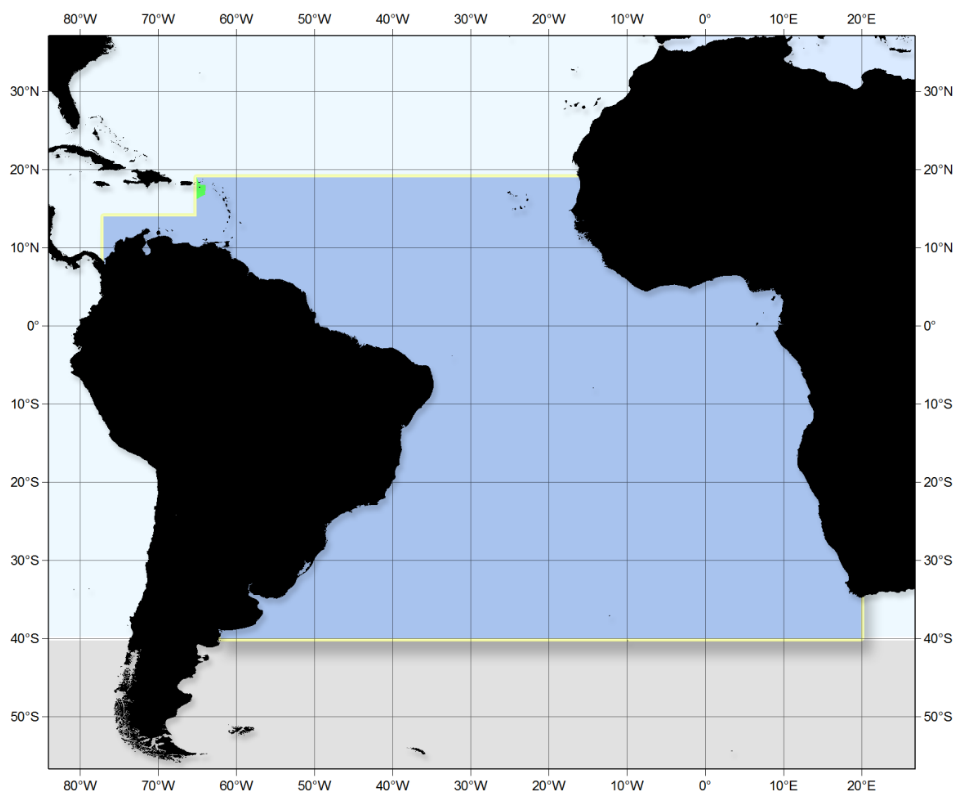


Figure 34. Range of the South Atlantic DPS within U.S. jurisdiction
Blue indicates the defining boundaries of the DPS; green (upper left) indicates the range of the DPS within the U.S. EEZ.

5.2 Essential Features

A recovery plan, with associated recovery criteria, has yet to be developed for the South Atlantic DPS. To identify the EFs essential to the conservation of the South Atlantic DPS, we referenced the Recovery Plan for the U.S. Population of the Atlantic Green Turtle (NMFS and USFWS 1991), which includes the South Atlantic DPS within U.S. jurisdiction (i.e., USVI) and identifies recovery criteria to delist the species (i.e., the goal of the plan). The recovery criteria are described in Section 4.2 for the North Atlantic DPS. We used this information, the best available scientific data, and unpublished data to describe the marine EFs, areas containing the EFs, whether the EFs may require special management considerations or protection, and the conservation value of the areas to the DPS.

5.2.1 Reproduction

The recovery of the DPS is dependent on successful reproduction. While nesting occurs on beaches (i.e., terrestrial habitat, under USFWS jurisdiction), the marine areas surrounding the nesting beaches are essential for mating, movement of reproductive females on and off nesting beaches, internesting, and the swim frenzy of post-hatchlings.

5.2.1.1 Reproductive EFs Essential to the Conservation of the South Atlantic DPS

The following reproductive EFs are essential to the conservation of the South Atlantic DPS: In depths up to 20 m, sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date) to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings.

To identify the EFs, we used information on the life history of the species (Section 3) and referenced the terrestrial critical habitat designation likely to be proposed by the USFWS. In addition, we used the following information to provide additional specificity. Many green turtles regularly mate in the waters around Sandy Point National Wildlife Refuge, which hosts 1,200 to 1,800 nests per year (K. Stewart, Ocean Foundation and Claudia Lombard, USFWS pers. comm. 2022). To determine the distance from shoreline that is essential to the conservation of the DPS, we considered satellite tracking data for 10 females nesting at Buck Island (USVI), which indicated that internesting females remained in nearshore (< 1.5 km), shallow waters (< 20 m depth) and within approximately 10 km of their nesting beaches (Figure 35; Hart *et al.* 2017).

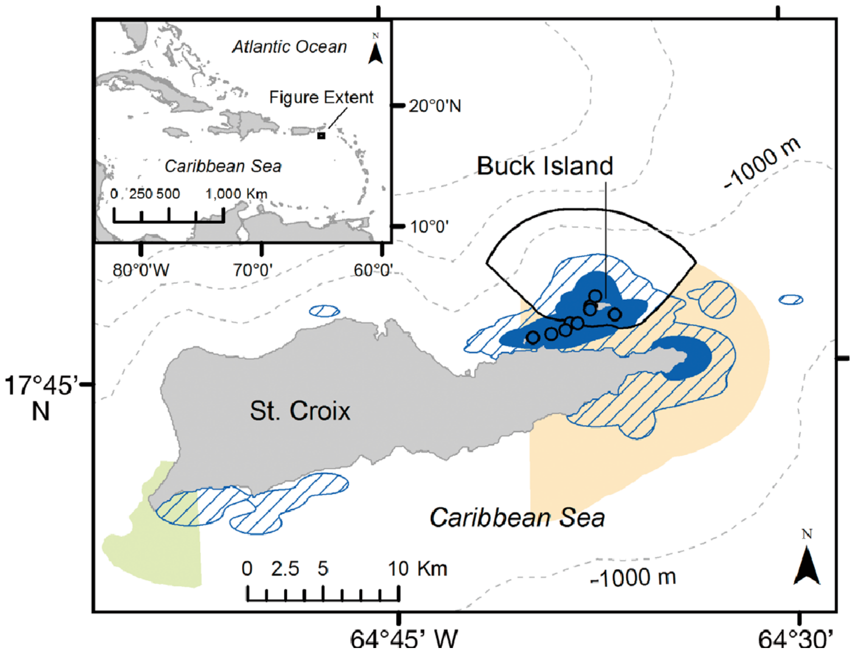


Figure 35. Internesting areas around Buck Island
Hatched blue lines show 95 percent kernel density estimation (KDE) and blue areas show 50 percent KDE core use areas for 10 inter-nesting females; black circles represent centroids of the 50 percent KDE. Shading indicates marine protected areas at East End Marine Park (orange) and Sandy Point National Wildlife Refuge (green) (Hart *et al.* 2017).

5.2.1.2 Special Management Considerations or Protection

The reproductive EFs may require special management considerations or protection to maintain unobstructed access to and from nesting beaches and disturbance-free neritic areas for mating and internesting activities. The reproductive season is a time of increased vulnerability for sea turtles because a large proportion of adults are concentrated within relatively small areas adjacent to nesting beaches (Meylan 1982). Copulating turtles may remain mounted for hours at the surface (Witherington *et al.* 2006), limiting their mobility, vigilance, and ability to avoid in-water obstructions or operations. Internesting females require disturbance-free neritic reefs to rest (Carr *et al.* 1974; Meylan 1982), escape courting males (Booth and Peters 1972), andproduce eggs for subsequent nesting (i.e., reovulation; Pearse and Avise 2001). Females and hatchlings need unobstructed waters to move to (females) and from nesting beaches (females and post hatchlings). The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the destruction of habitats from oil and gas, dredging, fishing, and vessel activities. In addition, the EFs may require special management considerations regarding neritic and offshore structures, construction, aquaculture, seismic surveys, and military activities. Climate change may result in the shift or loss of nesting beach habitat, which would alter the location or value of associated marine reproductive areas.

Nearshore structures or operations have the potential of blocking the passage of nesting females and post-hatchlings. Nearshore or offshore structures may also impact post-hatchlings' movement through the following mechanisms: disorientation due to lighting, concentration of predators, disruption of wave patterns necessary for orientation, and/or creation of excessive longshore currents.

Oil and gas activities may impact the EFs. Oil spills pose a considerable threat by obstructing or contaminating access to and from nesting beaches (Meylan 1982). Alternative energy facilities (such as wind farms and underwater turbines) and fishing, dredging, and aquaculture may block passage of reproductive individuals or post-hatchlings. Construction (on land and in water), vessel traffic, military activities, and seismic surveys may also act as deterrents (visual or auditory) to reproductive individuals, preventing their use of preferred areas.

5.2.1.3 Areas Containing the Reproductive EFs

To identify areas containing the EFs essential to the conservation of the DPS, we used information on nesting beaches considered for proposed critical habitat by USFWS. USFWS and its technical advisors used the following criteria to select nesting beaches within the geographical range of the DPS which have: (1) the highest nesting densities, (2) a good representation of total nesting, (3) a good spatial distribution (to ensure protection of genetic diversity), and (4) the inclusion of expansion areas - beaches adjacent to those with the highest density nesting.

USFWS applied these criteria to nesting beaches in USVI that occur primarily in St. Croix. USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat within St. Croix and which will be published as a proposed rule in the Federal Register. For each of the nesting areas, we identified the associated marine area, from the shoreline to the 20 m depth contour, as containing the reproductive EFs essential to the conservation of the DPS and which may need special management consideration or protection.

5.2.2 Migration

The recovery of the DPS requires that adult turtles reproduce and forage/rest. When reproduction and foraging/resting areas are geographically separated, turtles must successfully migrate between these areas; however, reproductive individuals of the South Atlantic DPS generally do not migrate from nesting beaches to distant foraging areas. Instead, most (7 of 10 tracked post-nesting females) remain resident in USVI waters for both reproduction/nesting and foraging/resting (Hart *et al.* 2017). Those that migrate to distant areas do not appear to use narrow, constricted migratory corridors: long-distance captures of adults tagged at Buck Island (n = 3) reveal the use of multiple pathways, over oceanic waters (Hart *et al.* 2017).

Given these data, we concluded that green turtles of this DPS do not use a narrow, constricted migratory corridor. Instead, they use multiple oceanic migratory paths. We were unable to identify a particular depth or distance from shore used by adult green turtles to migrate between reproductive and benthic foraging/resting areas. We were also unable to identify any other physical or biological feature used by migrating turtles because the best available data demonstrate variation among movement patterns of individuals in oceanic habitats. That is to say that migration is not constricted or confined by a continental shelf, current, or other feature, but rather occurs over a large, oceanic environment without defining features (such as depth or distance from shore). Therefore, while migration between reproductive and benthic foraging/resting habitats is essential to the conservation of the DPS, we were unable to identify or define a migratory feature for this DPS.

5.2.3 Foraging/Resting

The recovery of the DPS requires successful survival, growth and development of juveniles and the successful survival and reproduction of adults. Benthic-foraging habitats provide the food resources and refugia necessary to survive, develop, grow, and reproduce.

5.2.3.1 Foraging and resting EFs Essential to the Conservation of the South Atlantic DPS

The following foraging and resting EFs are essential to the conservation of the South Atlantic DPS: In depths up to 20 m, underwater refugia (e.g., rocks, reefs, and troughs) and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles and adults.

To identify the EFs, we used information on the life history of the species (Section 3). Seven of 10 tagged post-nesting females did not migrate to distance foraging/resting areas but rather foraged within 50 km of nesting beaches (Hart *et al.* 2017). Green turtles are significantly more abundant in neritic waters (within one mile of land) than offshore waters (Boulon and Olsen 1982) and forage in depths of up to 23 m (Hart *et al.* 2017). In a NMFS analysis of tracking data from Hart *et al*. (2017), comparison of 20 and 30 m depth boundaries demonstrated that a 20 m depth limit was sufficient because it accounted for 94% of the tracking data (i.e., turtles spend the majority of their time in depths under 20 m). Gehrke (2017) tracked 5 juvenile green turtles using an acoustic array in Brewers Bay. The turtles used larger core habitats for foraging on seagrass during the day and smaller core habitats for resting within nearby coral reefs and artificial dolosse reefs at night (Ogden *et al*. 1983; Gehrke 2017; P. Jobsis, University of the Virgin Islands pers. comm. 2022). Green turtles forage on the abundance of seagrass beds within USVI (Boulon 1983). We do not describe foraging and resting EFs for post-hatchlings and surface-pelagic juveniles because we do not have data to determine such EFs.

5.2.3.2 Special Management Considerations or Protection

The benthic-foraging and resting EFs for juveniles may require special management considerations or protection to maintain the food resources and refugia in neritic waters. The Recovery Plan (NMFS and USFWS 1991) indicates that protection is needed to prevent the degradation of habitats due to dredging, pollution, oil and gas, fishing, and vessel activities. The Recovery Plan specifically highlights the following activities needed to protect marine habitat: restore and limit further development in important foraging habitats (e.g., seagrass beds, which are relatively fragile habitats requiring low energy and low turbidity waters; NMFS and USFWS 1991).

The St. Croix and St. Thomas East End Marine Park Management Plans identify sea turtles, seagrass, and coral reefs (which serve as green turtle refugia) as natural resources requiring conservation and protection from threats including: land-based sources of pollution, fishing practices that impact seagrass, oil spills, and climate change.

Shipping channels within Vessup Bay, Long Bay, Crown Bay, Druif Bay and Gregorie Channel (St. Thomas) and Cruz Bay (St. John) create the risk of pollutants and disturbance to foraging and resting turtles. There has been a historical decline in the seagrass beds in Maho and Francis

Bays, St. John, U.S. Virgin Islands, due to heavy boat usage (Williams 1988). At the time of writing, 15 to 50 boats anchored nightly in the bays such that only five small seagrass beds remained in shallow water (Williams 1988). Anchor scars caused a loss of seagrass beds up to 6.5 m^2/day or 1.8 percent per year, and there was minimal regrowth within 7 months (Williams 1988). Anchors destroy the regenerative capacity of seagrass roots and rhizomes and disrupt critical nutrient remineralization processes in the sediments; such losses are expected to reduce the carrying capacity for green turtles (Williams 1998). In St. Croix, sediment contamination from coastal and upstream industrial sites has the potential to impact foraging habitat (Ross and DeLorenzo 1997).

St Thomas and St John districts are very close, less than a mile for St John, to the British Virgin Islands, which has an active and legal sea turtle fishery. The removal of adult and juvenile greens from the nearby bays of the British Virgin Islands may act as a sink for turtles in the protected waters of the USVI. Not only may turtles find vacant foraging grounds in the unprotected waters of the BVI, but the legal sale of turtle meat may increase poaching in USVI waters and explain the relatively lower turtle density in the well-protected bays within the Virgin Islands National Park on St John (Michael 2020).

5.2.3.3 Areas Containing the Foraging and Resting EFs

Within the range of the South Atlantic DPS, many areas contain food resources and underwater refugia. Specifically, USVI supports a substantial amount of seagrass beds (Figure 36), providing an abundance of food for green turtles (Boulon 1983). We rely on the occurrence of green turtles, as documented in published and unpublished scientific literature, to determine which of these areas contain sufficient resources to support survival, development, growth, and reproduction. In addition to foraging within USVI, some turtles may forage in areas identified as containing the foraging/resting EFs for the North Atlantic DPS; genetic analyses are underway to evaluate the extent of shared foraging areas.

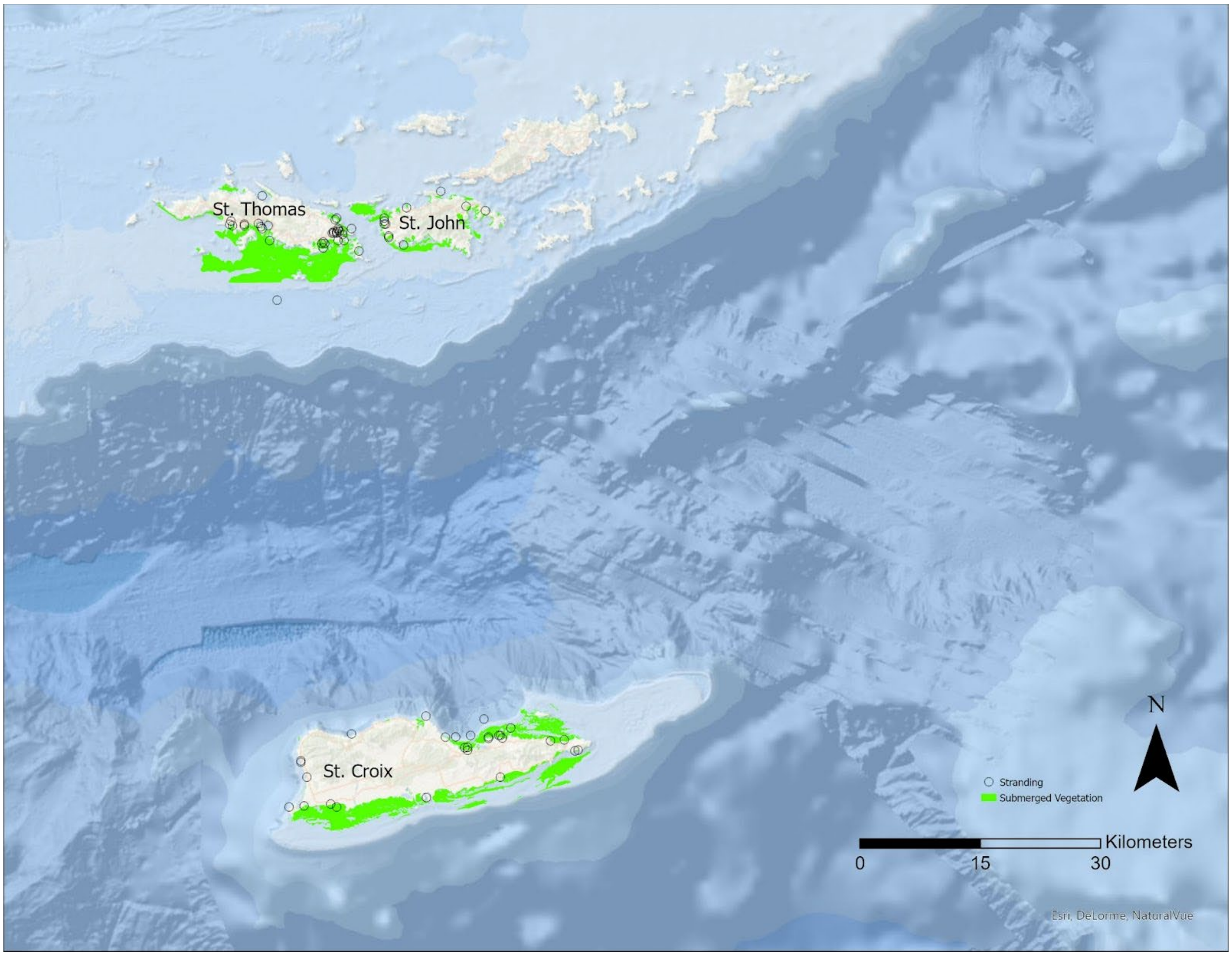


Figure 36. Seagrass cover and strandings in the USVI
Strandings shown as black circles (Sea Turtle Stranding and Salvage Network (STSSN) unpublished data 2022); submerged vegetation shown in green (National Center for Coastal Ocean Science 2022)

Foraging and resting green turtles are of highest abundance and density in the waters of St. Croix (N. Angeli and Sean Kelly, USVI DPNR pers. comm 2022). They forage within seagrass beds and rest in coral reefs. Stranding data reflect their presence in waters surrounding the island (Figure 36; USVI DPNR unpublished data 2022). In St. Croix, aerial surveys documented 108 green turtles during 25 flights over 7 months in 1979, and 173 green turtles were observed during 29 flights over 2 months in 1980 (Boulon and Olsen 1982). The highest densities were observed near Buck Island, but turtles were observed throughout waters surrounding the island ranging from 0.14 to 0.44 turtles per nautical mile (Boulon and Olsen 1982). While green turtles are found throughout the waters of St. Croix, research has focused on turtles at or near nesting beaches, including those near Buck Island and East End Marine Park.

In waters off Buck Island Reef National Monument, St. Croix, Pollock (2013) observed 132 green turtles, mainly juveniles and subadults, along the southern forereef (Figure 37). Adult sightings were positively correlated to seagrass cover (Pollock 2013). In waters off Buck Island, adults forage close to shore to 1.6 km offshore and in relatively shallow waters (up to 23 m depth; Hart *et al.* 2017), on *T. testudinum* seagrass beds (Gulick *et al.* 2020; Gulick *et al.* 2021). Juveniles also forage and rest in waters of Buck Island Reef National Monument, where they have small (on average, less than 3 km^2), specific home ranges (Griffin *et al.* 2020). K. Hart (USGS unpublished data 2022) captured 205 green turtles (mainly juveniles) around Buck Island. Near this area (in Teague Bay, St. Croix), Ogden *et al.* (1983) reported that green turtles forage on seagrass (*T. testudinum*) during the morning and afternoon and use coral reef resting sites (separated from the feeding areas by 0.2 to 0.5 km) at night and mid-day.

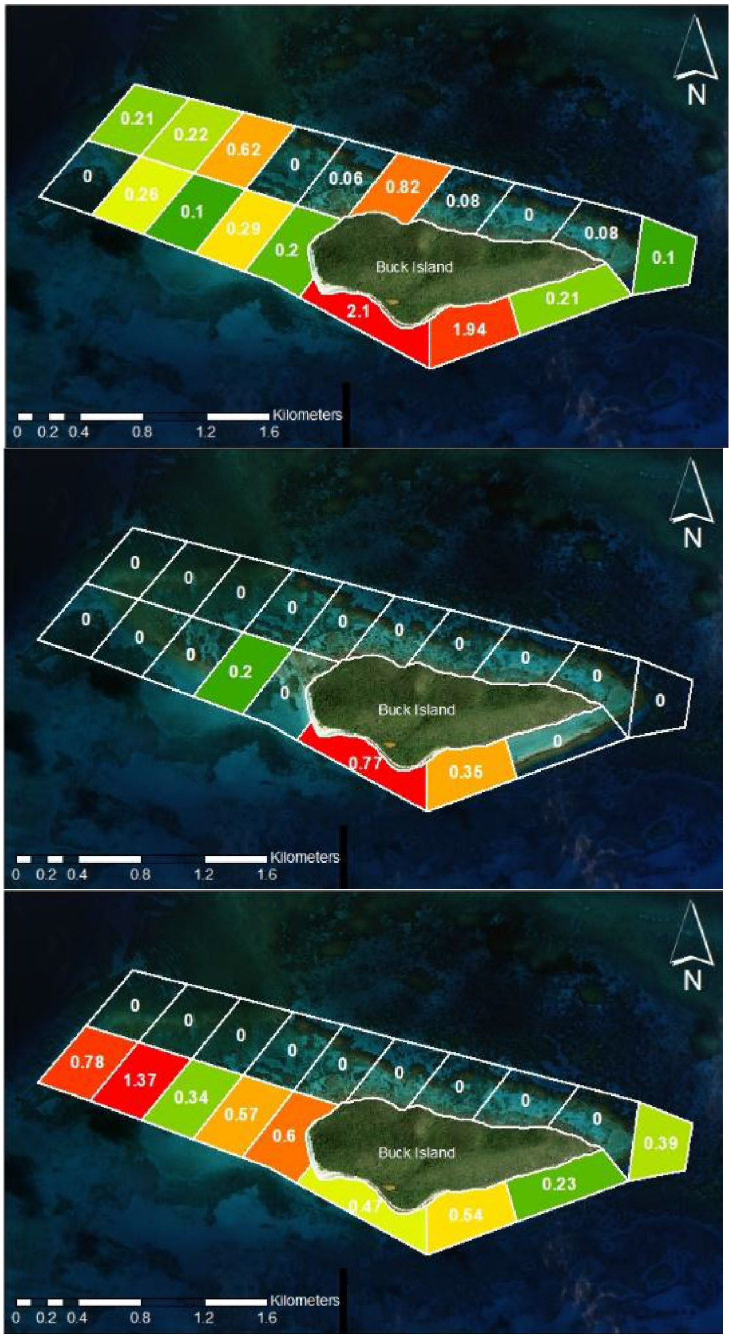


Figure 37. Juvenile, subadult, and adult relative abundance off Buck Island
Catch per unit effort (CPUE = turtles per effort corrected hour) for juveniles (top), subadults, and adults (bottom) captured in 2012 (Pollock 2013).

Additional high density foraging areas in St. Croix include East End Marine Park and the southwest portion of the island (Hart *et al.* in review). Green turtles also occur in large numbers along the south shore, such as south of the airport and off the refinery (K. Stewart, Ocean Foundation and Claudia Lombard, USFWS pers. comm. 2022), and all along the lee side of the island, near Frederiksted andthe pier(K. Stewart, Ocean Foundation pers. comm. 2022). Green turtles are observed in moderate abundance in other waters where foraging nd resting EFs are available, which occurs throughout St. Croix (K. Stewart, Ocean Foundation and Claudia Lombard, USFWS pers. comm. 2022).

Green turtles are found in moderate to high abundance in waters surrounding St. Thomas and St. John (P. Jobsis University of Virgin Islands; A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022). Michael (2020) observed 167 green turtles in 13 bays around St. Thomas and St. John (Figure 38). The highest densities of turtles (at least 1 turtle per hectare) were found in Druif (DRU), Brewers (BRE), Bolongo (BOL), Magens (MAG), and Sapphire (SAP) Bays in St. Thomas and Great Lameshur (GRE), Salt Pond (SAL), and Waterlemon (WAT) Bays in St. John (Table 5; Michael 2020). Earlier studies also identified juvenile benthic foraging areas in waters surrounding St. Thomas and St. John (Boulon and Frazer 1990). Green turtles were observed in greatest numbers in Smith Bay and Red Hook (near Sapphire Bay) and Magens Bay (Boulon 1983). The juveniles are "quite resident," exhibiting limited movement (Boulon 1983). Recapture data indicate that most turtles remained in the bay where they were tagged (Boulon 1983). Gehrke (2017) found a high bay residency rate, as the five acoustically tracked sea turtles stayed within Brewers Bay 98% of the time showing a relatively small average home range of 63.3 hectare. In 1986, Williams (1998) observed 50 to 78 green turtles foraging on seagrass in Maho and Francis Bays (St. John), moving in and out of the bays to forage and rest (Williams 1998). As with other DPSs, the presence of one or more green turtles during these rapid assessments indicates that the area supports EFs in sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, and growth.

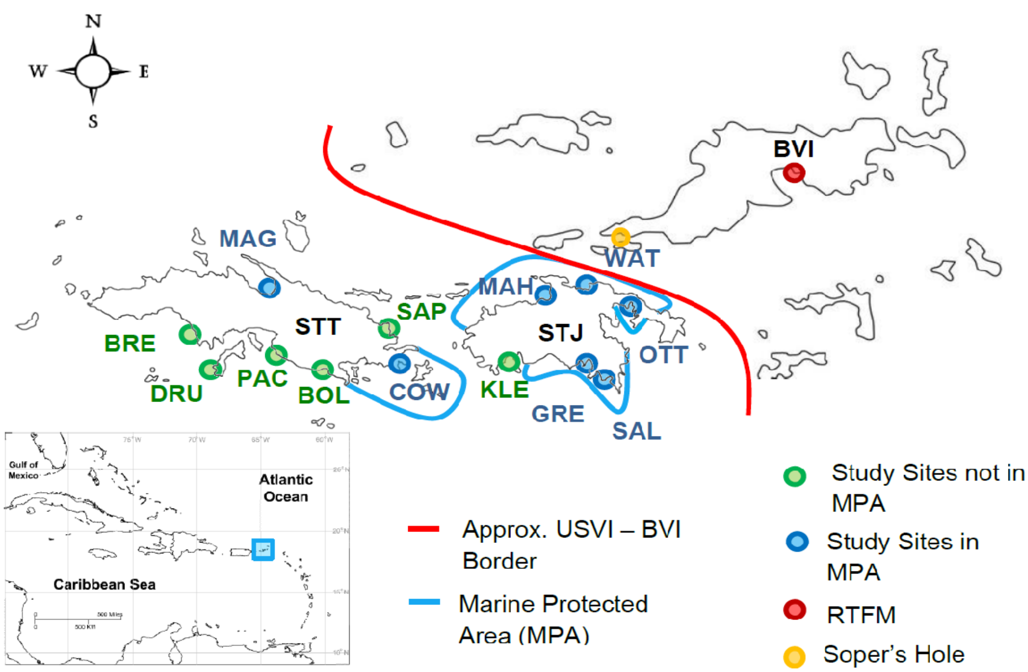


Figure 38. Occurrence of green turtles in St. Thomas and St. John
Blue circles represent study sites where green turtles were sighted (Michael 2020).

Table 5. Relative abundance of green turtles in bays of St. Thomas and St. John (Michael 2020)

Bay	Bay Area (ha)	Transect Area (ha)	Number of transects	Avg Turtles per transect	Avg Turtles per ha
BOL	5.5	0.27	10	0.6	2.5
BRE	63.0	0.88	10	5.5	6.3
COW	13.0	0.29	10	0.1	0.3
DRU	7.7	0.26	10	3.5	12.8
GRE	25.0	0.64	9	0.8	1.2
KLE	2.2	0.43	10	0.3	0.7
MAG	362.0	0.60	10	1.9	3.0
MAH	15.8	0.88	10	0.1	0.1
OTT	5.3	0.74	10	0	0
PAC	2.3	0.44	10	0.1	0.2
SAL	16.6	0.38	9	1.8	4.6
SAP	9.5	0.51	10	0.5	1.0
WAT	19.0	0.84	10	1.8	2.1

Between 1981 and 1983, resident foraging subadults and juveniles were captured in relatively large numbers at Little St. James and in the following areas of St. Thomas: Smith Bay, Magens Bay, Red Hook Point, and Thatch Cay (Boulon 1983).

Aerial surveys indicate green turtles in neritic waters off St. Thomas and St. John, where 266 green turtles were observed during 27 flights over 7 months in 1979, and 260 green turtles were observed during 21 flights over 2 months in 1980 (Boulon and Olsen 1982). The greatest densities of green turtles were observed in Magens Bay, St. Thomas and in waters around St. John (Boulon and Olsen 1982).

In St. John, A. Anderson and W. Melamet (Friends of Virgin Islands National Park pers. comm. 2022) identified several bays that have a high probability of green turtle detection: Maho, Francis, Leinster, Great and Little Lameshur, Honeymoon, Chocolate Hole, Caneel/Scott, Salt Pond, Bjork Creek/Hurricane Hole, Round Bay, Hawksnest, and Coral Bay.

5.3 Value to the South Atlantic DPS

In Figure 39, we summarize the areas containing EFs essential to the conservation of the South Atlantic DPS that may require special management consideration or protection. Table 6 lists the qualitative rating (high, medium, or low) of the conservation value that each area provides to the DPS. All reproductive areas are of high value to the DPS because nesting is paramount to the recovery of the DPS. For foraging/resting areas, we rated areas based on available data on green turtle usage and abundance, which is at least moderate in all areas of USVI and high in the areas identified in this report (N. Angelia and Sean Kelly, USVI DPNR; K. Stewart, Ocean Foundation; Paul Jobsis, University of Virgin Islands, and A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022).

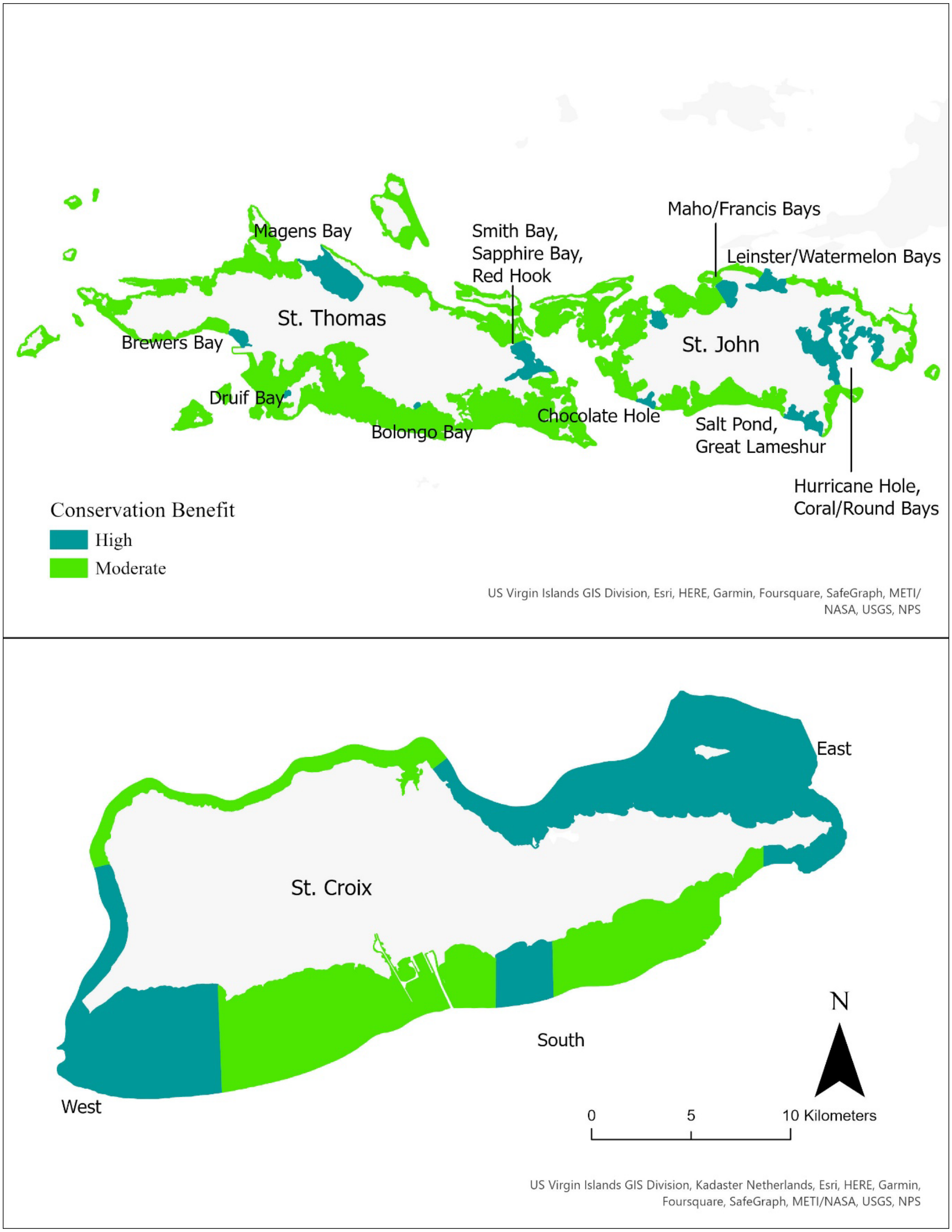


Figure 39. Areas containing the EFs and their conservation value to the South Atlantic DPS
Dark green represents high conservation value areas from mean high water to 20 m depth; medium green represents moderate conservation value areas from mean high water to 20 m depth.

Table 6. Areas containing the EFs essential to the conservation of the South Atlantic DPS

Area	Value	Rationale
St. Croix		
East including Buck Island and East End Marine Park	High	Reproductive and foraging/resting EFs; high density nesting; foraging EFs support high number of adults (Pollock 2013; Hart *et al*. 2017; Hart *et al*. in review)
West including Sandy Point NWR	High	Reproductive EFs and foraging/resting EFs; high density nesting
South	High	Reproductive EFs; high density nesting
All other areas (St. Croix)	Moderate	Foraging/resting EFs; moderate abundance of foraging and resting green turtles (K. Stewart, Ocean Foundation, N. Angeli and Sean Kelly, USVI DPNR pers. comm. 2022).
Little St. James	Moderate	Foraging/resting EFs; moderate numbers of foraging and resting juveniles (Boulon and Olsen 1982; Boulon 1983; P. Jobsis, University of the Virgin Islands pers. comm 2022)
Great St. James	Moderate	Foraging/resting EFs; moderate numbers of foraging and resting juveniles (Boulon and Olsen 1982; Boulon 1983; P. Jobsis, University of the Virgin Islands pers. comm 2022)
St. Thomas		
Druif Bay	High	Foraging/resting EFs; highest densities of turtles in USVI (12.8 turtles/hectare; Michael 2020)
Brewers Bay	High	Foraging/resting EFs; high density of turtles in USVI (6.3 turtles/hectare; Michael 2020)
Magens Bay	High	Foraging/resting EFs; high density of turtles (3 turtles/hectare; Michael 2020); foraging/resting juveniles (Boulon and Olsen 1982; Boulon 1983)
Bolongo Bay	High	Foraging/resting EFs; high density of turtles (2.5 turtles/hectare; Michael 2020)
Sapphire Bay, Smith Bay, Red Hook	High	Foraging/resting EFs; moderate density of turtles (1 turtle/hectare; Michael 2020); foraging/resting juveniles (Boulon and Olsen 1982; Boulon 1983)
All other areas (St. Thomas)	Moderate	Foraging/resting EFs; moderate numbers of foraging and resting juveniles (Boulon and Olsen 1982; Boulon 1983; P. Jobsis, University of the Virgin Islands pers. comm 2022)
St. John		
Saltpond Bay, Great Lameshur Bay	High	Foraging/resting EFs; high density of turtles (4.6 turtles/hectare; Michael 2020)
Watermelon Bay	High	Foraging/resting EFs; moderate density of turtles (2.1 turtles/hectare; Michael 2020)
Maho, Francis, and Leinster Bays	High	Foraging/resting EFs; high numbers of foraging and resting juveniles (A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022)
Hawksnest, Honeymoon, Caneel, and Scott Bays	High	Foraging/resting EFs; high numbers of foraging and resting juveniles (A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022)
Chocolate Hole	High	Foraging/resting EFs; high numbers of foraging and resting juveniles (A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022)
Hurricane Hole, Coral and Round Bays	High	Foraging/resting EFs; high numbers of foraging and resting juveniles (A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022)

Area	Value	Rationale
All other areas (St. John)	Moderate	Foraging/resting EFs; moderate numbers of foraging and resting juveniles (Boulon and Olsen 1982; Boulon 1983; A. Anderson and W. Melamet, Friends of Virgin Islands National Park pers. comm. 2022)

6. EAST PACIFIC DPS

6.1 Geographical Area Occupied by the East Pacific DPS

The East Pacific DPS is defined as green turtles originating from the eastern Pacific Ocean, including those hatching from nests on the beaches in Mexico and foraging off the coast of California. The range of the DPS is bounded by: 41° N., 143° W. in the northwest; 41° N. Lat. in the north; along the western coasts of the Americas in the east; 40° S. Lat. in the south; and 40° S., 96° W. in the southwest. If we apply the U.S. EEZ, we are left with the range of the DPS within U.S. jurisdiction (Figure 40).

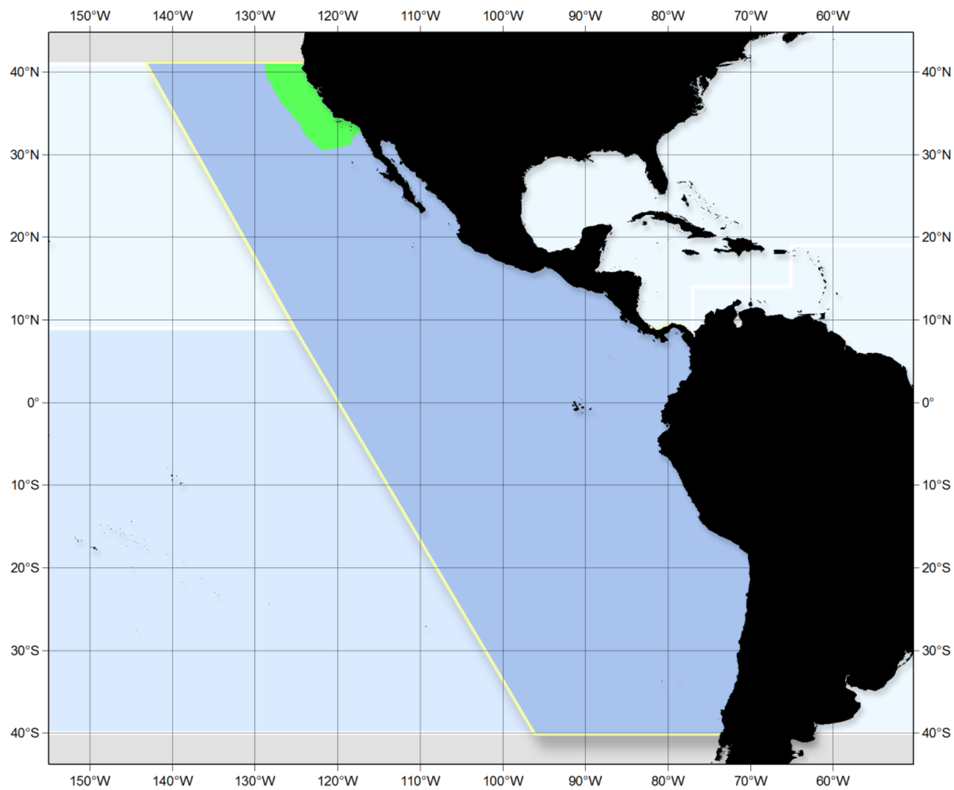


Figure 40. Range of the East Pacific DPS within U.S. jurisdiction

Blue indicates the defining boundaries of DPS; green indicates the range of the DPS within the U.S. EEZ.

6.2 Essential Features

To identify the EFs for the East Pacific DPS, we referenced the 1998 Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (NMFS and USFWS 1998b), which includes turtles of the DPS and identifies the following recovery criteria:

- All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters
- Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually over 6 years
- Nesting populations at "source beaches" are either stable or increasing over a 25-year monitoring period
- Existing foraging areas are maintained as healthy environments
- Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region
- All priority #1 tasks have been implemented
- A management plan to maintain sustained populations of turtles is in place
- International agreements are in place to protect shared stocks

To achieve these criteria, the Recovery Plan requires protection and management of marine habitat, including foraging habitats, as follows:

> "East Pacific green turtles inhabit a variety of marine habitats, although we are most familiar with their coastal habitat. Increased human presence in this and other sea turtle habitats have contributed to habitat degradation, primarily by coastal construction, increased recreational and fisheries use, and increased industrialization. Habitat loss and degradation must be prevented or slowed."

The Recovery Plan identifies the following activities needed to protect marine habitat:

1. Identify important marine habitats, which may include hatchling, juvenile and adult foraging areas and migratory ranges for all age classes
2. Ensure the long-term protection of marine habitat (e.g., *Sargassum* beds, coral reefs or seagrass and algal beds, estuarine habitats)
3. Prevent the degradation or destruction of marine habitats caused by dredging or disposal activities, which cause mechanical destruction of reefs, add suspended sediments that may damage corals and seagrasses, and smother existing flora and fauna
4. Prevent the degradation or destruction of important habitats caused by upland and coastal erosion and siltation
5. Prevent the degradation or destruction of reefs by dynamite fishing and construction blasting
6. Prevent the degradation of important habitat caused by oil transshipment activities
7. Identify other threats to marine habitat and take appropriate actions

6.2.1 Reproduction

As with the other DPSs, the following reproductive EF is essential to the conservation of the DPS: sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date), to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings. While green turtles have been observed copulating within the San Gabriel River foraging area (Cassandra Davis, Aquarium of the Pacific pers. comm. 2021), nesting beaches used by this DPS do not occur in areas under U.S. jurisdiction. Thus, USFWS is not considering proposed critical habitat for this DPS, and no areas (including San Gabriel River) contain the reproductive EF.

6.2.2 Migration

The recovery of the DPS requires that adult turtles forage and reproduce. Because foraging and reproductive areas are usually geographically separated, recovery also requires turtles to successfully migrate between these areas.

6.2.2.1 Migratory EFs Essential to the Conservation of the East Pacific DPS

The following migratory EF is essential to the conservation of the East Pacific DPS: Up to 10 km offshore, sufficiently unobstructed waters that allow for unrestricted transit between foraging and nesting areas for reproductive individuals.

To identify the EF, we used the natural history summary for the species (Section 3). In addition, we used tracking data from four individuals that were tagged in San Diego Bay, departed the Bay, and traveled south to Mexico. They remained within 10 km of the shoreline, prior to crossing the U.S.-Mexico border. These unobstructed, narrow migratory corridors are essential to the conservation of the DPS because they allow turtles to move between their nesting beaches in Mexico and foraging areas in California. Tracking data from an individual tagged at Seal Beach National Wildlife Refuge (NWR) demonstrated use of oceanic waters off southern California and Baja California, Mexico.

6.2.2.2 Special Management Considerations or Protection

During migration, reproductive individuals become concentrated into relatively narrow corridors, making them particularly vulnerable to anthropogenic threats. These narrow, constricted migratory corridors may require special management considerations or protection to ensure that passage between foraging and nesting areas is not obstructed, deterred, or disturbed by:

- Oil and gas activities such as seismic exploration, construction, removal of platforms, oil spills and response
- Alternative energy activities such as installation of turbines, offshore wind facilities, and means to convert wave or tidal energy into power
- Dredging, fishing, and aquaculture activities

Reproductive individuals are agile and able to move around minor structures within migratory corridorswithout using excessive time or energy. However, obstructions may impede their migration in narrow, coastal corridors. For example, an oil spill and resulting response activities may move turtles far off their preferred track. Similarly, energy, fishing, aquaculture, or dredging operations may deter turtles via blockages or noise (e.g., seismic surveys, Nelms *et al.* 2015). In addition, alternative energy activities, such as windfarms, may emit magnetic waves that alter the migratory paths of turtles. While we do not expect these disturbances to prevent migration, they may delay arrival at mating areas and nesting beaches, which could lead to suboptimal productivity. Furthermore, the additional energy used during migration could reduce energy available for reproductive effort.

In oceanic environments, where migration may take place over a broader area (i.e., not a narrow corridor, lacking constraint by land and the continental shelf), turtles would likely be able to avoid all impediments. Therefore, such features in oceanic environments (e.g., the area used by the individual migrating from Seal Beach NWR) do not require special management considerations or protection and thus do not meet the criteria for EFs.

6.2.2.3 Area Containing the Migratory EFs

The East Pacific DPS has a small but increasing population size. This DPS primarily nests in Mexico, Costa Rica, and Ecuador (Seminoff *et al*. 2015). Some green turtles nesting on beaches in Mexico forage in the waters of California, thus requiring migration to complete their life cycle. The foraging population in California is small and has been increasing since the early 2000s, likely as a result of increases in nesting observed at Mexico nesting beaches, which may be attributed to nesting beach protections (Cliffton *et al.* 1982; Alvarado-Díaz *et al.* 2001). Juveniles comprise the majority of the California foraging population, which is expected given the recent re-establishment of this population and a 15-25 year age-to-maturity (Seminoff *et al*. 2002).

Satellite tracking data were collected for 25 green turtles for a foraging study in San Diego Bay (SWFSC unpublished data 2021). The majority of tracked turtles were juveniles, reflecting the demography of the population. They remained in San Diego Bay to forage for the duration of the study. However, some adults were tracked, and five left the Bay (Dutton *et al*. 2019; SWFSC, unpublished data 2021). Four of the five adult turtles that left San Diego Bay migrated south to Mexico, beyond U.S. jurisdiction; the fifth turtle migrated north to other foraging areas (Figure 41). Three adult turtles were tracked to nesting beaches in Mexico, with one making the round trip back to San Diego Bay after nesting. The fourth turtle was male and presumably migrated to waters off Mexico nesting beaches to mate. Between North San Diego Bay and the U.S./Mexico border, the turtles remained close to shore (between the high water line and 10 km offshore). While the number of green turtles in San Diego Bay demonstrating use of the migratory corridor is somewhat small (n = 4), it is a large proportion of the entire foraging population, whose annual abundance was estimated by Eguchi *et al*. (2010) as ranging from 16 to 60 green turtles, with a confidence interval of 4 to 88 green turtles. Thus, the tracking data of four green turtles represents a large proportion of the population, especially given the age structure of the foraging population (i.e., mostly juveniles) and that females remigrate every three years (i.e., approximately one third of all mature females would be expected to migrate at the time of tracking). Therefore, we conclude that though small, the migratory behavior of these four turtles is representative of the population.

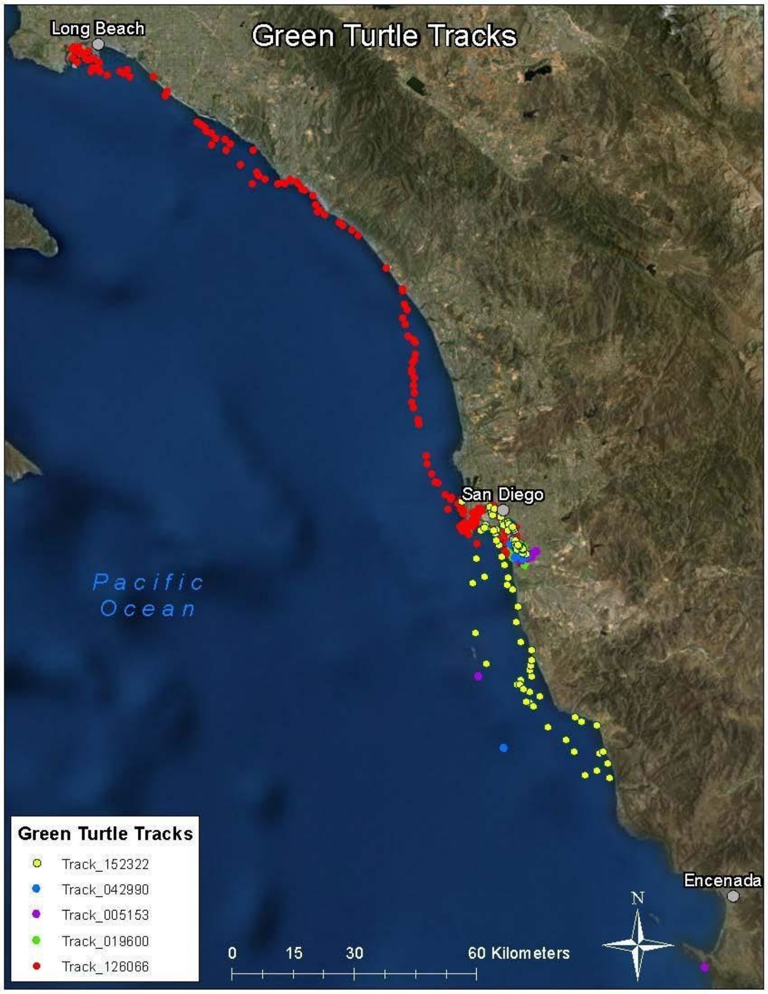


Figure 41. Satellite tracking data of five turtles captured in San Diego Bay (SWFSC unpublished data 2021)

One adult female has been satellite tagged and tracked from Seal Beach NWR to Mexico, a distance of approximately 850 km (Figure 42; SWFSC unpublished data 2022). Unlike the turtles tracked from San Diego Bay, this female did not use a nearshore narrow corridor but instead embarked on an oceanic path into offshore waters. In oceanic environments where migration may take place over a broader area (i.e., not a narrow corridor, lacking constraint by land and the continental shelf), turtles would likely be able to avoid such impediments. We were unable to identify any feature defining the migratory route taken by this turtle; she did not use a particular depth or remain within a consistent distance from shoreTherefore, we do not identify a migratory feature for the area between the Seal Beach NWR and Mexico.

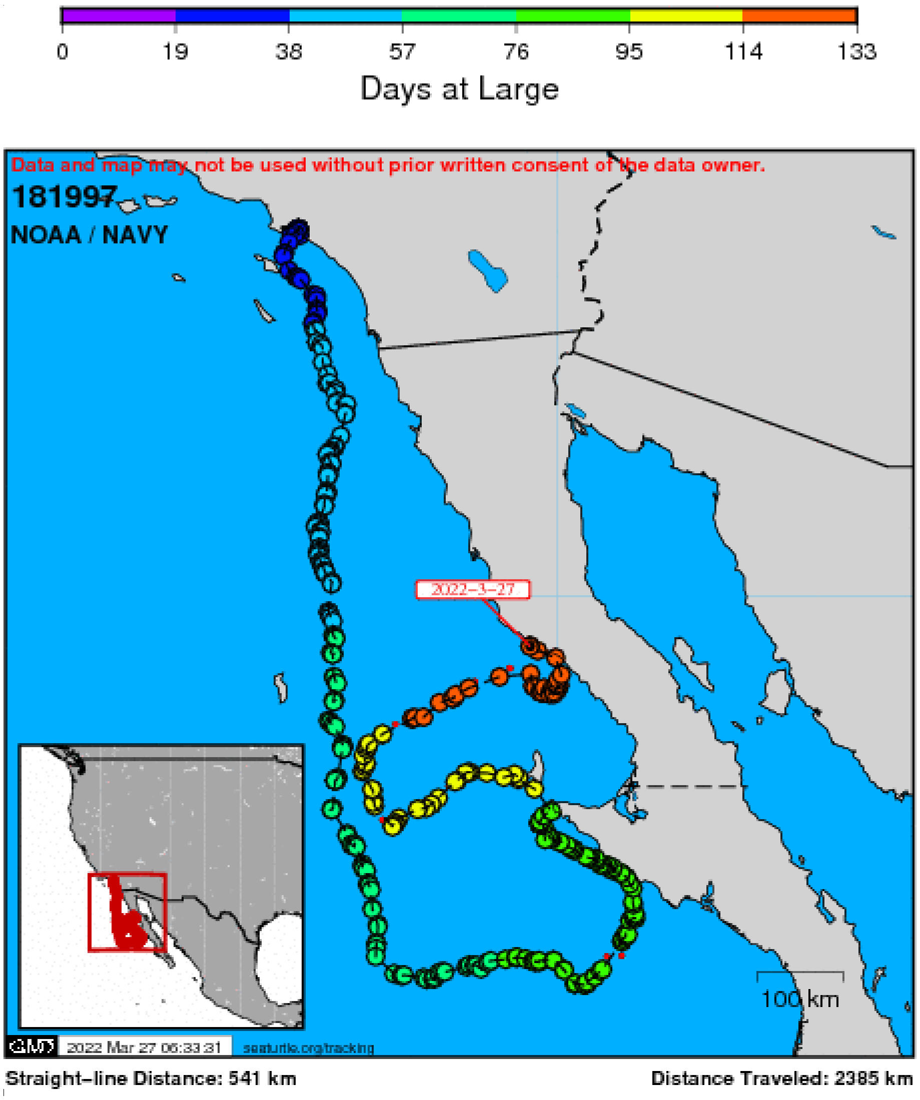


Figure 42. Satellite tracking data of female captured at Seal Beach

Female outfitted with GPS transmitter and tracked on nesting migration (SWFSC unpublished data 2022).

6.2.3 Foraging/Resting

The abundance of this population has increased significantly in recent years, as a result of ESA and foreign protections, leading to a change in status from endangered to threatened (81 FR 20057, April 6, 2016). This increase is reflected in the greater abundance of foraging and resting green turtles in southern California waters. Continued increases in abundance are necessary to recovery, requiring that areas containing EFs must be adequate to support the current population size and future increases. The recovery of the DPS requires successful survival, growth and development of juveniles and sub-adults and the successful survival and reproduction of adults. For the East Pacific DPS, benthic-foraging habitats provide the primary food resources and refugia necessary to survive, develop, grow, and reproduce.

6.2.3.1 Foraging and Resting EFs Essential to the Conservation of the East Pacific DPS

The following foraging and resting EFs are essential to the conservation of the East Pacific DPS: In waters up to 20 m depth, underwater refugia (e.g., rocks, reefs, and troughs) and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles, sub-adults, and adults.

To identify the EFs, we used information on the natural history of the species, found in Section 3 and the following paragraphs. For foraging and refugia, green turtles appear to use diverse habitats within lagoons and bays, including coastal inlets and estuaries. In coastal areas in depths up to 20 m, they appear to forage on seagrass, algae, and invertebrates in shallower areas and move to deeper resting areas for refugia. Areas located above the mean high tide line are exposed to the air (i.e., not underwater) for a significant amount of time and unlikely to contain food resources at levels necessary to support survival, development, growth, and/or reproduction. Therefore, the EFs occur from the mean high water line to the 20 m depth contour.

A stable isotope study on 718 green turtles foraging at 16 areas (including off the coast of California) indicate that turtles of this DPS are omnivorous (Seminoff *et al.* 2021). Another stable isotope study indicates that East Pacific green turtles in San Diego Bay forage on invertebrates (50 percent), seagrass (26 percent), and to a lesser extent red and green algae (Lemons *et al.* 2011). Local seagrass pastures, especially eelgrass (*Zostera marina*), are of great importance to the DPS because they provide a major food resource and serve as habitat for mobile and sessile invertebrate prey, such as sponges, tunicates, and mollusks (Lemons *et al.* 2011; Crear *et al.* 2017). Where eelgrass is not present, often in urbanized environments, green turtles forage on algae and invertebrates that attach to rocky bottoms and hard man-made structures (Crear *et al*. 2017). These data are consistent with studies of East Pacific green turtles outside of U.S. jurisdiction (e.g., waters of Mexico, Colombia, and Galapagos Islands) that also demonstrate omnivorous diets (Seminoff *et al.* 2002; López-Mendilaharsu *et al.* 2005; Amorocho and Reina 2007; Carrión-Cortez *et al.* 2010). To account for their omnivorous diet, the EFs include a variety of food resources (i.e., seagrass, marine algae, and/or marine invertebrates).

After foraging, green turtles rest in underwater refugia (MacDonald *et al.* 2013), even in urbanized environments where they rest among high relief substrate and structures, including bridge pilings and discharge outflows (Crear *et al.* 2017). Turtles move between foraging sites and underwater refugia areas throughout the diel cycle (Seminoff *et al.* 2006; MacDonald *et al.* 2013; Crear *et al.* 2017). Rest is marked by prolonged periods of inactivity punctuated by long, deep, resting dives that allow turtles to achieve neutral buoyancy and efficiently utilize oxygen; however, turtles have also been documented resting for shorter time periods (Seminoff *et al.* 2021). Turtles may rest in relatively deeper habitats (compared to foraging areas) that may allow longer resting dives (Crear *et al.* 2017). In the winter and in some locations, turtles use underwater refugia areas during the day, suggesting resting between diurnal foraging excursions (MacDonald *et al.* 2013; Crear *et al.* 2017). Turtles may rest adjacent to culverts (where tide scouring creates a deeper resting habitat), bridge pilings, runoff outflows (Crear *et al.* 2017), and on the seafloor within the warm-water effluent of power plants (MacDonald *et al.* 2012; 2013). Since the closure of a power plant and loss of its warm water effluent, green turtles continue to forage and rest in South San Diego Bay; however, their night-time home ranges have expanded, suggesting that they use resting sites that are separate from their foraging area (Eguchi *et al.* 2020). Therefore, both food resources and underwater refugia (e.g., rocks, reefs, and troughs) are essential for the conservation of the DPS.

Generally, adults and benthic-foraging juveniles occupy small home ranges that include foraging resources and underwater refugia. For example, green turtles acoustically tracked in San Diego Bay occupied areas of 2.09 to 8.70 km^2, remaining in one or two core areas more than half the time (MacDonald *et al.* 2012). Larger turtles may use smaller core areas as a result of increased familiarity and foraging efficiency (MacDonald *et al.* 2012). Multiple recaptures within San Diego Bay between 1990 and 2020 confirm the site fidelity of foraging turtles (Eguchi *et al.* 2010; MacDonald *et al.* 2012; NMFS' unpublished data 2021); however, some individuals move long distances between foraging areas, including one individual tracked from San Diego Bay to a foraging area near Long Beach, California (SWFSC unpublished data 2016). Because of site fidelity and small home ranges, underwater refugia and food resources must be available in sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles, sub-adults, and adults.

We did not include EFs for surface-pelagic juveniles because we do not have adequate data to identify such EFs.

6.2.3.2 Special Management Considerations or Protection

To conserve the quantity and quality of seagrass, marine algae, and marine invertebrates, special management considerations or protection may be required. Activities that may threaten the condition, distribution, diversity, abundance, and density of underwater refugia or food resources (or access to these EFs) include:

- Dredging and disposal
- Beach nourishment
- Pipeline and cable projects
- Alternative energy structures or activities such as installation of turbines, wind farms, and means to convert wave or tidal energy into power
- Shoreline development and construction projects
- Agriculture and other land-use projects
- Pollution
- Oil and gas activities, such as seismic exploration, construction, removal of platforms, oil spills and response
- Power and desalination plant operations (i.e., discharges)
- Wastewater treatment plant operations (i.e., discharges)
- Aquaculture
- Fishing activities
- Vessel operations

Dredging, beach nourishment, pipeline and cable projects, construction and maintenance of alternate energy structures, shoreline development, pile driving, and building or replacing piers may alter the benthos and modify or destroy eelgrass beds and associated shallow subtidal habitat. Such activities may result in a temporary loss of food resources, which would persist until seagrass, macroalgae, and invertebrates are able to recolonize the area. For example, Naval development in the Anaheim Bay/Seal Beach area includes in-water construction of an ammunition pier and associated waterfront facilities including: a break water to reduce wave heights at the pier, pile supported mooring dolphins to divert civilian traffic, a causeway with a truck turnaround, a new public navigation channel leading to Huntington Harbor for civilian boat traffic, and navy ship turning basin (Hanna 2021). Construction activities included dredging, filling, and rip rap removal and placement (Hanna 2021). As turtles use these areas for foraging and resting (and moving between foraging and resting areas), they are likely displaced (temporarily) from these areas during construction and until adequate resources are restored.

Shoreline development and construction, agriculture, oil and gas activities, desalination, wastewater treatment and power plant operations result in discharges or run-off, which may contribute to sediment toxicity (SCCWRP 2013), anthropogenic nitrogen loading (Seminoff *et al.* 2021), and other water-quality impairments. Dredging also releases contaminants into nearby waters and legacy chemicals back into coastal food webs, some of which (e.g., trace metals) accumulate in eelgrass, *Zostera marina* (Komoroske *et al.* 2011; Komoroske *et al.* 2012; Barraza *et al.* 2019; Barraza *et al.* 2020). Potential pollutants include heavy metals, toxins, oil, tar, marine debris, and plastics. Green turtles are known to carry high loads of contaminants (e.g., metals and persistent organic pollutants; Komoroske *et al.* 2011, 2012), but there is uncertainty regarding the impact of such environmental pollutants on the conservation of the DPS. Barraza *et al.* (2019) detected higher trace metal concentrations in green turtles foraging in urbanized areas, supporting the hypothesis that coastal cities can increase trace metal exposure to local green turtles. Green turtles foraging in urbanized areas also increases exposure to and bioaccumulation of persistent organic pollutants (Barraza *et al.* 2020). However, other health metrics of green turtles foraging in Southern California were similar to those of turtles in less urbanized areas (Banerjee *et al.* 2019).

Power generating facilities and their warm water discharges may affect the distribution of sea turtles and their prey (Eguchi *et al.* 2020). The South Bay Power Plant closure (December 31, 2010) and implosion (February 2, 2013) has removed the effluent water that provided a warm-water refuge for turtles in San Diego Bay (Turner-Tomaszewicz and Seminoff 2012); however, green turtles remained within the bay (Eguchi *et al.* 2020), where they have occurred since as early as the mid-1880s, prior to the operation of the power plant (Stinson 1984; Eguchi *et al.* 2010; MacDonald *et al.* 2012; Turner-Tomaszewicz and Seminoff 2012). Management considerations or protections may be required as the area undergoes construction and development, especially in light of the Chula Vista Bayfront Revitalization Project, which promises to add thousands of hotel rooms and much greater human traffic in the south San Diego Bay region (San Diego Unified Port District 2010). In the San Gabriel River, two power plants (i.e., Alamitos Generating Station and Haynes Generating Station) discharge warm water into the river, resulting in an influx of anthropogenically altered water temperatures that potentially affect the movement and distribution of green turtles in this area. Acoustically telemetered turtles were found to use the warm effluent as a thermal refuge, avoiding areas upstream and near the river mouth, which were colder than warmer discharges from the power plants (Crear *et al*. 2016). These power plants are in the process of being decommissioned, which will change the hydrological characteristics of this waterway. When these power plants cease to discharge warm water, green turtles in this area may change their movement patterns based on their thermal tolerance (Crear *et al*. 2016).

Aquaculture activities are relevant to the potential designation of critical habitat because they may displace food resources, such as seagrass beds. Fishing activities may reduce food resources (i.e., invertebrates) through competition and benthic modification (e.g., bottom trawling). Vessel activities modify seagrass beds through propeller scarring, anchoring, and groundings. These activities may also modify or destroy the underwater rocks, reefs, and troughs used as refugia. Several activities also produce noise, which may discourage the use of refugia (e.g., seismic surveys; Nelms *et al.* 2016).

In addition, climate change is likely to affect the foraging and resting EFs in ways that may require special management considerations or protection. Fortification of coastal developments, in response to sea level rise, is likely to limit habitat availability, with a negative impact on foraging resources, such as submerged aquatic vegetation. Increased temperatures and elevated sea level rise are likely to change the composition of seagrass beds as observed during El Niño Southern Oscillation events. For example, during the 1997 to 1998 El Niño event, conditions became unsuitable for one seagrass species (*Z. marina*) and favored another (*Ruppia maritima*) in Mission Bay and San Diego Bay, California (Johnson *et al.* 2003). Thus, the distribution and abundance of invertebrate and algal communities are likely to change as a result of climate change.

6.2.3.3 Areas Containing the Foraging and Resting EFs

Within the range of the East Pacific DPS, many areas contain food resources and underwater refugia that may serve as resting sites (Figure 43). We relied on the occurrence of green turtles to determine which of these areas contain sufficient resources to support their survival, development, and growth. First, we identified areas containing the EFs, where foraging or resting green turtles have been documented in published, peer-reviewed, scientific research studies. Next, we identified areas where foraging or resting green turtles have been sighted by scientists or members of the public (i.e., the NOAA turtle sightings database). Finally, we used stranding data to identify areas likely to contain the EFs and turtles. Within bays and estuaries, we have high confidence that these data represent green turtle foraging or resting locations (i.e., they have entered these areas to forage or rest and have stranded there); however, in coastal areas where currents may carry stranded turtles, we are less confident that the stranding location accurately represents a turtle foraging or resting location. We also identified areas where green turtles forage as determined by consistent data on the entrainment of live, healthy green turtles in once-through cooling water intake channels of power plants, possibly drawn to the warm water effluent. Alternatively, entrainment data may reflect weakened or sick turtles that are unable to avoid such areas.

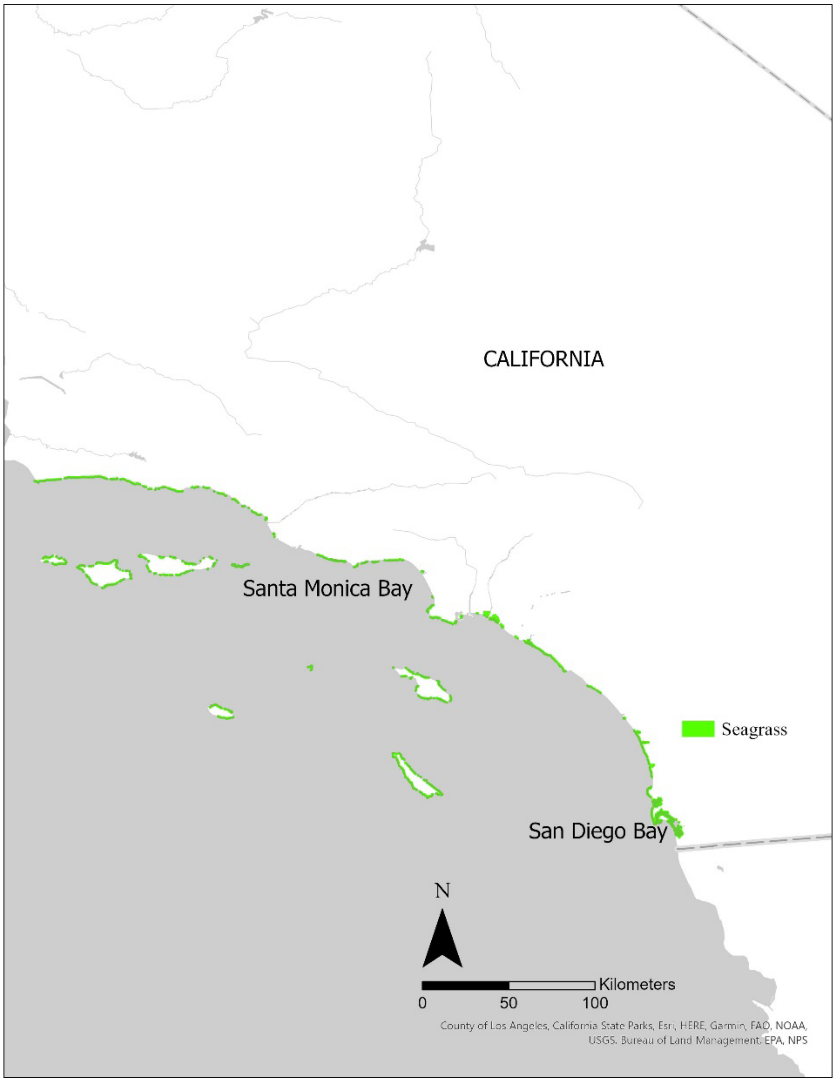


Figure 43. Seagrass coverage in Southern California
Green areas show seagrass coverage (Marine Cadastre 2023).

Numerous green turtle research studies have been conducted in San Diego Bay, which hosts a resident population of benthic-foraging juvenile and adult green turtles (Stinson 1984; McDonald *et al.* 1994; Eguchi *et al.* 2010; MacDonald *et al.* 2012; Turner-Tomaszewicz and Seminoff 2012; MacDonald *et al.* 2013). When the South Bay Power Plant was operational, the turtles occupied small home ranges in South San Diego Bay (south of Sweetwater Inlet), where they foraged on dense eelgrass (*Z. marina*) and associated macro algae and invertebrates during the day and rested at night (and during the day in winter) along the effluent outfall channel and jetty habitat (Figure 44; MacDonald *et al.* 2012; MacDonald *et al.* 2013). During that time, annual green turtle abundance ranged from 16 to 61 turtles of 44 to 110.4 cm SCL (Eguchi *et al.* 2010). Following power plant closure, turtles continue to be observed in this area year-round. Turtles forage on seagrass in the South and Central Bays (MacDonald *et al.* 2012; MacDonald *et al.* 2013), which have dense seagrass beds that have expanded to several thousand acres during the past several years; however, the industrialized jetties on the eastern shores of the Central Bay do not appear to be used by turtles, perhaps due to the heavy boat traffic. Although less studied, the

North Bay does not appear to support significant green turtle foraging (MacDonald *et al.* 2012; NMFS, unpublished data 2016), likely because seagrass is less abundant in this part of San Diego Bay; however, turtles must use this area to access foraging areas in the Central and South Bay (see Section 6.2.3 on migration).

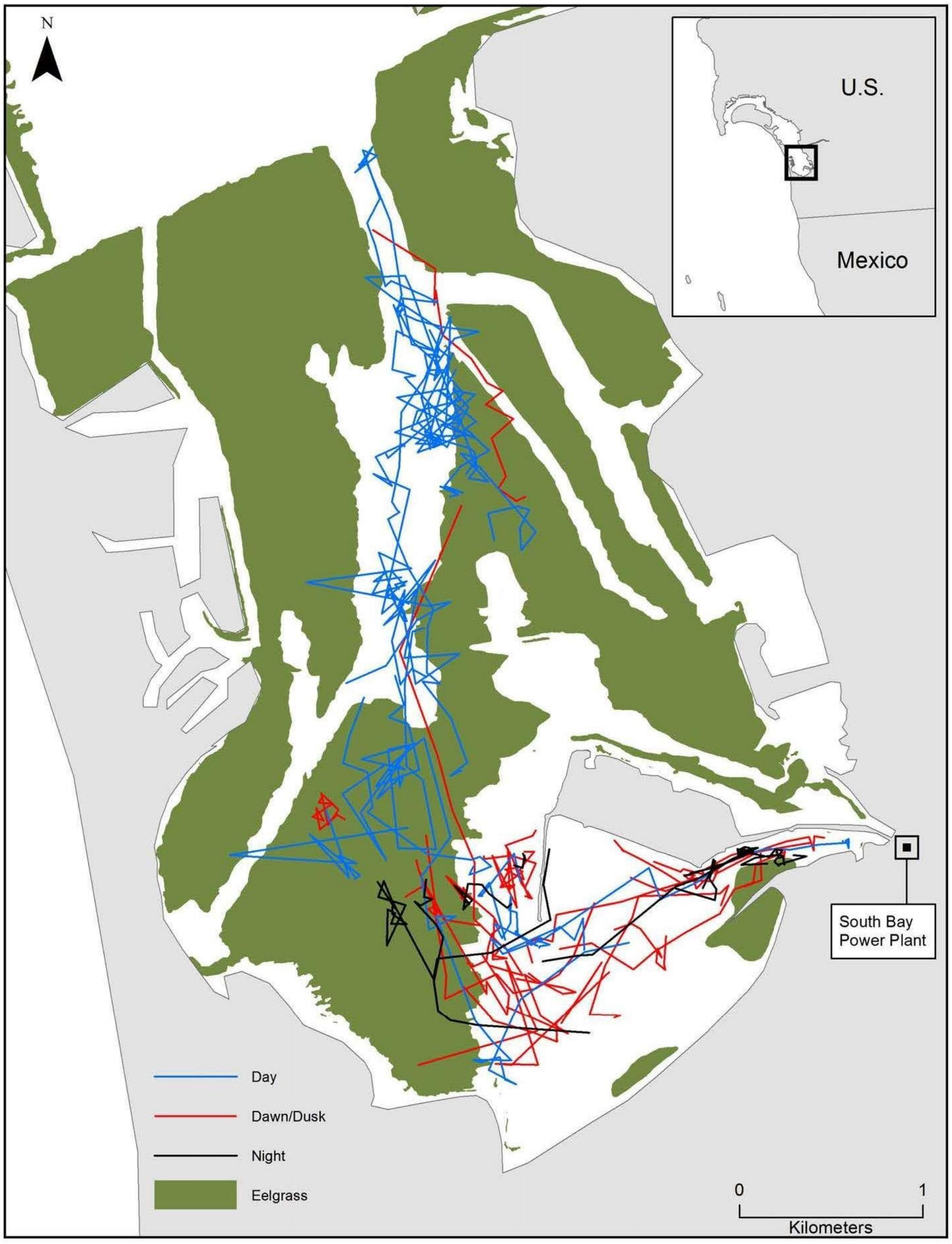


Figure 44. Satellite tracking of 14 green turtles in South San Diego Bay
Tracks occurred during dawn (n= 12), day (n =16), dusk (n =12), and night (n = 10); dark green shading represents cumulative annual distribution of eelgrass from 1994 to 2008 (MacDonald *et al.* 2012).

North of San Diego Bay, La Jolla Shores is an exceptionally productive area with rocky reefs (habitat for invertebrates), seagrass, and algae. Hanna (2021) described a resident population of green turtles at La Jolla Shores. In their community-based science study, the turtles were observed exhibiting foraging behavior 14.9 percent of the time and resting 2.3 percent of the time in water temperatures as low as 15.8°C, one of the lowest recorded temperatures documented for foraging green turtles (Hanna *et al.* 2021). This low foraging temperature may be the result of thermal acclimation to low water temperatures at this relatively exposed foraging site, which tends to be cooler than adjacent lagoons and bays (such as San Diego Bay). At La Jolla Cove, a small area within La Jolla Shores, consistent anecdotal data demonstrate year-round occupation by green turtles, often with multiple turtles congregating in a small area (R. Pace pers. comm. 2014 to 2016).

Studies of green turtles conducted near Seal Beach National Wildlife Refuge (NWR) in Orange and Los Angeles Counties demonstrate a resident green turtle population in that area (Crear *et al.* 2016; Crear *et al.* 2017; Hanna 2021). Juvenile and sub-adult sea turtles forage and rest in the San Gabriel River, Seal Beach NWR (including the 7th Street Basin), Alamitos Bay, and Anaheim Bay (Figure 45; Crear *et al*. 2017). Hanna (2021) satellite tracked 16 green turtles captured in Seal Beach NWR and found that they spent the majority of their time in the Refuge; however, four turtles transitioned into Anaheim Bay, two moved offshore before returning to Anaheim Bay, and one visited Huntington Harbor frequently (Figure 46; Hanna 2021). Generally, areas occupied by turtles were characterized by eelgrass and/or soft mud substrate, an important habitat for invertebrates (Hanna 2021). Crear *et al.* (2016) described the movement and behavior of 22 juvenile green turtles (SCL of 45.2 to 96.8 cm) in the San Gabriel River (a highly urbanized river that has been channelized for flood control and receives warm water effluent from two power plants) and the Seal Beach NWR. These turtles appear to utilize the areas for foraging, resting, and avoidance of cold water temperatures of less than 15 °C. Heat is attributed to the power plants (which will be phased out by 2029), channelization (i.e., concrete lining for flood control), urban runoff, and shallowness (Crear *et al.* 2016). The rock riprap in the San Gabriel River supports a variety of algae and invertebrates for foraging turtles; bridge pilings and runoff outflows may provide resting habitat by sheltering turtles from tidal flow (Crear *et al.* 2017). Turtles forage downstream and rest upstream in the river throughout the year; some turtles leave the river to forage in other locations, for example, in Alamitos Bay, where algae and invertebrates are abundant along the rock riprap, boat docks, and flats (Crear *et al.* 2017). Three turtles tracked in the San Gabriel River exhibited home ranges (95 percent daily area use) of 0.46 ± 0.023 km^2 with an average core area of 0.0118 ± 0.0066 km^2. Three turtles tracked in the 7th Street Basin exhibited home ranges of 0.024 ± 0.012 km^2 with an average core area of 0.0051 ± 0.0028 km^2 (Crear *et al.* 2017). The basin supports large, dense eelgrass beds (Merkel and Associates 2014), and the turtles appear to rest in deeper waters, including near the culvert within the 7th Street Basin (Crear *et al.* 2017). Turtles move through Anaheim Bay to access the 7th Street Basin and San Gabriel River (Crear *et al.* 2017). Crear *et al.* (2017) concludes that the urbanized San Gabriel River, with its rocky edges and lack of seagrass, nonetheless offers suitable habitat for green turtles, even in comparison to more “natural” habitats (such as the restored 7th St. Basin that has a single culvert and an abundance of eelgrass). This is further demonstrated by satellite tagged turtles that remain in these habitats despite access to more “natural” habitats (Hanna 2021).

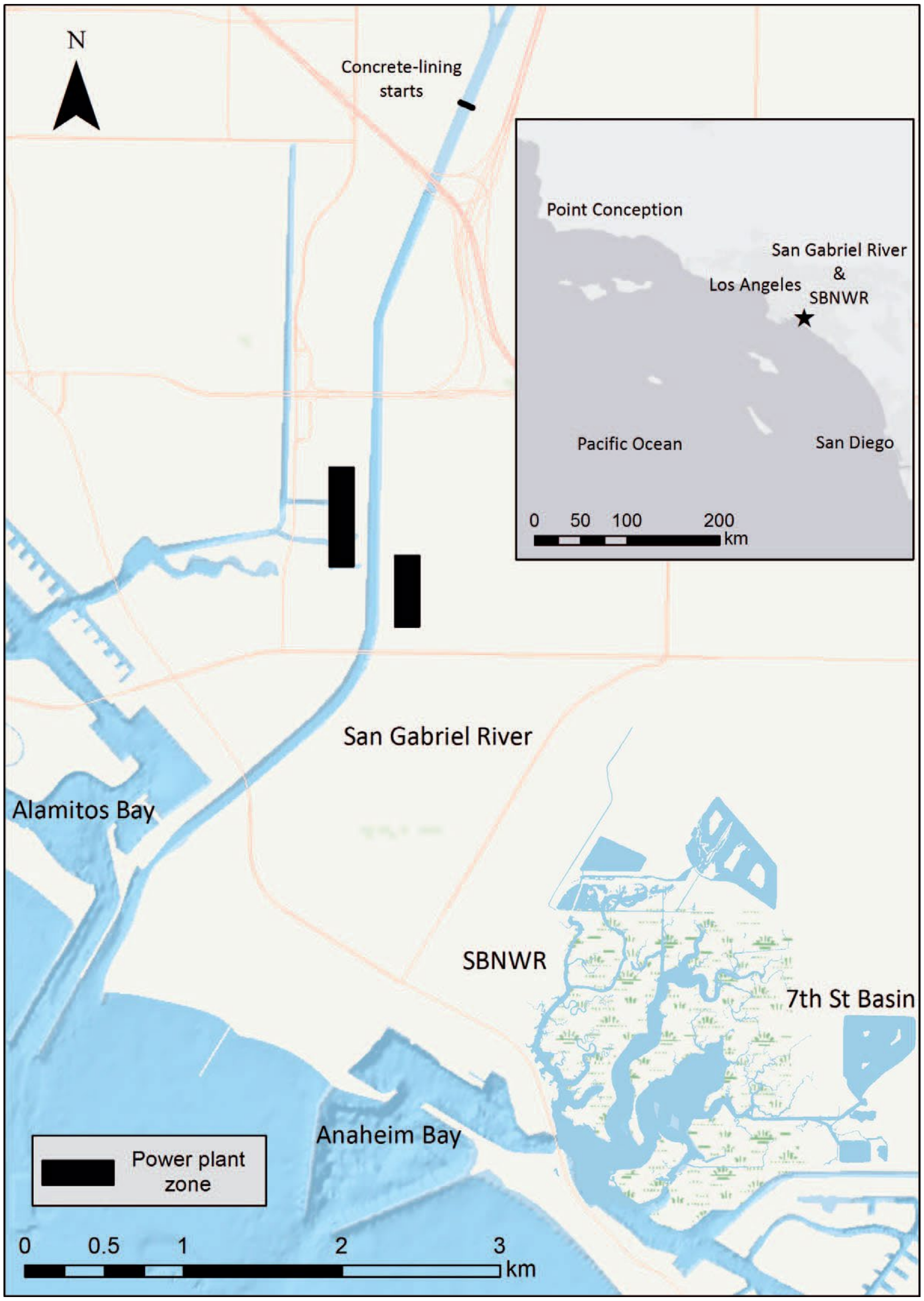


Figure 45. Foraging and rest areas of green turtles near Seal Beach
Data demonstrate that turtles forage and rest in the San Gabriel River, 7th St. Basin, Seal Beach National Wildlife Refuge (SBNWR), Alamitos Bay and Anaheim Bay (Crear *et al*. 2017).

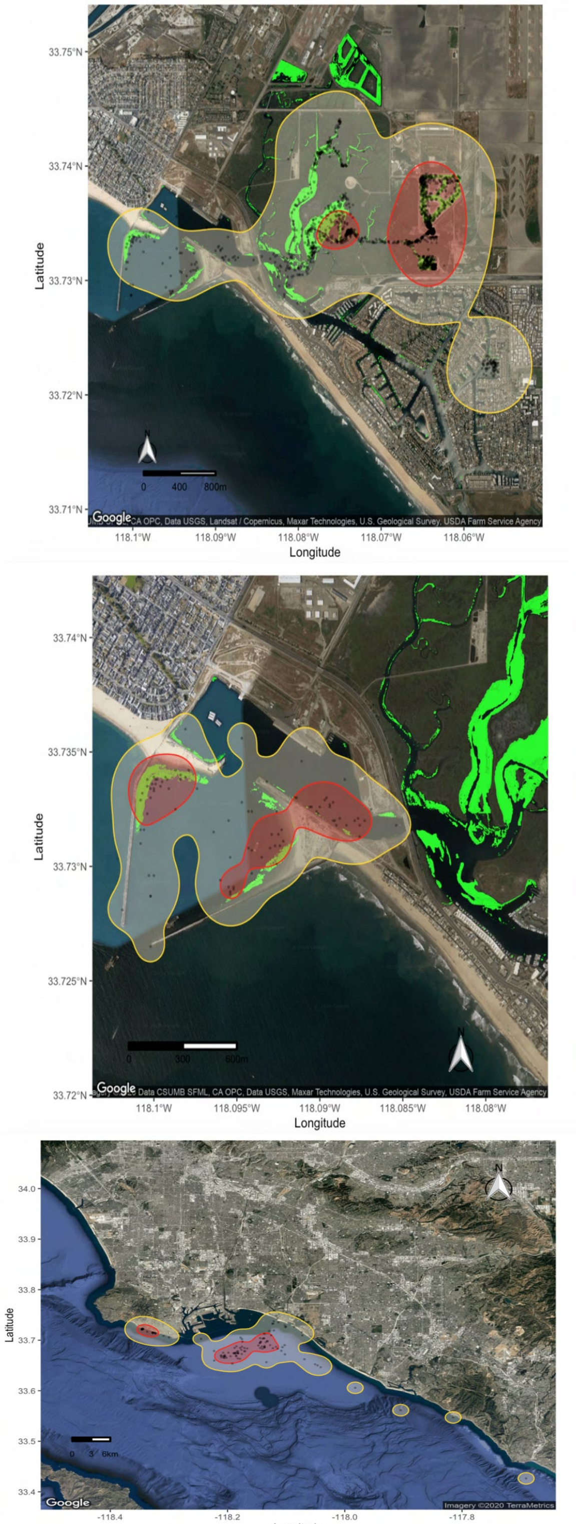


Figure 46. Green turtles' use of foraging and resting areas

Frequently visited core use areas (50 percent utilization distribution areas in red) and overall home range areas (95 percent utilization distribution areas in yellow) in Seal Beach NWR (top), Anaheim Bay and Huntington Harbor (middle), and offshore (bottom; Hanna 2021).

Sightings provide additional data on the occurrence of foraging and resting green turtles (Figure 47; SWFSC unpublished data 2022). These data demonstrate the greatest densities of green turtles in known foraging and resting areas around Seal Beach NWR and San Diego/La Jolla. Multiple or consistent sightings and live strandings also occur at Mission Bay, Aqua Hedionda Lagoon, and Santa Monica Bay, indicating the presence of the foraging/resting EFs in these areas (SWFSC unpublished data 2021).

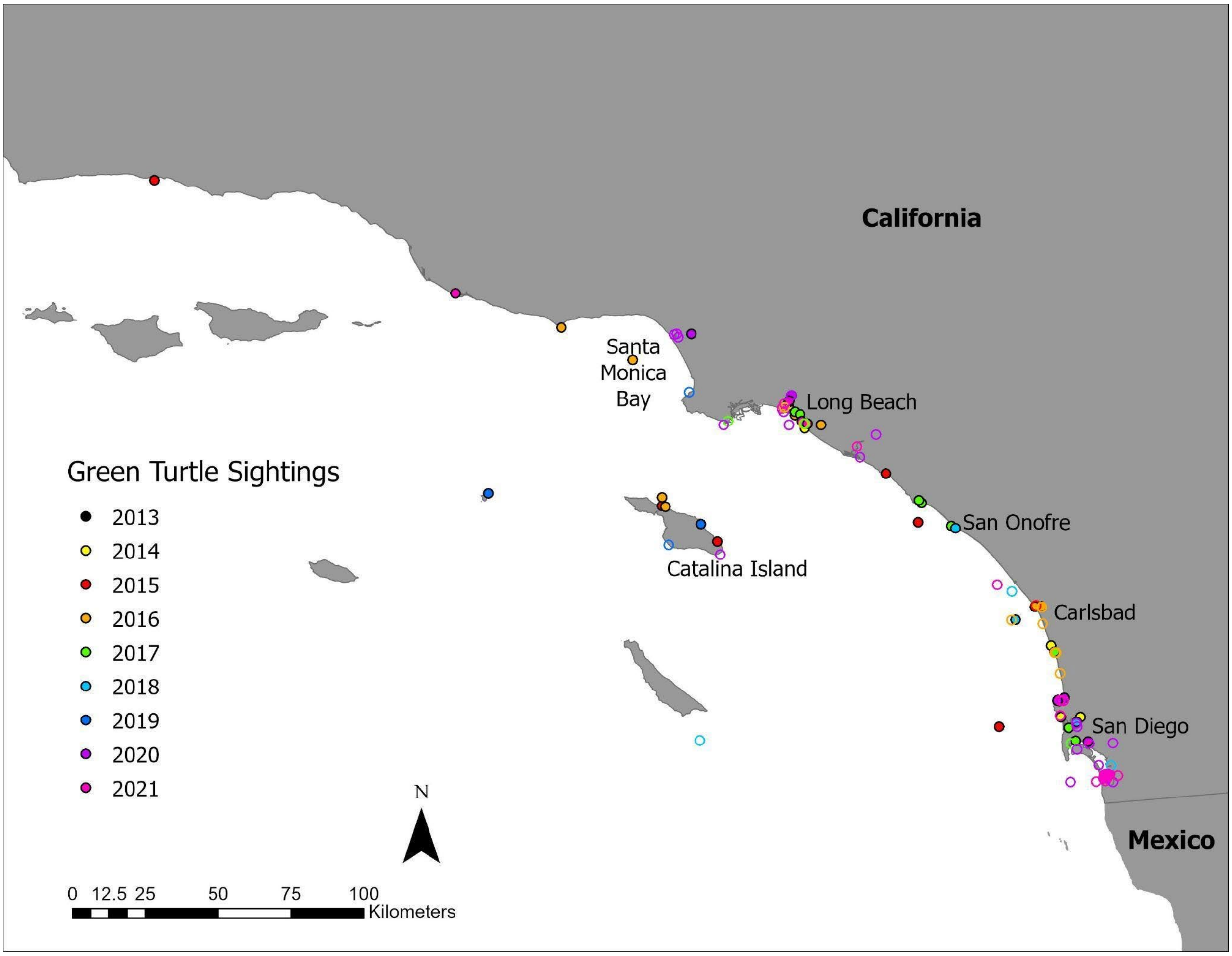


Figure 47. Green turtle sightings off the coast of California from 2013 to 2021
Filled circles represent sightings in which the species was verified; open circles could not be verified but are likely green turtles.

Strandings demonstrate the occurrence of foraging and resting green turtles (Figure 48; SWFSC unpublished data 2022). Hotspots of strandings were identified near Seal Beach NWR (n = 49) and San Diego/La Jolla (n = 79), which are also supported by data from focused scientific studies, and also near San Onofre, where warm water effluent from a power plant may have attracted turtles (n = 41) who were entrained within the cooling water intake structure (SWFSC unpublished data 2016).

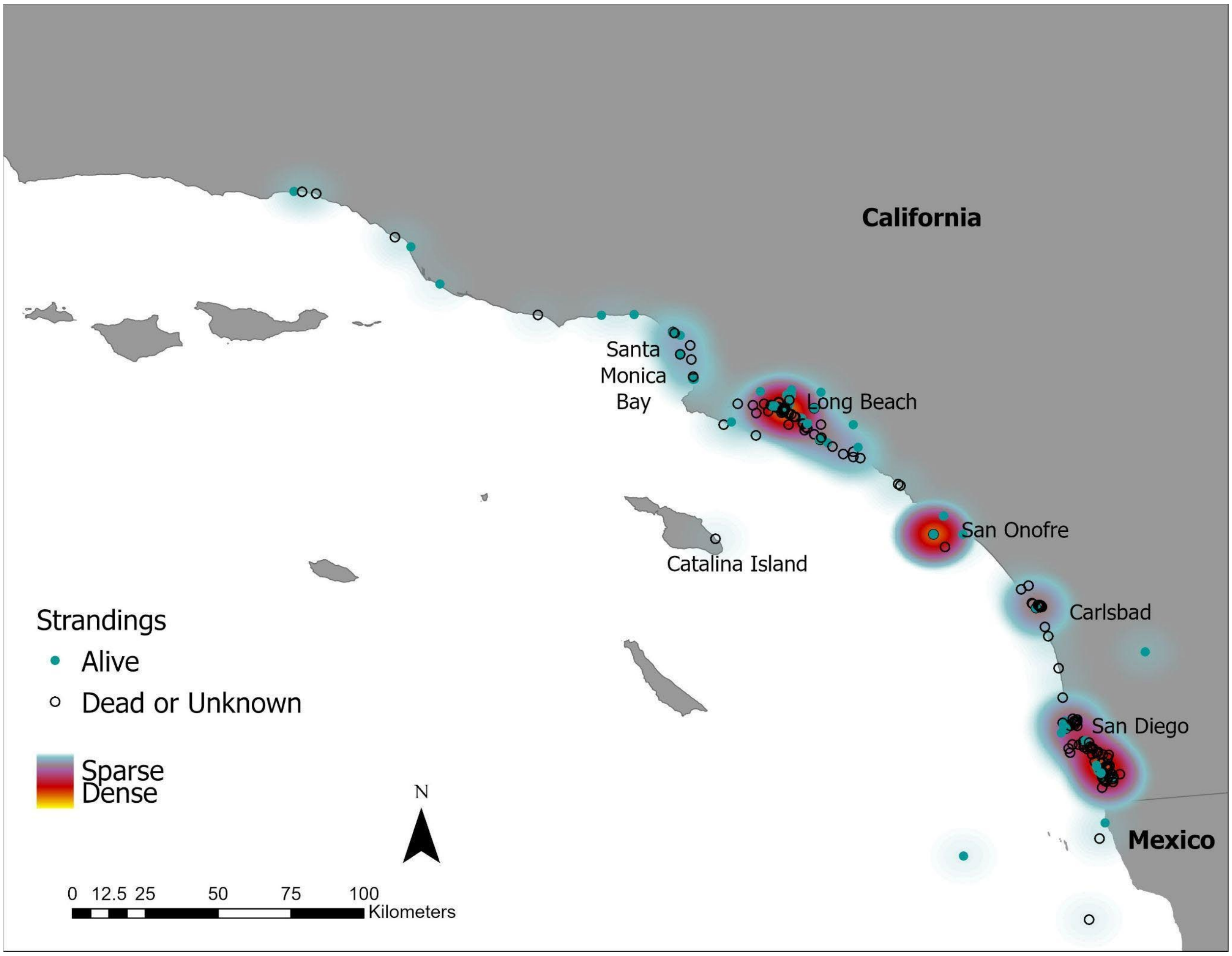


Figure 48. Green turtle strandings in California from 1961 to 2021
Green filled circles represent live strandings, and open circles represent dead strandings or turtles of unknown condition (SWFSC unpublished data 2022). The heat map shows where stranding density is highest (red) to lowest (blue).

6.3 Value to the East Pacific DPS

In Figure 49, we summarize the areas containing all EFs essential to the conservation of the East Pacific DPS that may require special management consideration or protection. We also include a qualitative measure (high, medium, or low) of the conservation value that individual areas provide to the DPS (Table 7). The migratory corridor between San Diego Bay and the U.S./Mexico border provides a high value to the DPS because reproductive individuals (i.e., the life stage most directly linked to population growth and recovery) must use it to migrate between nesting beaches in Mexico and foraging areas in California. For potential foraging/resting areas, we rated sites based on available data on green turtle usage and abundance. Researchers target areas of high turtle usage and abundance, where they can gather the greatest amount of data in the least amount of time. Therefore, the highest number of turtles recorded and greatest amount of data are located in the focused study areas near Seal Beach NWR and in San Diego Bay. These areas are of high value to the DPS due to the large abundance of foraging turtles and their year-round presence in these areas; we also have the greatest amount of data on these areas. Similarly, research has also focused on La Jolla Shores, where there is moderate to high abundance of turtles, year-round. We are familiar with turtles' usage of the San Onofre area because of entrainment data demonstrating year-round, moderate to high usage by green turtles. Strandings also occur in areas north of Point Conception to the US-Canada border. However, we do not recommend these areas for consideration as critical habitat. Green turtles require an adequate warm water season to gain enough nutrition to support normal body function and somatic growth. Six months is the minimum duration that constitutes an adequate growth season and 15°C is the minimum activity threshold (while temperatures at or slightly above 15°C are not ideal for green turtle activity, turtles will still forage at this temperature with mild regional endothermy). Areas north of Point Conception host an extremely limited warm water season, as offshore temperatures remain above 15°C for less 3 months per year, and some months fall below 10°C. Because these areas host suboptimal temperatures for most of the year, they are unable to support survival and growth of juveniles, and therefore, do not contain the foraging/resting EFs.

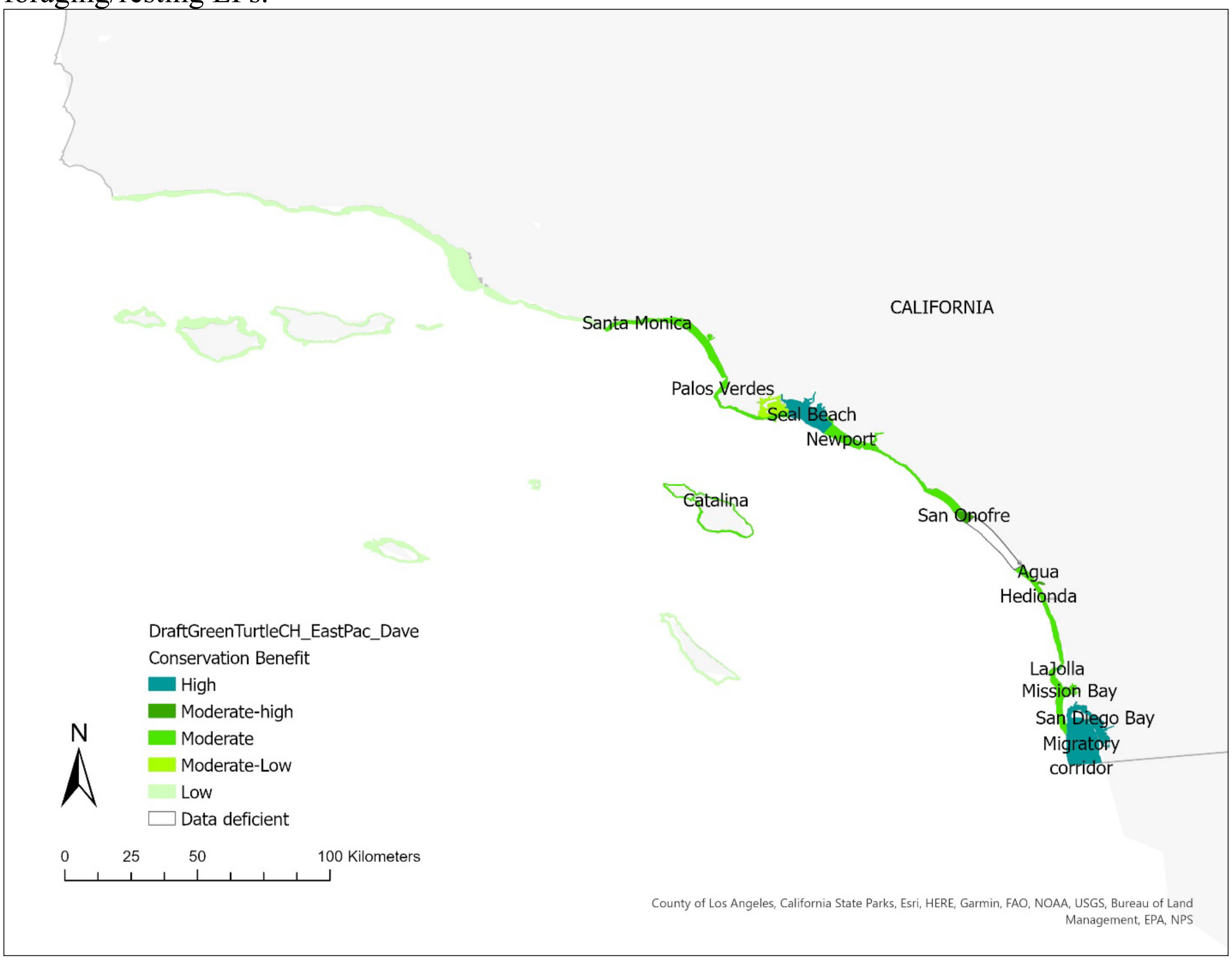


Figure 49. Areas containing the EFs essential to the conservation of the East Pacific DPS
Dark green represents high conservation value areas from mean high water to 20 m depth; medium green represents moderate conservation value areas from mean high water to 20 m depth; light green represents low conservation value areas from mean high water to 20 m depth; black outline represents data deficient.

Table 7. Areas containing the EFs and their conservation value to the East Pacific DPS

Area	Value	Rationale
United States/Mexico border to San Diego Bay including North San Diego Bay	High	Migratory and foraging/resting EFs; tracking data demonstrate that adults turtles use a 10 km migratory corridor to migrate between foraging areas in San Diego Bay to nesting beaches in Mexico (Dutton *et al*. 2019; SWFSC unpublished data 2022); foraging density appears to be low, with fewer sightings and stranding data in this area (SWFSC unpublished 2022)
South San Diego Bay	High	Foraging/resting EFs; satellite tracking, in-water captures, and other studies document a year-round resident population of juvenile and adult green turtles foraging within dense seagrass beds (MacDonald *et al.* 2012; MacDonald *et al.* 2013); many sightings and stranding data (SWFSC unpublished 2022)
Central San Diego Bay	High	Foraging/resting EFs; satellite tracking, in-water captures, and other studies document a year-round resident population of juvenile and adult green turtles foraging within dense seagrass beds, especially near Coronado Island/Naval Air Base (MacDonald *et al.* 2012; MacDonald *et al.* 2013); many sightings and stranding data (SWFSC unpublished 2022).
Mission Bay (San Diego)	Moderate	Foraging/resting EFs; high quality habitat; multiple and consistent sightings of foraging and/or resting adult and juvenile turtles (Hanna *et al*. 2021; SWFSC unpublished data 2022) and stranding data (SWFSC unpublished data 2022).
Point Loma to (but not including) La Jolla Shores	Moderate	Foraging/resting EFs; moderate number of sightings and stranding data (SWFSC unpublished 2022).
La Jolla Shores/Cove	Moderate-High	Foraging/resting EFs; published study documents resident population of green turtles observed foraging and resting (Hanna *et al*. 2021); many sightings and some stranding data (SWFSC unpublished 2022).
La Jolla Shores to Oceanside (including Oceanside)	Moderate	Foraging/resting EFs; moderate number of sightings and stranding data (SWFSC unpublished 2022).
Agua Hedionda Lagoon	Moderate–High	Foraging/resting EFs; published and unpublished studies document multiple and consistent sightings of foraging turtles (Hanna *et al*. 2021; SWFSC unpublished data 2022) and strandings (SWFSC unpublished data 2022); new studies have been initiated to further investigate turtles in this area (WCR, SWFSC, Aquarium of the Pacific, SoCal Sea Turtles Inc., collaboration 2022).
Oceanside to San Onofre	Data deficient	We have no data for this area because there is no access to this area, which is Camp Pendleton.

Area	Value	Rationale
San Onofre	Moderate-High	Foraging/resting EFs; many sightings and stranding data, including 41 cooling water intake strandings (SWFSC unpublished data 2022).
San Onofre to Newport (including Newport Bay)	Moderate	Foraging/resting EFs; moderate number of sightings and stranding data (SWFSC unpublished 2022).
Newport to Huntington Beach	Moderate	Foraging/resting EFs; moderate number of sightings and stranding data (SWFSC unpublished 2022).
Bolsa Chica Lowlands (Basin)	Moderate	Foraging/resting EFs; moderate number of sightings and stranding data (SWFSC unpublished 2022).
Seal Beach Wetland and Nearshore Complex: including San Pedro Bay, San Gabriel River, Alamitos Bay, Anaheim Bay, Huntington Harbor, Bolsa Chica (excluding lowlands), Seal Beach NWR, 7th Street Basin, and offshore waters	High	Foraging/resting EFs; resident population of green turtles foraging on a variety of algae and invertebrates and resting in rocky, often urbanized areas along the rock riprap, boat docks, and flats (Crear *et al*. 2016; Crear *et al*. 2017; Hanna 2021); many sightings and stranding data (SWFSC unpublished data 2022).
LA and Long Beach Harbors	Moderate-Low	Foraging/resting EFs; moderate-low number of sightings and strandings (SWFSC unpublished data 2022).
LA and Long Beach Breakwater	Moderate	Foraging/resting EFs; moderate number of sightings and strandings (SWFSC unpublished data 2022).
Palos Verdes	Moderate	Foraging/resting EFs; moderate number of sightings and strandings (SWFSC unpublished data 2022).
Santa Monica Bay	Moderate	Foraging/resting EFs; moderate number of sightings and strandings (SWFSC unpublished data 2022).
Catalina Island	Moderate	Foraging/resting EFs; multiple and consistent sightings of foraging and/or resting turtles (Hanna *et al*. 2021; SWFSC unpublished data 2022) and stranding data (SWFSC unpublished data 2022).
Channel Islands	Low	Foraging/resting EFs; few sightings or strandings (SWFSC unpublished data 2022).
Santa Monica Bay to Point Conception	Low	Foraging/resting EFs; few sightings or strandings (SWFSC unpublished data 2022).
Point Conception to US/Canada border	Very low	We do not recommend this area for consideration as critical habitat because it is suboptimal habitat due to water temperatures preventing the long-term residencies necessary to provide the energy for survival, development, growth, and/or reproduction

7. CENTRAL NORTH PACIFIC DPS

7.1 Geographical Area Occupied by the Central North Pacific DPS

The Central North Pacific DPS is defined as green turtles originating from the Central North Pacific Ocean, including those hatching from nests on the beaches within the Hawaiian Archipelago and those occurring at Johnston Atoll. The range of the DPS is bounded by the following coordinates: 41° N., 169° E. in the northwest; 41° N., 143° W. in the northeast; 9° N., 125° W. in the southeast; and 9° N., 175° W in the southwest. This area includes waters outside of U.S. jurisdiction. Applying the U.S. EEZ provides the range of the DPS within U.S. jurisdiction (Figure 50).

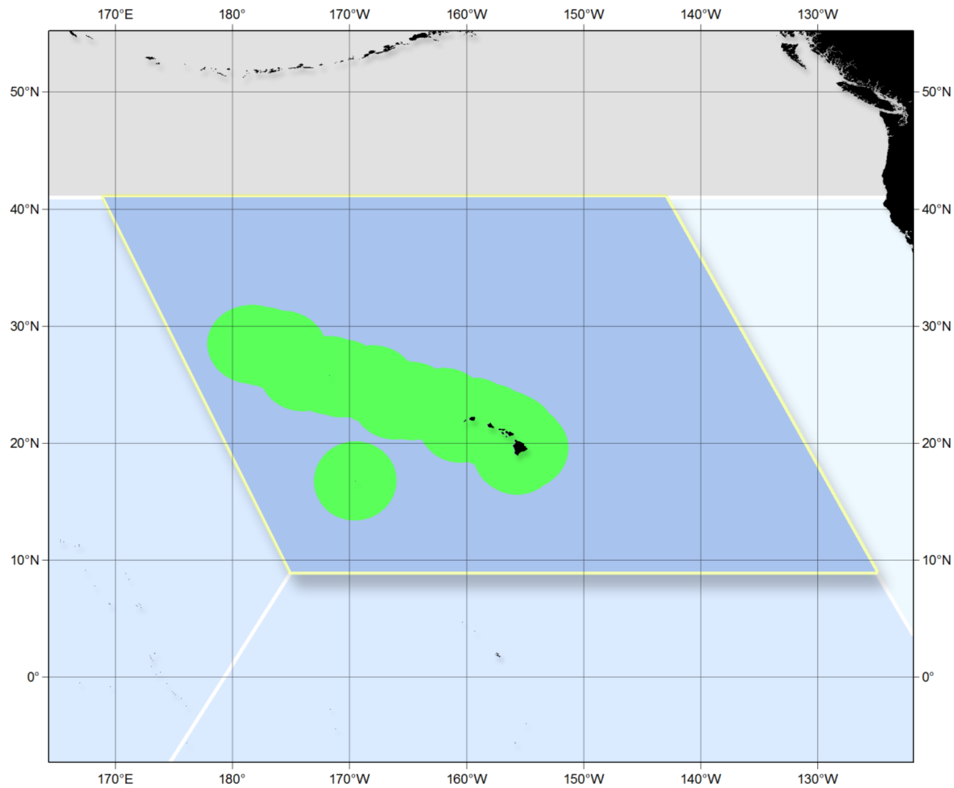


Figure 50. Range of the Central North Pacific DPS within U.S. jurisdiction
Blue indicates the defining boundaries of the DPS; green indicates the range of the DPS within the U.S. EEZ.

The Hawaiian Islands are the most geographically isolated archipelago in the world. Johnston Atoll, located 850 km south, is the closest neighbor. The Hawaiian Archipelago includes the Main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands, the latter of which comprise the Papahānaumokuākea Marine National Monument (PMNM). The MHI include eight large, high (in elevation), and geologically young islands with resident human populations: Hawai'i, Maui, Kaho'olawe, Lana'i, Moloka'i, O'ahu, Kaua'i, and Ni'ihau Islands. The PMNM include small, low, and geologically older islands or atolls with no resident human populations: Nihoa Island, Mokumanamana/Necker Island, Lalo/French Frigate Shoals, 'Ōnūnui, 'Ōnūiki/Gardner Pinnacles, Kamokuokamohoali'/Maro Reef, Kamole/Laysan Island, Kapou/Lisianski Island, Manawai/Pearl and Hermes Atoll, Kuaihelani/Midway Atoll, and

Hōlanikū/Kure Atoll. Over geological time, the Hawaiian archipelago is rising and growing in the southeast but sinking and disappearing in the northwest (Figure 51).

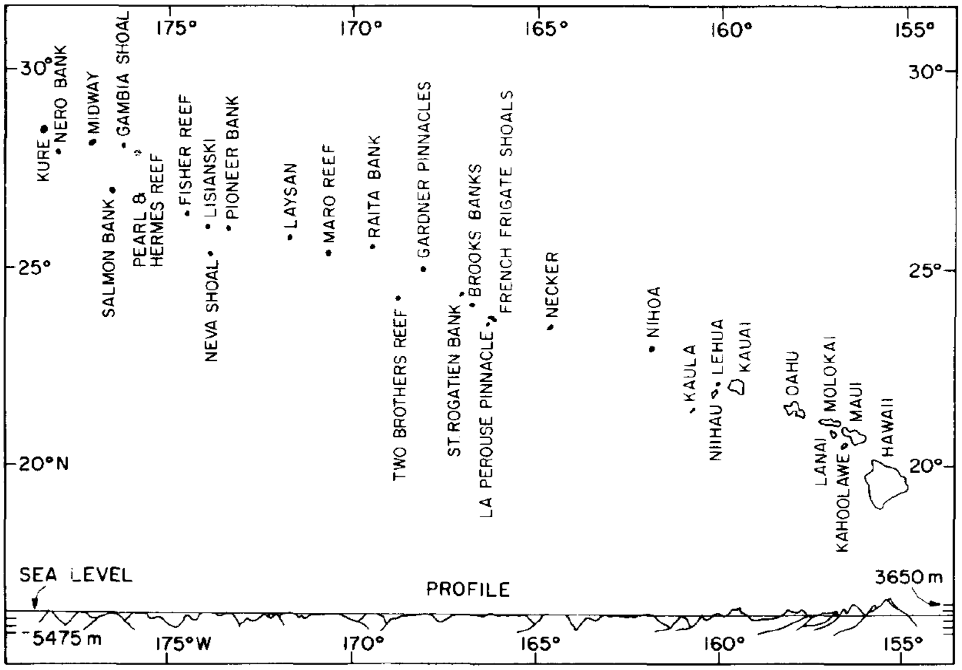


Figure 51. The Hawaiian Archipelago with island altitude relative to sea level
(Balazs 1976)

The range of the DPS also includes Johnston Atoll, which is an unincorporated territory of the United States. It is a National Wildlife Refuge and part of the Pacific Remote Islands Marine National Monument.

7.2 Essential Features

A recovery plan, with associated recovery criteria, has yet to be developed for the Central North Pacific DPS. To identify the EFs essential to the conservation of the Central North Pacific DPS, we referenced the 1998 Recovery Plan for U.S. Pacific Populations of the Green Turtle (NMFS and USFWS 1998), which includes the the Central North Pacific DPS (i.e., Hawaiian population) and identifies the following recovery criteria to delist the species (i.e., the goal of the plan):

- All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters
- Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest *annually* over 6 years
- Nesting populations at "source beaches" are either stable or increasing over a 25-year monitoring period
- Existing foraging areas are maintained as healthy environments
- Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region
- All Priority #1 tasks have been implemented
- A management plan to maintain sustained populations of turtles is in place

- International agreements are in place to protect shared stocks

To achieve these criteria, the 1998 Recovery Plan (NMFS and USFWS 1998) indicates a need to protect and manage nesting habitat from the following terrestrial threats: killing of gravid [fertile] females, poaching of nests, predation (native and feral), destruction of the habitat through mining, destruction of vegetation, artificial lighting, coastal development, and increased human beach use. Recovery also requires protection and management of marine habitat, including foraging habitats, as follows:

> "Green turtles inhabit a variety of marine habitats, although we are most familiar with their coastal habitat. Increased human presence in this and other sea turtle habitats have contributed to reef degradation, primarily by coastal construction, increased recreational and fisheries use, and increased industrialization. Habitat loss and degradation must be prevented or slowed."

The Recovery Plan identifies the following activities needed to protect marine habitat:

1. Identify important marine habitats, which may include hatchling, juvenile, and adult foraging areas and migratory ranges for all age classes
2. Ensure the long-term protection of marine habitat
3. Assess and prevent the degradation or destruction of reefs and seagrass beds caused by boat groundings, anchoring, and trampling by fishers and divers
4. Prevent the degradation of reef, algal, and seagrass habitat caused by environmental contaminants such as sewage and other pollutants
5. Prevent the degradation or destruction of marine habitats caused by dredging or disposal activities, which cause mechanical destruction of reefs, add suspended sediments that may damage corals and seagrasses, and smother existing flora and fauna
6. Prevent the degradation or destruction of important habitats caused by upland and coastal erosion and siltation
7. Prevent the degradation or destruction of reefs by dynamite fishing and construction blasting
8. Prevent the degradation of important habitat caused by oil transshipment activities
9. Identify other threats to marine habitat and take appropriate actions

Although these criteria and activities were written prior to the identification and listing of the Central North Pacific DPS, they provide insight into the EFs essential to the conservation of the DPS. We used this information, the best available scientific data, and unpublished data to describe the marine EFs, areas containing the EFs, whether the EFs may require special management considerations or protection, and the value of the areas to the DPS.

7.2.1 Reproduction

The recovery of the DPS is dependent on successful reproduction, and as suggested by the criteria listed above, increased nesting and nesting locations. While nesting occurs on beaches (i.e., terrestrial habitat, under USFWS jurisdiction), the marine areas surrounding the nesting beaches are essential for mating, movement of reproductive females on and off nesting beaches, internesting, and the swim frenzy of post-hatchlings.

7.2.1.1 Reproductive EFs Essential to the Conservation of the Central North Pacific DPS

The following reproductive EF is essential to the conservation of the Central North Pacific DPS: In depths up to 20 m, sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date) to allow for the transit, mating, and internesting of reproductive individuals, and the transit of hatchlings

To identify the EF, we used the natural history summary for the species (Section 3 of this report). In addition, we used the following information to provide additional specificity. Both males and females return to the neritic waters off their natal beaches (Dizon and Balazs 1982), where mating occurs in shallow waters, usually within 2 km of the coastline (Balazs 1980). Preliminary analyses of adult males and females (n = 28) demonstrates that turtles spend 90 percent or more of their time at depths of 20 m or less (PIFSC unpublished data 2022). We used the 20 m depth contour rather than a 2 km radius (which is similar in shape and size) to coincide with other areas of critical habitat (see Section 7.2.2 on foraging) for ease of analysis under section 7 of the ESA.

Mating occurs from March to June, and nesting occurs from May to September throughout the Hawaiian Archipelago (PIFSC unpublished data 2022). Egg deposition takes place at night prior to sunrise (one reason to limit artificial lighting), but females may begin excavating a nest site as early as 2 hours prior to sunset (Balazs 1980). Each night, less than half of females that emerge to nest successfully lay eggs; they emerge on subsequent nights until oviposition is achieved (Balazs 1980). During a season, females lay up to nine clutches (mean = 1.8 clutches) with an internesting interval of 11 to 18 days (mean = 13 days; Dizon and Balazs 1982; Balazs *et al.* 2015). During the internesting interval, males and females regularly occupy neritic waters adjacent to nesting beaches and the undersides of reefs as refugia (Balazs 1980). Females appear to stay relatively close to shore during the internesting interval; the maximum diving depth recorded during that time was 12.8 m (Balazs 1980). Dizon and Balazs (1982) used radio-telemetry to track turtles (4 male and 4 female, tagged at Whale-Skate Island) for one season; they found that both females and males remained in the neritic waters immediately off the basking (non-reproductive terrestrial emergence behavior) and nesting beaches. Some turtles move between islets during the internesting interval (PIFSC unpublished data 2022).

Most eggs hatch between mid-July and early October, though hatchlings have been recorded in late December (Niethammer *et al.* 1997). Hatchlings emerge from their nests and enter the water at night, usually within a few hours after sunset (Balazs 1980). Post-hatchlings move rapidly (i.e., swim frenzy) through the neritic waters on their way to their oceanic habitat (Balazs 1980). Hatchlings use light cues to orient toward the relatively bright horizon over the ocean. Even after entering the ocean, post-hatchlings are attracted to artificial lighting, which can cause them to linger in neritic habitats and increase their risk of predation (Thums *et al.* 2016). This is another reason for limiting artificial lighting on beaches and in neritic habitats.

Thus, unobstructed neritic waters are essential for mating, nesting, and post-hatchling transit to oceanic environments. Darkness is essential for nesting and post-hatchling transit to oceanic environments. Over 96 percent of all nesting occurs at Lalo, and over 50 percent of all nesting at Lalo occured at East Island (Nurzia-Humburg *et al.* 2013; Seminoff *et al.* 2015) prior to hurricane Walaka (2018). Thus, for this DPS, the majority of data on mating and nesting has been collected at East Island. Since hurricane Walaka swept through the atoll, initial evidence indicates that much of the nesting at East Island has shifted to Tern Island (PIFSC unpublished data 2021). We provide details about all nesting and reproductive sites below, but we mention these sites here to emphasize the importance of the quality *and* quantity of such features (nesting and reproductive sites).

The Recovery Plan for the U.S. Pacific Populations (that includes the Hawaiian population) calls for an average of 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually over 6 years (NMFS and USFWS 1998). Balazs *et al*. (2015) estimated total female nesting abundance of roughly 4,000 individuals; dividing this number by four (because females in Hawai'i nest on average every 4 years; Balazs *et al.* 2015), provides an estimate of 1,000 females nesting annually throughout the Hawaiian Archipelago. The estimated maximum number (n = 889) of turtles nesting at East Island was in 2014 (Staman *et al.* 2020) and that maximum has not been reached again since surveys ceased on East Island after the 2018 season (due to hurricane Walaka impacts). Therefore, critical habitat should accommodate approximately five times the current nesting population if previous recovery criteria are maintained for this DPS. In addition, the Recovery Plan for the U.S. Pacific Populations calls for stable or increasing nesting populations (over a 25-year monitoring period) at "source beaches" (NMFS and USFWS 1998). Though nesting at Lalo meets this criterion (Balazs and Chaloupka 2004, 2006; Chaloupka and Balazs 2007), other nesting beaches throughout the Archipelago do not. Because the loss or degradation of Lalo, for example by sea level rise or erosion or catastrophic events (e.g. Hurricane Walaka), would endanger the DPS, the presence of *multiple* stable or increasing nesting beaches are essential to the conservation of the DPS.

Studies have considered whether the Hawaiian green turtle population has already reached overall or nesting carrying capacity (Balazs and Chaloupka 2004, 2006; Chaloupka and Balazs 2007; Snover 2008; Tiwari *et al.* 2010). Regarding overall carrying capacity, Balazs and Chaloupka (2004; 2006) cite the substantial, long-term increase in the abundance of nesting females at East Island and a constant level of new recruits; however, the data are uninformative for carrying capacity (Chaloupka and Balazs 2007). Snover *et al.* (2008) cited further problems with using these data to indicate carrying capacity, specifically: nester abundance is still growing exponentially and not close to carrying capacity; the predictive abilities of the models are poor; and the 95 percent credible interval ranges from critically depleted to nearly double the estimated carrying capacity. Furthermore, since the original study in 2004, the population has continued to increase from an average of 338 estimated nesting females (from 2000 to 2003) to an average of 464 estimated nesting females (from 2009 to 2012; Nurzia-Humburg and Balazs 2014), indicating that the population is not at overall carrying capacity (Balazs *et al.* 2015). Using a simulation model, Tiwari *et al.* (2010) found that East Island is well below nesting carrying capacity and is capable of supporting a larger nesting population. Nesting habitat loss (e.g., Trig and East Islands) could increase nesting at other islets (e.g., Tern Island) that may be nearing carrying capacity or have poor habitat quality that may not be able to sustain the increase of nesting activity. Preliminary results of two research projects (1) examining the spatial distribution of nests laid on East and Tern Islands within Lalo and (2) the quality of nesting habitat at Tern Island found that (1) clustered nest distributions combined with the increasing trend in the number of nesting females per year suggests that the nesting beaches at Lalo may soon reach carrying-capacity, and (2) that limited locations with a suitable (substrate, sand depth, no entrapment hazards) nesting habitat exist on Tern Island (Reininger *et al.* 2019 ; Staman *et al.* 2020). Finally, the most recent analysis of the increasing nesting trend (Piacenza *et al.* 2016) indicates nesting increases with increasing nester abundance; these results suggest that nesting probability is more likely driven by environmental factors and that a positive trend in nesting may reflect an increase in nesting frequency rather than an increase in population abundance. We conclude that the Central North Pacific DPS has not yet reached overall or nesting carrying capacity, but significant nesting and reproductive sites at locations other than Lalo are essential to increase diversity and resilience, and especially if the DPS is at or near nesting carrying capacity, additional nesting areas throughout the MHI are necessary for the recovery of the DPS.

7.2.1.2 Special Management Considerations or Protection

The reproductive EF may require special management considerations or protection to maintain unobstructed access to and from nesting beaches and disturbance-free neritic areas for mating and internesting. The reproductive season is a time of increased vulnerability for sea turtles because a large proportion of adults (the most productive life stage) is concentrated within relatively small areas adjacent to nesting beaches.

The marine reproductive EF may need special consideration due to nearshore structures, which have the potential of blocking access to nesting beaches or open water for hatchlings and post-nesting females. For example, the seawall surrounding Tern Island is dilapidated, trapping green turtles as they move on and off nesting beaches (Staman *et al*. 2020). Both males and females exhibit natal site fidelity, and it is not clear what happens when access to these areas is impeded (Balazs 1980). Four nesting females and four males acoustically tagged at Trig and Whale-Skate Islands (within Lalo) remained near these islands and did not travel the 9 km to East Island within a nesting season; over multiple years, only 33 percent of males and 24 percent of females strayed from Trig and Whale-Skate Islands (Dizon and Balazs 1982). The authors concluded that once imprinted on a nesting beach, a green turtle is unlikely to switch its breeding habitat (Dizon and Balazs 1982): "Because of the specificity of the marine turtle's choice of breeding sites and times, any significant disturbance by man during this period could have profound effects upon the population…Yet it is when the turtles are in the neritic waters that the greatest potential for conflicts with humans exists… It is imperative for the well-being of the population that no alterations in the habitat be made since once imprinted the green turtle is unlikely to switch its breeding habitat." Turtles that once nested on Whale-Skate Island have nested at neighboring islets of Lalo; however, some may not have nested or may have nested in suboptimal habitats. Survey data indicate that the disappearance of Whale-Skate Island in the late 1990s did not appear to result in unusual increases in nesting at East Island in 1998, 1999, or 2000 relative to prior years (Nurzia-Humburg and Balazs 2014).

In 2018, Hurricane Walaka passed directly over Lalo, all but destroying East Island (Figure 52; https://www.papahanaumokuakea.gov/new-news/2018/11/21/Lalo-walaka/). As a result, Tern Island may become increasingly important to nesting turtles, despite its degraded habitat, which was heavily modified by artificial structures and has significant entrapment, entanglement, and potentially hazardous chemical risks due to contaminants and polychlorinated biphenyls (PCBs) buried on island to build the runway prior to World War II (Baker *et al.* 2020). Baker *et al.*

(2020) indicated that steps may be needed to mitigate habitat degradation. We conclude that the reproductive EF may require special management considerations or protection to maintain unobstructed access to and from nesting beaches and disturbance-free neritic areas for mating and internesting within the marine areas surrounding Lalo.

Figure 52. East Island, Lalo (French Frigate Shoals), before and after hurricane (https://www.papahanaumokuakea.gov/new-news/2018/11/21/Lalo-walaka/)

Prior to 2018, East Island (5 hectares, 120 m x 800 m) within Lalo hosted more than 50 percent of the nesting activity for the Hawaiian green sea turtle population with the remaining percentage of females nesting on four other islets within the atoll (Balazs *et al*. 2015); one (Trig) of those four islets also eroded away in 2018 (Baker *et al*. 2020). Since 2018, East has reappeared as a small, unstable sandspit (Baker *et al*. 2020), and nests laid there are threatened with erosion and inundation. Currently, approximately 18 hectares (Tern: 13, East: 1, Gin: 2, Little Gin: 2) of nesting habitat is available within Lalo for the majority of the Hawaiian green sea turtle population (Baker *et al*. 2020). Few turtles nest on different islands within a season (Balazs 1980); however, over several seasons, females may nest and males may bask at nearby islands (Dizon and Balazs 1982). Tern Island is the largest of all remaining islets (encompassing about 77 percent of the remaining land mass within Lalo) and is the tallest island with most of it above 2 m elevation, thus making it the most resilient and viable nesting habitat (Baker *et al*. 2020) for the Central North Pacific DPS. However, Tern Island is fraught with degrading infrastructure and littered with anthropogenic debris presenting entrapment hazards for wildlife (Baker *et al*. 2020). Additionally, landfilled materials adjacent to beaches at Tern Island have been shown to contain hazardous substances such as dioxins/furans, polychlorinated biphenyls, lead, hydrocarbons, and heavy metals, which can have negative impacts on wildlife in the marine and terrestrial ecosystems (EPA 2014).

Climate change is likely to alter or result in additional losses of essential reproductive habitat. Sea level rise is likely to result in 3 to 75 percent loss of terrestrial habitat in the PMNM (Baker *et al.* 2006); total land area loss across Lalo is expected to be 12 percent at one meter of sea level rise and 32 percent at two meters of sea level rise (Reynolds *et al.* 2012). As described above, a hurricane severely diminished East Island, which was previously projected to lose a smaller percentage of area than other islands, though nests located below rising spring tides were predicted to be subject to periodic inundation and relatively high failure rates (Baker *et al.* 2006). Reynolds *et al.* (2012) concluded that reductions in nesting areas at Lalo are likely to limit nesting habitat for Hawaiian green turtles if philopatry (i.e., natal beach fidelity) prevents their dispersal. They also predicted that along the coastline, groundwater levels and turtle nesting density will likely change as a result of sea level rise and that these changes, along with increasing temperatures, would negatively impact green turtle nesting (Reynolds *et al.* 2012). Compared to projections based on historical data, accelerated sea level rise between now and 2050 is likely to increase average coastal erosion (i.e., shoreline recession) by 5.4 ± 0.4 m (nearly twice the historical extrapolation) for 92 percent of shorelines studied in the MHI (Anderson *et al.* 2015). Coral degradation caused by climate change may also increase the wave energy reaching reef-fronted beaches, which will mobilize beach sand (Sheppard *et al.* 2005; Anderson *et al.* 2015). Such mechanisms (i.e., beach and coral reef loss) may reduce or alter the structure of available nesting habitat and associated marine reproductive habitats. For these reasons, this DPS is considered to be one of the least resilient sea turtle populations to climate change.

As previously discussed, the recovery of the DPS is dependent upon population growth and the expansion nesting elsewhere in the PMNM or in the MHI, which hosts larger and wider beaches. MHI nesting sites could offer an evolutionary "buffer" to protect against loss of low-lying areas in the PMNM due to climate change (Dutton *et al.* 2014). They could also help generally address the problem of poor spatial diversity and the associated risks (e.g., from stochastic or unexpected events). However, turtles using reproductive habitats in the MHI have a much greater likelihood of encountering human disturbance as compared to those in the remote and uninhabited PMNM. Activities with the potential to block or impede beach access include: oil and gas activities, power generating activities, recreational activities, dredging, and aquaculture. Artificial lighting in neritic habitats is likely to disorient nesting females and post-hatchlings. The noise pollution from construction (on land and in water), shipping, and military activities may also act as a deterrent to reproductive turtles and could prevent use of the area for mating or internesting.

As indicated in the Status Review (Seminoff *et al.* 2015), marina construction, beach development, resort development or activities, increased vessel traffic, and other human-associated activities or impacts are all considered threats to this DPS and its marine habitat. The Recovery Plan for the U.S. Pacific Populations (NMFS and USFWS 1998) calls for the prevention of reef and other marine habitat degradation, caused by: coastal construction; increased recreational activities; fisheries; increased industrialization; boat groundings; anchoring; reef trampling by fishers and divers; environmental contaminants such as sewage and other pollutants; upland and coastal erosion and siltation; construction blasting; oil transshipment activities; and dredging or disposal activities, which cause mechanical destruction of reefs, add suspended sediments that may damage corals and seagrasses, and smother existing flora and fauna. Additionally, reef degradation occurs as a result of military activities and trampling that occurs as a result of other recreational activities (e.g., swimming, snorkeling, and surfing).

We conclude that reproductive EFs may require management consideration or protections from: offshore and nearshore structures, construction, lighting, oil and gas activities, power generating activities, fishing, dredging, aquaculture, noise pollution from construction (on land and in water), shipping, and military activities, and climate change.

7.2.1.3 Areas Containing the Reproductive EFs

To identify areas containing the EFs essential to the conservation of the DPS and which may require special management considerations or protection, we relied on information from the USFWS. USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat within the Hawaiian Archipelago and which will be published as a proposed rule in the Federal Register. For each of the areas, we identified the associated marine area, from the shoreline (mean high water line) to 20 m depth, as containing the reproductive EFs essential to the conservation of the DPS and which may need special management consideration or protection.

We are not aware of (and FWS did not identify) any nesting sites at Johnston Atoll (Balazs 1985); therefore, we cannot identify areas containing the reproductive EFs essential to the conservation of the DPS.

7.2.2 Migration

The recovery of the DPS requires that adult turtles forage and reproduce. Because reproduction and foraging/resting are often geographically separated, the recovery of the DPS requires turtles to successfully migrate between these areas.

Individual green turtles of the Hawaiian Archipelago return to their resident foraging areas at the end of each breeding season i.e., individuals demonstrate nesting and foraging site fidelity (Balazs 1976; Rice and Balazs 2008). Most adult green turtles of the Central North Pacific DPS migrate between foraging sites in the MHI and reproductive sites at Lalo (Balazs 1976, 1980); they take 20 to 94 days to travel the 800 to 1,100 km distance (Rice and Balazs 2008; Balazs *et al.* 2017). Most satellite tracked reproductively active green turtles, migrate between Lalo and the MHI, with two turtles migrating from Lalo to Johnston Atoll, and one transmission stopped between Lalo and the MHI (Figure 53; Balazs *et al.* 2017; PIFSC unpublished data 2021). Turtles also migrated from Manawai/Pearl and Hermes Atoll and Kapou/Lisianski Island to Lalo, distances of 1075 and 834 km, respectively (Balazs 1976), and from Kamole/Laysan Island to Lalo (Amerson *et al.* 1974). A study of three adult turtles equipped with time/depth recorders prior to their reproductive migration revealed that they make shallow dives during the day (1 to 4 m) and dive to great depths at night (138 m maximum dive depth), presumably to forage and rest (Rice and Balazs 2008). Adult females undertake reproductive migrations at intervals of 4 years on average (the range is 2 to 9 years; Balazs *et al.* 2015), while adult males often migrate more frequently to breed (Balazs 1980; Dizon and Balazs 1982; Balazs *et al.* 1987).

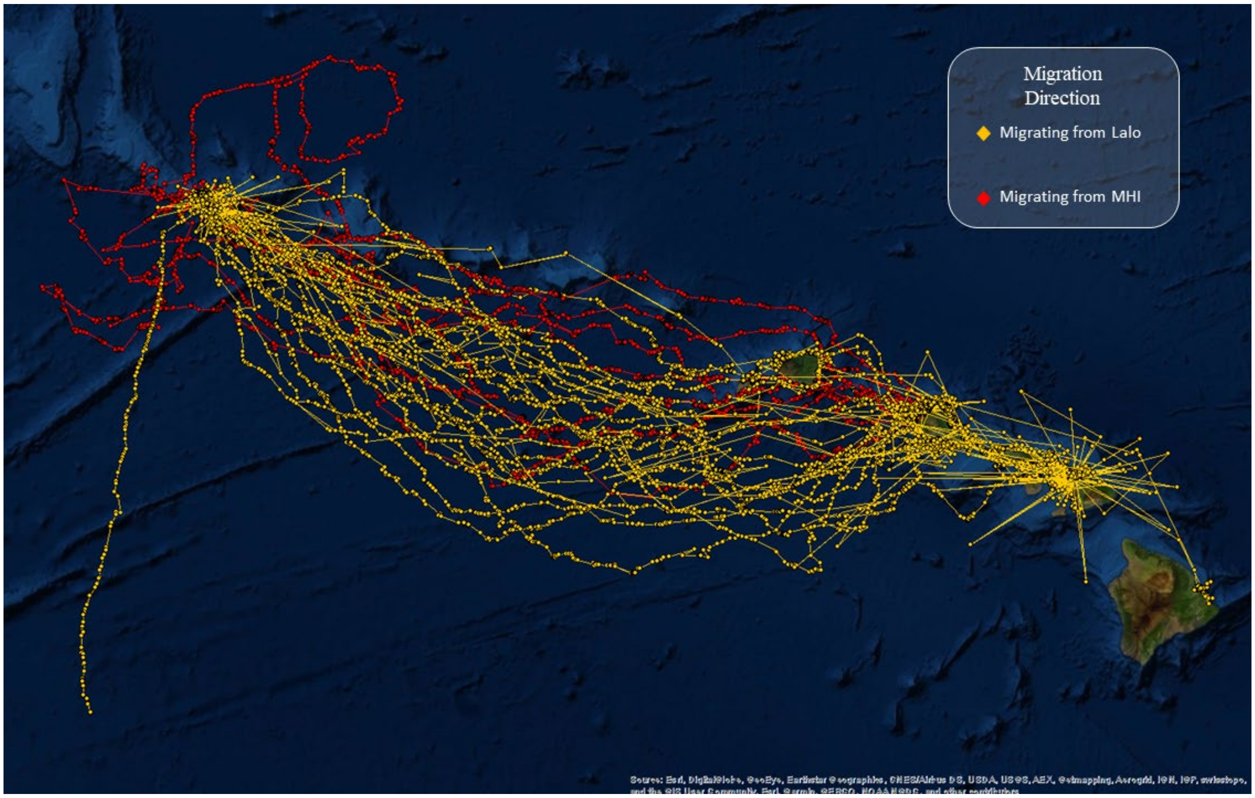


Figure 53. Satellite tracking reproductive migrations of Hawaiian green sea turtles
Reproductive migrations of all CNP green turtles that were satellite tagged during 1995 to 2021 (n = 39) that migrated to Lalo from MHI foraging areas (red lines) or from Lalo to MHI foraging areas or Johnston Atoll (yellow lines) (Balazs *et al.* 2017; PIFSC unpublished data 2021).

Of the 5,806 turtles encountered at Lalo between 1965 and 2013, 77 percent (n = 4,480) of all turtles were encountered more than once and 339 (324 females and 15 males) were observed at Lalo and at least one other island (PMNM, MHI, or Johnston Atoll); nine of the 339 were observed at Lalo and two other islands (Nurzia-Humburg and Balazs 2014). For the remaining 330 turtles, 167 were originally tagged at Lalo, with 140 later sighted at one of the MHI and 27 later observed elsewhere in the PMNM (Nurzia-Humburg and Balazs 2014). An additional 163 turtles tagged elsewhere (121 in the MHI and 42 in the PMNM) were later observed at Lalo (Nurzia-Humburg and Balazs 2014). Though the large number of sightings in the MHI is likely due to the large human presence there relative to the PMNM (Nurzi-Humburg and Balazs 2014), it also reflects the predominant migratory behavior between nutrient-rich neritic foraging areas around the MHI and the largest nesting aggregation at Lalo.

To migrate between Lalo and MHI, reproductive turtles use two general routes: south over deep, oceanic waters or a direct track via Mokumanamana/Necker and Nihoa Islands (Balazs *et al*. 2017). Most turtles used the oceanic route (Balazs *et al.* 2017; PIFSC unpublished data). The female tracked from Lalo to Johnston Atoll used a direct open-ocean pathway (Balazs *et al.* 2017). Some turtles tracked from the North Shore of O'ahu to Lalo (from foraging to nesting areas) used different migration routes: the direct track via Mokumanamana/Necker and Nihoa Islands; south over deep, oceanic waters; and north over deep, oceanic waters (Balazs *et al.* 2017; NMFS Unpublished data 2021).

Given these data, the Team concluded that green turtles of this DPS do not use a narrow, constricted migratory corridor. Instead, they use multiple oceanic migratory paths. We were unable to identify a particular depth or distance from shore used by adult green turtles to migrate between reproductive and benthic foraging/resting areas. We were also unable to identify any other physical or biological feature used by migrating turtles because the best available data demonstrate variation among movement patterns of individuals in oceanic habitats. That is to say that migration is not constricted or confined by a continental shelf, current, or other feature, but rather occurs over a large, oceanic environment without defining features (such as depth or distance from shore). Therefore, while migration between reproductive and benthic foraging/resting habitats is essential to the conservation of the DPS, we were unable to identify or define a migratory feature for this DPS.

7.2.3 Foraging/resting

The recovery of the DPS requires successful survival, growth, and development of juvenile life stages and the successful survival and reproduction of adults. Foraging and refugia habitats provide the food resources and resting areas necessary for green turtles to survive, develop, grow, and reproduce.

7.2.3.1 Foraging and Resting EFs Essential to the Conservation of the Central North Pacific DPS

The following foraging and resting EFs are essential to the conservation of the Central North Pacific DPS: in depths up to 20 m, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles and adults.

To identify the EFs, we used the natural history summary for the species (Section 3 of this report). We also used the following information to provide additional specificity. Green turtles spend most of their lives residing in neritic areas, alternating between feeding and quiescence (Balazs 1980). The underwater refugia are generally located within 2 km of foraging locations (Balazs *et al.* 1987). Preliminary analyses of adult males and females (n = 28) demonstrates that turtles spend 90 percent or more of their time at depths of 20 m or less (PIFSC unpublished data 2022). Once recruiting to an area, juveniles demonstrate foraging site fidelity and have small home ranges (Balazs 1980; Brill *et al.* 1995). Adults are likely to return to the same foraging site after nesting migrations (Balazs 1976; Rice and Balazs 2008).

Adults and benthic-foraging juveniles appear to be selective foragers that target a few species but opportunistically feed on many others, including: 275 species of marine macroalgae, two species of seagrass (*Halophila hawaiiana* and *H. decipiens)*, and nine marine invertebrate taxa (Balazs 1980; Russell *et al*. 2003; McDermid *et al.* 2015). The most common diet items include seagrass (*H. hawaiiana*) and nine species of benthic red, green, and brown algae, including: *Ulva fasciata*, *Codium edule, C. arabicum,* and *C. phasmaticum* throughout the Archipelago; *Pterocladia capillacea* and *Amansia glomerata* in the MHI; and *Caulepa racemosa*, *Spyridia filamentosa*, and *Turbinaria ornata* in the PMNM (Balazs 1980). Some introduced algal species

(*Acanthophora spicifera*, *Hypnea musciformis,* and *Gracilaria salicornia*) have become a common element in the turtles' diet (Arthur and Balazs 2008; Russell and Balazs 2009; Russell and Balazs 2015). As these non-native species have increased in abundance, their prevalence in the green turtle diet has increased (Russell and Balazs 2015). The preferred algal species generally occur in greater abundance in the MHI (Balazs 1980), and seagrasses occur only in the MHI and Kuaihelani/Midway Atoll (Balazs 1980). In addition, sea turtles forage on introduced terrestrial grasses and tree leaves, which are abundant in the MHI and provide high caloric content (Russell *et al.* 2011; McDermid *et al.* 2015; McDermid *et al.* 2018). Balazs (1980) observed juveniles and subadults "voraciously foraging" on hydrozoans (*Physalia* and *Velella* spp.) and planktonic mollusks (*Janthina* spp.) in coastal areas of the PMNM. The analysis of 2,471 digestive track samples, collected over 35 years, revealed more than 30 animal taxa, including cnidarians, mollusks, crustaceans, echinoderms, and sponges (Russell *et al.* 2011).

While turtles of the DPS as a whole, consume numerous species, individual turtles appear to be selective and opportunistic feeders that target a primary species rather than grazing on multiple species (Arthur and Balazs 2008). This may be driven by the availability of forage items within their foraging area (Arthur and Balazs 2008). Individuals may specialize on a particular forage item and develop specialized fermentive gut microflora that are able to efficiently digest either the cellulose of seagrasses or the complex carbohydrates of macroalgae (Bjorndal 1980). Also nutritional requirements may vary with age, activity, and reproductive condition (Bjorndal 1980).

Periodic dietary shifts likely help turtles meet their requirements for essential nutrients that may vary among algae (Balazs 1980), and dietary components may differ by location (Arthur and Balazs 2008). A modeling study of five major foraging areas indicates size-specific growth rates that differ among foraging sites (Balazs and Chaloupka 2004; Murakawa *et al*. 2018). A significant, long-term decline in the size-specific growth rates at some foraging areas may reflect density-dependent effects (Balazs and Chaloupka 2004). Though such effects are not well understood and warrant further investigation, the DPS could be approaching foraging carrying capacity at three locations off Hawaiʻi Island (Balazs and Chaloupka 2004; Wabnitz *et al.* 2010). While preferred food resources occur in greater abundance in the MHI, benthic habitat surrounding these islands is limited because depths increase precipitously just a few kilometers from shore (Balazs *et al.* 1987), restricting the overall potential foraging habitat of green turtles. These factors highlight the importance of protecting multiple, varied foraging areas for the Central North Pacific DPS. If the DPS is at or near carrying capacity, additional foraging areas throughout the MHI are necessary for the recovery of the DPS.

Generally, benthic marine algae, the principal food source, are restricted to shallow depths with adequate sunlight, nutrients, and substrate (Balazs 1980). Foraging areas include reef flats and shallow rocky shelves often not exceeding 3 m in depth (Brill *et al.* 1995), as well as coves and rocky shores (Francke *et al.* 2013). Both adults and juveniles forage within nearshore waters of the Hawaiian Archipelago. Towed diver surveys around O'ahu, for example, detected that 49 percent of observed green turtles were adults (Becker *et al.* 2019). Adult foraging areas are usually less than 10 m deep, and frequently not more than 3 m deep (Balazs 1980). Benthic-foraging juveniles and subadults frequently reside in the same general area as adults but are able to use even shallower feeding areas (Balazs 1980). The average green turtle home range is less than 7.2 km^2, with a typical core habitat of approximately 1 km^2 (Balazs *et al.* 2017), where food resources are concentrated (e.g., Kaneohe Bay; Brill *et al.* 1995).

For rest and protection from predators, green turtles retreat to underwater refugia located near foraging areas. Such refugia include caves, coral recesses, the undersides of ledges, and sand bottom areas (called “nests”) that are relatively free of strong currents and disturbances (Balazs 1980). In addition, turtles often rest in vertical crevices or vertical walled channels within a reef flat, which are typically shallower than 8 m (Balazs *et al.* 1987; Rice *et al.* 2000; Francke *et al.* 2013). Most resting areas occur adjacent to foraging areas at depths of 20 to 50 m; however, juveniles and subadults may use shallower areas (Balazs 1980). A common feature of underwater refugia is fine-grained sand or powdery silt (Balazs *et al.* 1987). Turtles may stay submerged in these areas for up to 2.4 hours (Dizon and Balazs 1982); however, for most juveniles (90 percent) tracked in Kaneohe Bay (n = 12) submergence intervals were 33 minutes or less and none exceeded 66 minutes (Brill *et al.* 1995). During times of light winds and calm seas, however, turtles float at the surface to thermoregulate and rest without expending the energy needed to periodically swim to the surface for respiration (Balazs 1980).

In addition to underwater refugia areas, Hawaiian green turtles use terrestrial beach habitat for thermoregulation, digestion, rest, and protection from marine predators, such as sharks (Whittow and Balazs 1982; Van Houtan *et al.* 2015). This ‘basking’ behavior is reviewed by the USFWS in their consideration of terrestrial critical habitat. However, we consider basking areas in this section because green turtles bask on beaches after foraging in adjacent neritic areas. USFWS has identified important basking areas, and we consider the adjacent foraging/resting areas where resources are likely concentrated.

As hatchlings, green turtles move offshore to pelagic waters, after leaving their natal beaches (Murakawa and Snover 2018). During the surface-pelagic juvenile stage, they likely rely on driftlines or areas of convergence near the ocean surface for food and shelter (Balazs *et al.* 1987). Hawaiian turtles appear to follow the typical sea turtle life history cycle (Parker *et al.* 2011), in which small, surface-pelagic juveniles spend less than 4 to 10 years in the oceanic environment before recruiting to neritic foraging habitats between 35 and 45 cm SCL (Balazs *et al.* 1987; PIFSC unpublished data 2015). However, there have been few observations of surface-pelagic juveniles, and little is known about their development (Balazs 1980). For these reasons, we cannot identify areas containing the EFs for post-hatchling foraging and refugia, essential to the conservation of the DPS.

Larger turtles also forage in oceanic habitats: juveniles may delay their recruitment to neritic habitats or move between neritic and oceanic foraging habitats as adults (Parker *et al.* 2011). Parker *et al.* (2011) analyzed the stomach contents of at least two, and possibly five, surface-pelagic juvenile green turtles (30 to 70 cm curved carapace length) of the Central North Pacific DPS (as confirmed by mitochondrial DNA haplotype and/or morphotype). These turtles were collected as bycatch mortalities in pelagic fisheries (high seas drift-net fishery and Hawai‘i-based pelagic longline fishery), north of the Hawaiian Islands (Parker *et al.* 2011). The stomach contents revealed mainly carnivorous (most frequently zooplankton, pelagic crustaceans, and mollusks) and opportunistic foraging (including bait) behavior at or near the surface (to depths of 100 m); 70 percent of stomach samples included plastics and anthropogenic debris (Parker *et al.*

2011), which is consistent with other studies (Clukey *et al.* 2017; Clukey *et al.* 2018; Jung *et al.* 2018; Lynch 2018). The surface convergence zones that aggregate food resources for green turtles also aggregate pollutants (Thiel and Gutow 2005), and the Hawaiian Archipelago is surrounded by three areas of concentrated marine debris aggregations (Howell *et al.* 2012) with an annual accumulation of 52.0 metric tonnes within the PMNM (Dameron *et al.* 2007) - where most of the Hawaiian green turtles reproduce. The turtles were captured 60 to 1,700 km from land, over water depths of 1,890 to 5,780 m (Figure 54).

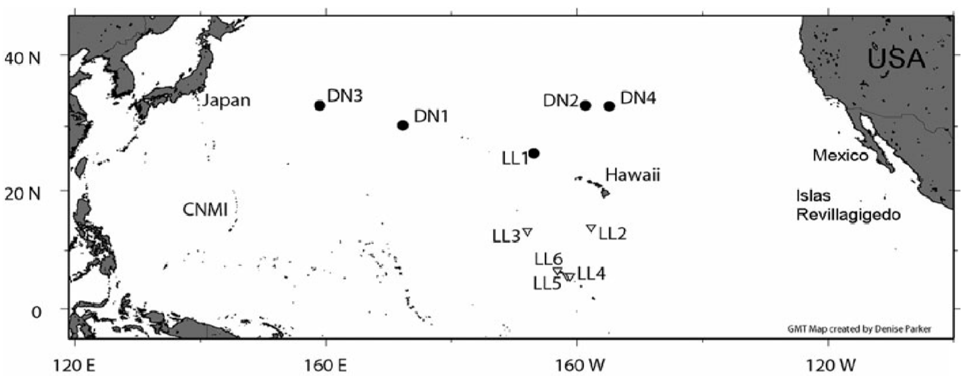


Figure 54. Location of bycatch-sampled green turtles in the oceanic environment
Turtles captured as bycatch in drift-net (DN) and longline (LL) fisheries (samples obtained 1990-1991 and 1999-2004). Genetic tests confirm that turtles DN1 and DN2 are members of the Central North Pacific DPS; DN3, DN4, and LL1 were too degraded for genetic testing but exhibited the morphotype typical of turtles from the Central North Pacific DPS (Parker *et al.* 2011).

The oceanic environment provides habitat and food resources for green turtles. However, we do not have sufficient data or knowledge to determine whether there are specific EFs targeted by turtles, what those EFs would be, or areas containing such EFs, targeted as foraging areas. The data presented above constitute a small sample size from widely dispersed locations (i.e., not clustered), which cannot be distinguished from the vast expanse of all oceanic areas. For these reasons, we cannot identify areas containing the oceanic foraging and resting EFs essential to the conservation of the DPS.

7.2.3.2 Special Management Considerations or Protection

The foraging and resting EFs may require special management considerations or protection to maintain the food resources and refugia in neritic waters. The survival and recovery of the DPS is limited by the sensitivity of coastal habitats to environmental and anthropogenic stressors; coral reefs, an important feeding ground for green turtles, are highly sensitive to and threatened by overfishing, terrestrial runoff, and climate change (Becker *et al.* 2019). The Recovery Plan (NMFS and USFWS 1998) indicates that protection is needed to prevent the degradation of marine habitats due to construction, dredging, disposal, pollution, coastal erosion, fishing, and vessel activities (e.g., groundings and anchoring). Military and recreational activities also destroy or modify reefs and seagrass beds.

The turtles' main food source, macroalgae, is available in neritic areas throughout the Archipelago; however, it appears to be most abundant in the MHI, where coral reef habitats may require protection due to land-based sources of pollution, overfishing, and recreational overuse (Friedlander *et al.* 2005). Such activities may result in siltation and contamination of foraging areas (NMFS and USFWS 1998; Friedlander *et al.* 2006; Wedding and Friedlander 2008; Wedding *et al.* 2008; Van Houtan *et al.* 2010). Seagrass and coral reef habitat of Moloka'i Island has been degraded from upland soil erosion and siltation, and coral reefs of Hawai'i, Kaua'i, Lana'i, Maui, and O'ahu Islands have been degraded by sedimentation, sewage, and coastal construction (NMFS and USFWS 1998). Recreational and vessel activities, such as groundings and anchoring, damage seagrass beds and coral reefs, which provide substrate to algal communities. In addition to reducing food resources, environmental degradation may be linked to increased incidence of fibropapillomatosis (Hargrove *et al.* 2016), which was one of the threats identified in the listing of the Central North Pacific DPS (81 FR 20057, April 6, 2016). Fibropapillomatosis primarily affects medium-sized juvenile turtles in coastal foraging pastures; it results in oral and internal tumors (often severe) that may reduce survivorship (Hargrove *et al.* 2016). While its incidence has declined over time (Chaloupka *et al.* 2009), it persists in the population (Van Houtan *et al.* 2010, PIFSC unpublished data 2021).

Degradation or destruction of reefs and seagrass beds caused by boat groundings, anchoring, and trampling by fishers, divers, snorkelers, swimmers, and surfers. Military activities, including the explosion of unexploded ordinances, may also degrade or destroy reefs and seagrass beds.

Discharges from agriculture, development, construction, and stormwater occur throughout the MHI and have a significant effect on the taxonomic and chemical composition of algal communities (e.g., Lapointe and Bedford 2011; Dailer *et al.* 2010; Swarzenski *et al.* 2017). The herbicide glyphosate is introduced to coastal environments through run-off and was shown to negatively impact native macroalgae and seagrasses in Hawaiian waters (Kittle and McDermid 2016). This herbicide negatively impacts green turtles via dermal exposure, changes in marine plant communities, and/or alterations of gastrointestinal tract microflora, reducing their digestion efficiency and overall health (Kittle *et al.* 2018).

The protection of food resources is especially important at high density foraging areas, such as the Kaloko-Honokohau National Historical Park on Hawai'i Island. Wabnitz *et al.* (2010) expressed concern over water quality in the area because plans have been proposed for the development of adjacent lands that would result in a 300 percent expansion of the small boat harbor and construction of hotels, condominiums, and an industrial park; expected impacts include reduced groundwater flow and increases in sedimentation, nutrient influx, and chemical pollutants. There is also a proposal to dredge areas in front of the Kahala Hotel, O'ahu Island, where both seagrass species are located (K. Foster, USFWS, pers. comm. 2015). In the PMNM, there is concern regarding pollution from previous construction. At Tern Island, landfilled materials contain hazardous substances such as dioxins/furans, polychlorinated biphenyls, lead, hydrocarbons, and heavy metals, which can have negative impacts on wildlife in marine and terrestrial ecosystems (EPA 2014). The seawall surrounding Tern Island is dilapidated and is no longer retaining contaminated sediments, which may be released into the surrounding marine habitat (J. Keller Lynch, pers.comm. 2016). Though such contaminants could become concentrated in macroalgae and ingested by green turtles, we do not understand the consequences of such pathways. For example, in a study of 53 Hawaiian green turtles foraging in the MHI (~1,000 miles from Tern Island), Keller *et al.* (2014) found very low levels of persistent organic pollutants and halogenated phenols, and there was no correlation between the concentration of contaminants and fibropapillomatosis.

Nonnative algae were introduced into Hawaiʻi for the purposes of commercial aquaculture in the past (Russell and Balazs 2009); however, we are unaware of any plans for the commercial harvest of algae. Traditional harvest targets only two species of limu (i.e., native algae) that are also eaten by green turtles. These species, *U. fasciata* and *C. edule*, are both common (Abbott 1984). Green turtle grazing controls growth of non-native algae, which may benefit native species as well as coral reef ecosystems (Bahr *et al.* 2018).

Underwater refugia may be in need of special management considerations or protection as well. Dredging and beach nourishment may cover or destroy underwater refugia. Disrupted underwater rest (which may account for 12 hours of their day; Rice *et al.* 2000) may prevent adequate digestion, development, and growth.

Given these sensitivities, we conclude that foraging and refugia EFs may require special management considerations or protection, especially for the following activities: construction, dredging, disposal, pollution, coastal erosion, fishing, and vessel activities. Climate change also has the potential to negatively affect food resources via changes in water temperatures, ocean acidification, and coral reef habitat (Friedlander *et al.* 2008).

7.2.3.3 Areas Containing the Foraging and Resting EFs

Within the range of the Central North Pacific DPS, many areas contain food resources and underwater refugia. We rely on the occurrence of green turtles to determine which of these areas contain sufficient resources for resting and foraging to support survival, development, growth, and/or reproduction. First, we identified areas containing the EFs, where green turtles have been documented in published scientific research studies. Next, we considered unpublished data from scientific research studies and aerial and in-water surveys. We only used stranding data to support other data and to demonstrate the likely extent of the EFs because the origins of strandings are often unknown and strandings may be the result of suboptimal habitat use.

From 2002 to 2015, B *et al.* (2019) conducted biennial or triennial nearshore surveys throughout the U.S. Pacific Islands, comparing green turtle densities. Such analyses are especially valuable for identifying foraging sites and rating their conservation value because density reflects the interplay between reproduction, resource availability, behavior, and top-down forces; also, it provides an objective and consistent measure of conservation value across the DPS. Within the Hawaiian Archipelago, there were high densities (≥ 0.10 green turtles/km) off the Island of Hawai'i, O'ahu, Maui, Kaua'i, and Moloka'i, and low densities (< 0.10 green turtles/km) at Ni'ihau and throughout the PMNM (Table 8; Becker *et al.* 2019). These densities reflect other data, described below, that demonstrate high densities of foraging and resting green turtles throughout the MHI. However, these data do not reflect the importance of foraging areas in PMNM, as reflected by basking data.

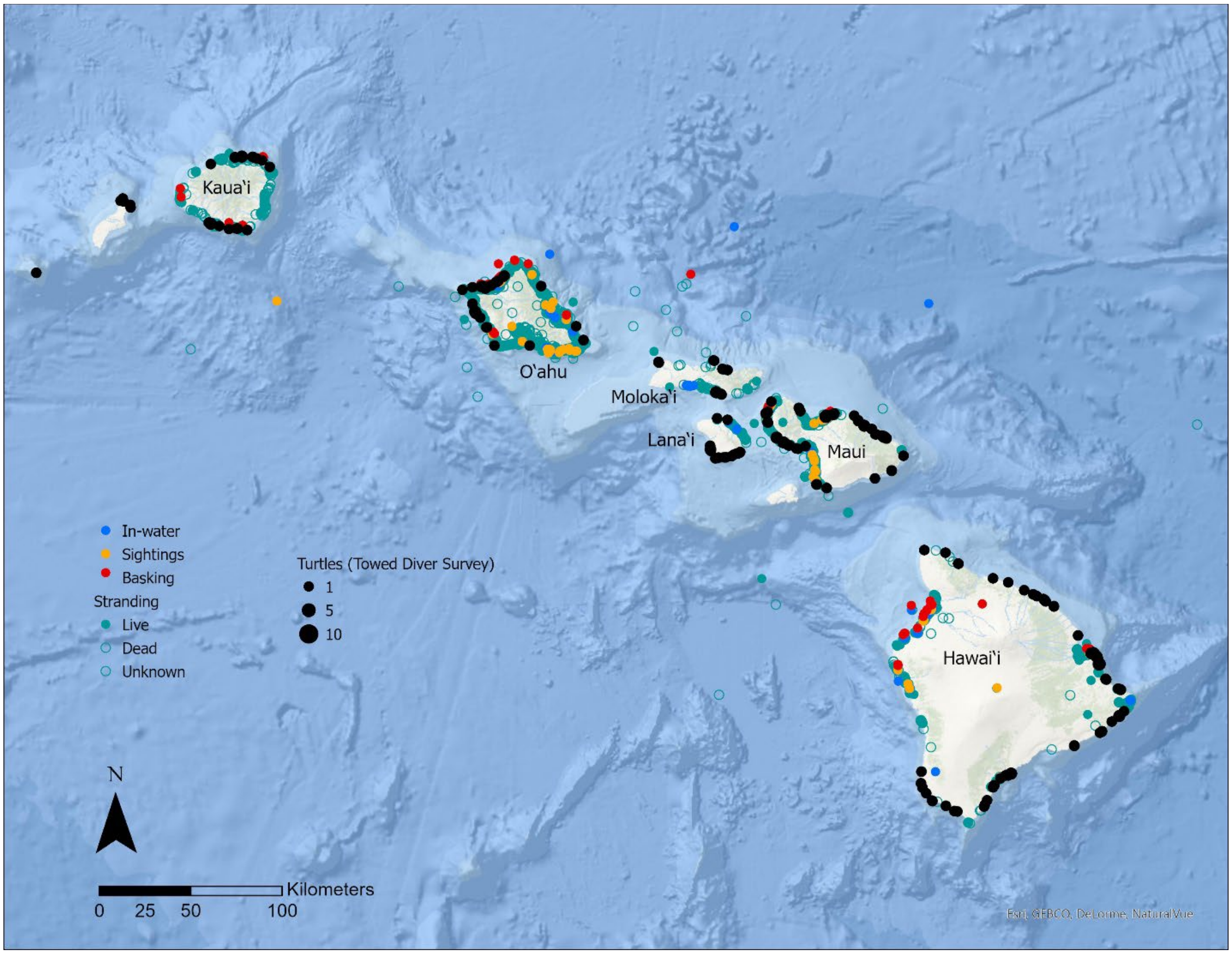
Table 8. Density of green turtles in the Hawaiian Archipelago and Johnston Atoll

Table modified from the supplemental materials provided by Becker *et al.* (2019). Density represents the number of green turtles per 1,000 tow segments or kilometer.

Survey location		Green turtles per 1000 tow segments	Green turtles per km
Region	**Island/Atoll**		
	Johnston	**5**	**0.02**
Hawaii	**O'ahu**	**74**	**0.11**
	Hawaii	**60**	**0.27**
	Maui	**54**	**0.24**
	Kauai	**43**	**0.18**
	Molokai	**30**	**0.13**
	Pearl and Hermes	**27**	**0.12**
	Lanai	**23**	**0.10**
	Hōlanikū/Kure	**18**	**0.08**
	Kuaihelani/Midway	**14**	**0.06**
	Lehua	**8**	**0.04**
	Niihau	**7**	**0.03**
	Maro	**4**	**0.02**
	French Frigate	**3**	**0.01**
	Kamole/Laysan	**3**	**0.01**

Survey location	Green turtles per 1000 tow segments	Green turtles per km
Kapou/Lisianski	**3**	**0.01**
Gardner	**0**	**0.00**
Kaula	**0**	**0.00**
Mokumanamana	**0**	**0.00**
Nihoa	**0**	**0.00**
Raita	**0**	**0.00**

We were also able to compare these data at a finer scale, combining PIFSC in-water capture surveys between 1985 and 2016 with the Coral Reef Ecosystem Program (CREP) towed diver surveys between 2000 and 2015 in some neritic waters throughout the Archipelago (Becker *et al.* 2019). Green turtles were observed foraging or resting in most areas surveyed (Figure 55; NMFS CREP, unpublished data 2016; PIFSC unpublished data 2022). In support of the above data, stranding data are available throughout much of the Archipelago (Figure 55; PIFSC unpublished data 1975 to 2016; Roberson *et al.* 2016). Given the small home range and foraging site fidelity of Hawaiian green turtles (Balazs 1980; Brill *et al.* 1995), it is likely that stranded turtles are found in areas with the foraging and resting EFs. Because these surveys comprise a representative sample of all potential foraging areas in the Archipelago, and turtles foraged and rested in nearly every sampled area, green turtles likely forage and rest in neritic areas throughout the Archipelago.



Kaua'i
O'ahu
Moloka'i
Lana'i
Maui
Hawai'i
In-water
Sightings
Basking
Stranding
Live
Dead
Unknown
Turtles (Towed Diver Survey)
1
5
10
N
Kilometers
0 25 50 100
Esri, GEBCO, DeLorme, NaturalVue

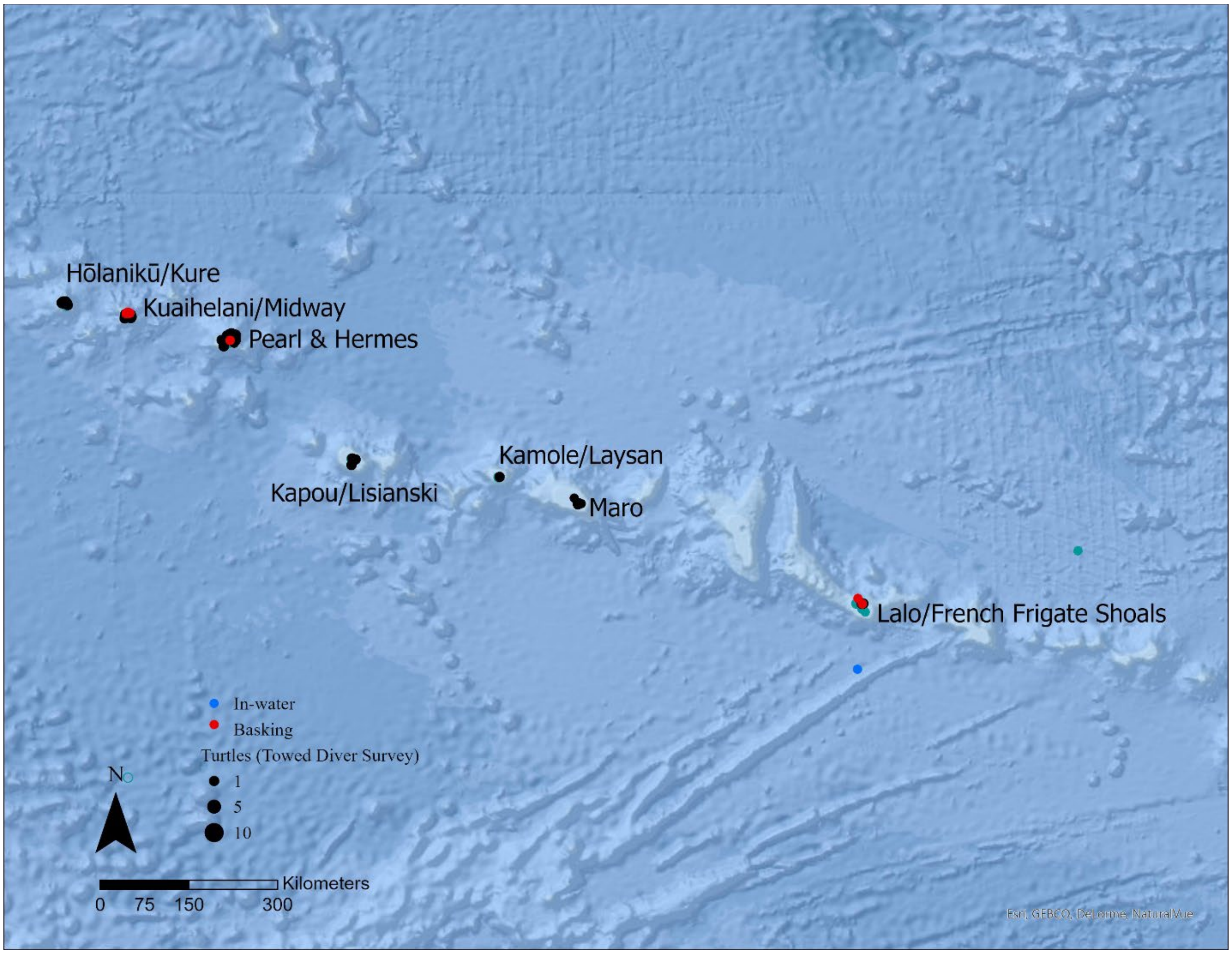


Figure 55. In-water green turtle observations throughout the Hawaiian Archipelago
Data collected from MHI (top) and PMNM (bottom) during nearshore captures (blue dots); towed-diver surveys (black dots); and strandings (green dots); red dots represent basking turtles (NMFS CREP, unpublished data 2016; PIFSC unpublished data 2016)

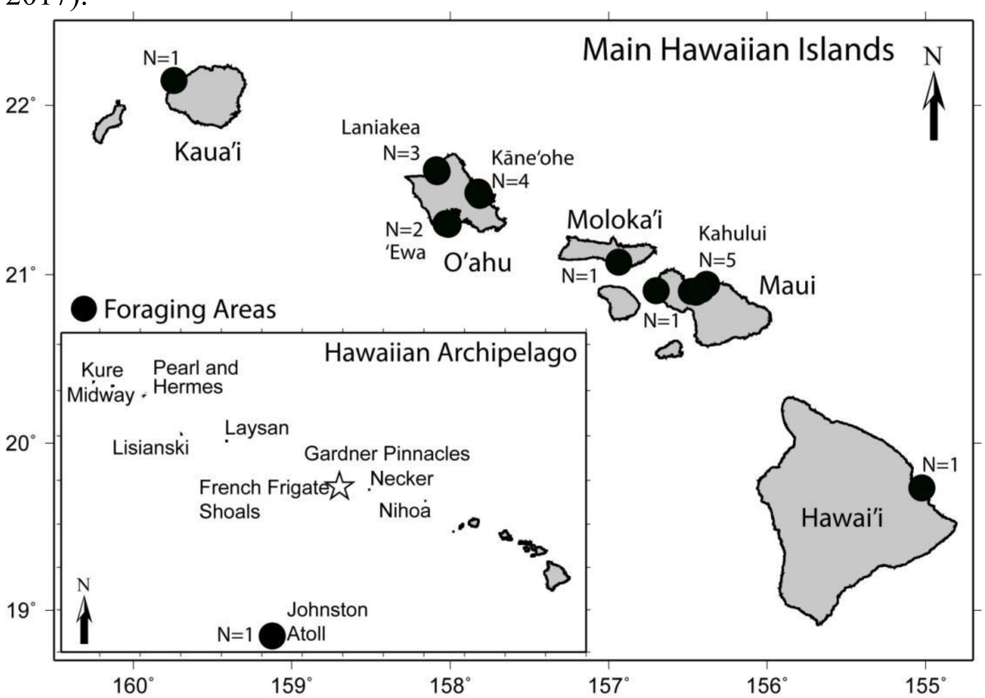
Most juveniles and adults forage in the neritic habitat of the MHI, where foraging habitat and preferred food are greater relative to the PMNM (Balazs *et al.* 1987). Foraging and resting occur within specific habitats (Francke *et al.* 2013). While green turtles are known to occur in marine habitats throughout Hawai‘i, published scientific studies have identified the following important foraging and refugia areas in the MHI (Balazs 1980; Balazs *et al.* 1987; Brill *et al.* 1995; Balazs and Chaloupka 2004; King 2007; Arthur and Balazs 2008):

- Kaua‘i Island: Princeville; northwestern coastal areas of Na Pali; southern coastal areas from Kukuiula to Makahuena Point
- O‘ahu Island: Kaneohe Bay; Kawela Bay; Kailua Bay; northwestern coastal areas from Mokuleia to Kawailoa; Maunalua Bay; West Beach; Sandy Beach
- Moloka‘i Island: southern coastal areas from Kamalo to Halena; Pala‘au
- Lana‘i Island: northern and northeastern coastal areas bordering Kalohi and Auau Channels; Keomuku; Kuahua; Polihua Beach
- Maui Island: Kahului Bay; Hana District and Paia; Honokowai; Maliko Bay; Olowalu; Kihei, Napili, Ka‘anapali, and Lahaina

- Kahoʻolawe Island
- Hawaiʻi Island: Kau and North Kohala Districts; Kiholo Bay; Kaloko-Honokohau, National Historical Park; Kapoho; Punaluʻu Bay; Keaukaha coastline

Foraging sites that may be at or near carrying capacity include three locations off Hawaiʻi Island: Kaloko-Honokohau National Historical Park (Wabnitz *et al.* 2010), Kiholo Bay, and Punaluʻu Bay (Balazs and Chaloupka 2004). Because they are at or near carrying capacity, additional foraging areas throughout the MHI are necessary for the recovery of the DPS.

Other important foraging areas include those areas where turtles forage after migrating from reproductive areas of Lalo (Figure 56). Satellite tracking of 17 post-nesting females at Lalo between 1992 and 2014 revealed the importance of foraging areas in Kaneʻohe Bay, Oʻahu, and Kahului Bay, Maui, which were the destinations for ~50 percent of the turtles (Balazs *et al.* 2017).



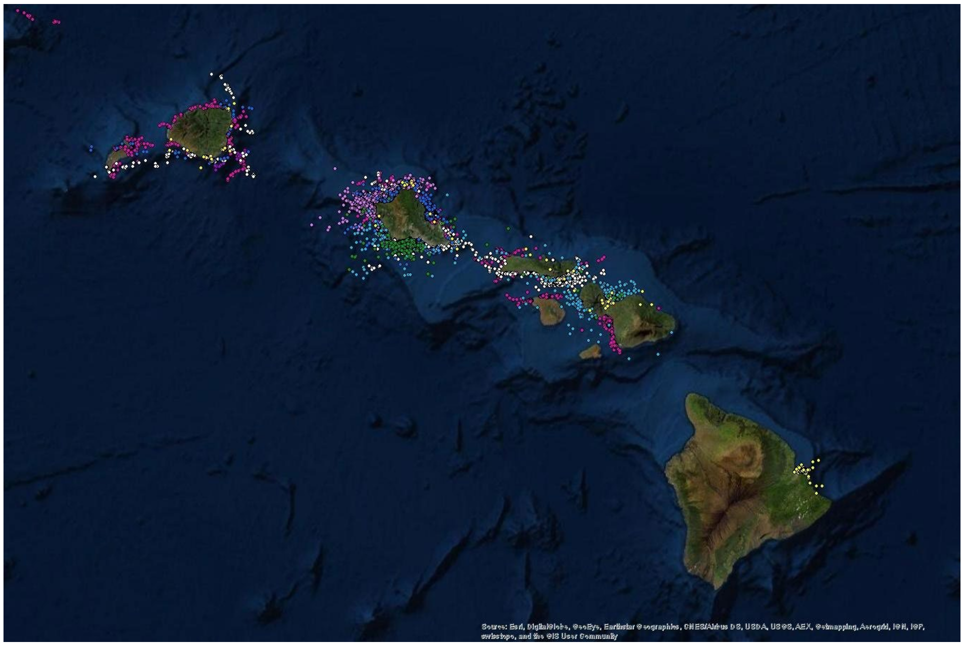


Figure 56. Foraging/resting areas determined by satellite tracking of post-reproductive adults
Top figure: Black dots represent foraging destinations for 17 adult female green turtles tracked from 1992 to 2014 (Balazs *et al.* 2017). Bottom figure: Similar colored dots represent each year from 1995–2021 and the foraging ground destinations of satellite tag deployments on adult male and female green turtles (n = 39) (PIFSC unpublished data 2022).

Off Hawai‘i Island, juvenile turtles use foraging and resting habitat along the Kona/Kohala coast. Numerous turtles (over 300; Balazs *et al.* 2000) forage in Kiholo Bay (Balazs and Chaloupka 2004; Seaborn *et al.* 2005) on red and green macroalgae, especially *Pterocladia* and *Cladophora* spp. (Arthur and Balazs 2008). Juvenile turtles (n = 44) use the Wainanali‘i Lagoon and adjacent fishponds for rest and possible thermoregulation (Balazs *et al*. 2000; Harrington *et al*. 2000). The rocky inshore reef of Kaloko-Honokohau National Historical Park provides foraging habitat supporting red and green macroalgae for juvenile green turtles (n = 35; Arthur and Balazs 2008). Turtles forage on turf algae close to shore, possibly to avoid shark predation, at this important foraging area (Wabnitz *et al.* 2010). Kahalu‘u Bay is also an important foraging area for juvenile and subadult green turtles (Balazs 1996). The waters off the Ka‘u and North Kohala Districts contain foraging and refugia EFs for resident adult turtles (Balazs 1980). Balazs (1980) describes turtles foraging along the coastlines of the Ka‘u District, where red algae (*P. capillacea*) grows in shallow, turbulent water on rocks just below the low tide line and in areas where freshwater enters the ocean from underground springs. This area includes Punalu'u Bay, where green turtles forage on intertidal red algae inside the bay at depths of 0 to 2 m for approximately 9 hours daily and rest outside of the bay at depths of 4 to 38.5 m for approximately 12 hours nightly (Rice *et al.* 2000). Prior to 2018 when lava completely filled Kapoho Bay (CNN 2018), juvenile turtles (n = 8) used the geothermal-heated pools for thermoregulation and underwater resting near Kapoho; they foraged on red macroalgae, including *Gracilaria* and *Amansia* spp. (Arthur and Balazs 2008). Turtles in the waters off Hilo forage at high tide on a terrestrial, salt-tolerant turfgrass (seashore paspalum, *Paspalum vaginatum)*, which was first introduced to the Hawaiian Islands in the 1930s (McDermid *et al.* 2015)(McDermid *et al.* 2015).

On Maui Island, the waters off the Paia and the Hana District contain foraging and refugia EFs for resident adult turtles (Balazs 1980). Balazs (1987) studied foraging areas off Honokowai, Maliko Bay, Olowalu, and Kahului Bay, where numerous turtles forage and rest. At Kahului Bay, large turtles (including many adults) aggregate in the warm water outfall of the power plant, where temperatures range from 27 to 33 °C, for thermoregulation and resting; foraging likely occurs outside of the warm water plume (Balazs *et al.* 1987). The Kahului Generating Station, which was built in 1947, will be decommissioned by 2024 (*https://www.mauinews.com/news/local-news/2020/11/kahului-power-plant-shutdown-plan-presented/*). This cessation of warm water outfall is likely to reduce physiological functions, somatic growth rates, and nesting frequencies of resident turtles (Balazs, pers. comm., July 28 2016). The following have been identified as areas where sea turtles are known to occur in Maui (https://embracesomeplace.com/snorkeling-maui-sea-turtles/): Slaughterhouse Beach, Black Rock Beach, Hoʻokipa Beach Park, Five Caves, Maluaka Beach, Ulua Beach, Hanakaoʻo Park, Makena Landing, Mala Pier, Chang's Beach, Honokeana Bay, and Kapalua Bay.

On Kahoʻolawe Island, King (2007) used aerial, in-water, and coast surveys to collect 708 sea turtle sightings in the reserve, including 18 identified as foraging and 10 identified as resting green turtle sightings. Turtles foraged on turf algae (King 2007). Green turtles occurred in clear, shallow water (1 to 6 m depth) within coral reef habitats 5 to 20 m from shore. Juvenile turtles (including recent recruits) predominated and were fairly evenly distributed around the island with higher density in the Kākā, Hakioawa and Kealaikahiki regions (Figure 57; King 2007).

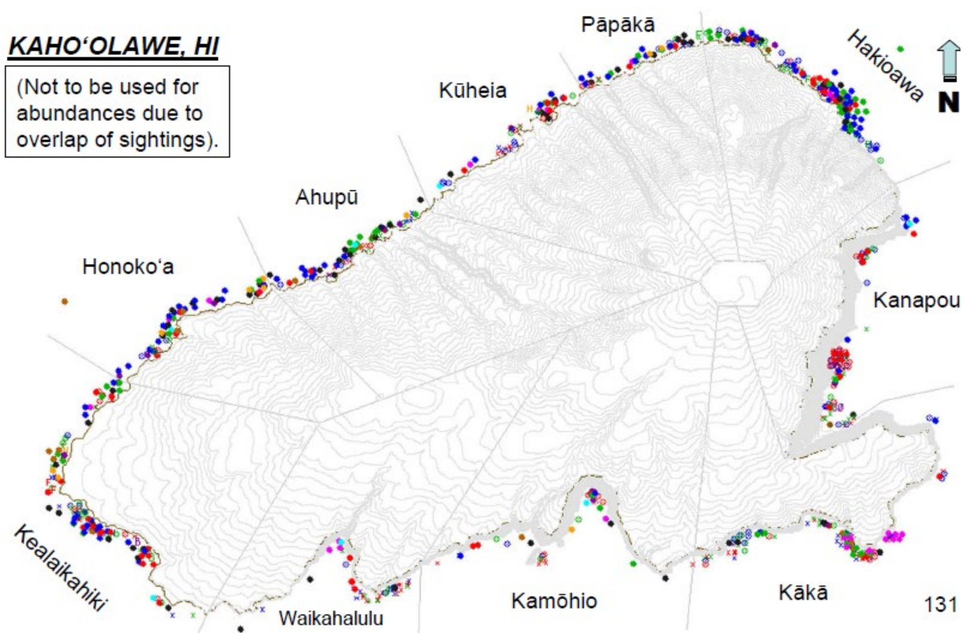


Figure 57. Green turtles identified during all surveys of Kahoʻolawe Island Reserve
Dots represent all turtle sightings (Figure 26 from King 2007)

On Lanaʻi Island, the northern and northeastern coastal areas bordering Kalohi and Auau Channels contain foraging and refugia EFs for resident adult turtles (Balazs 1980). Balazs (1987) studied foraging areas off Keomuku, Kuahua, and Polihua Beach for their current or historic importance to green turtles or their unique or representative ecology. Arthur and Balazs (2008) found that the diets of juvenile turtles (n = 20) from the northeastern coast of Lana‘i Island included red macroalgae, primarily *A. spicifera*. This species was accidentally introduced to the Hawaiian Islands in the 1950s (Doty 1961). It colonized successfully and spread quickly (Russell and Balazs 1994). By 1980, it had become a principal component of green turtle diets (Arthur and Balazs 2008).

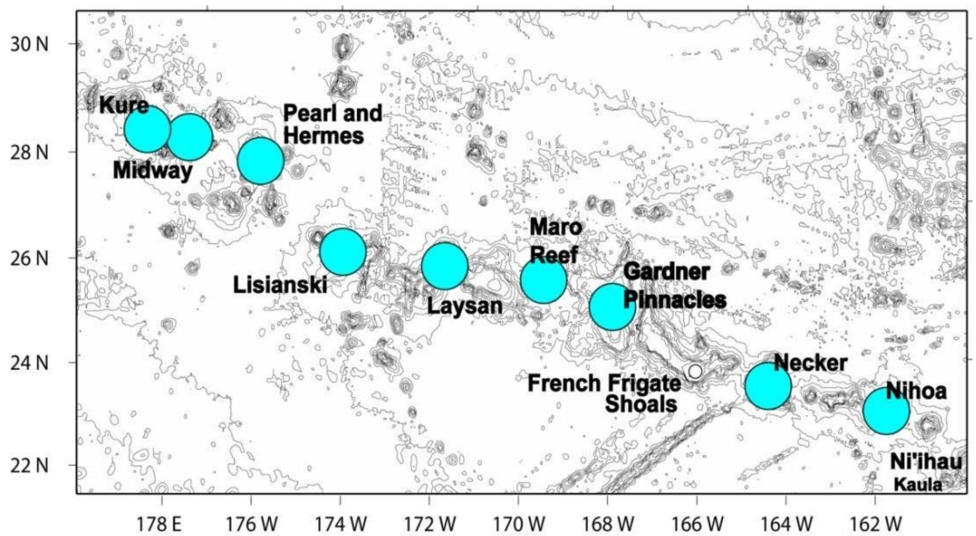
On Moloka‘i Island, the southern coastal areas from Kamalo to Halena contain foraging and refugia EFs for resident adult turtles (Balazs 1980). There is significant foraging habitat along the Pala‘au coastline (Balazs and Chaloupka 2004; Balazs *et al.* 1987), where algae grow on hard-bottom surfaces and coral rubble; resting occurs in crevices, holes, sand channels, and at the base of coral heads inside of the reef zone within the breakers (Balazs *et al.* 1987). These foraging habitats support the red macroalgae diet of juvenile turtles (n = 17) that consists of *Amansia* spp., *Hypnea* spp., and non-native *A. spicifera* (Arthur and Balazs 2008).

On O'ahu Island, many areas contain foraging and refugia EFs, with concentrated foraging/resting areas on the North Shore, West coast (Ewa Beach/Pearl Harbor), South Shore, and East coast (Kaneohe and Kailua Bays). Kaneohe Bay, Kailua Bay, and the northwestern coastal areas from Mokuleia to Kawailoa host foraging and resting resident adult turtles (Balazs 1980). Kaneohe Bay is an important foraging area that provides 135 species of algal and seagrass food resources (Brill *et al.* 1995; Balazs *et al.* 2000; Russell *et al.* 2003; Balazs and Chaloupka 2004; Russell and Balazs 2009; Russell and Balazs 2015). Foraging and resting juvenile turtles (n = 12) remained within Kaneohe Bay, where patch reefs are common and algal growth is most abundant (Brill *et al.* 1995). Though juvenile green turtles in Kaneohe Bay (n = 26) forage on native and non-native macroalgae, seagrasses *(H. decipiens* and *H. hawaiiana)* also comprise a large portion of their diet (Russell *et al.* 2003; Seaborn *et al.* 2005; Arthur and Balazs 2008). The three most common algal species consumed are non-native species: A. spicifera, *H. musciformis*, and *Gracilaria salicornia* (Russell and Balazs 2009; Russell and Balazs 2015). In Kailua Bay, juvenile green turtles (n = 41) primarily foraged on the non-native red macroalgae, *A. spicifera* (Arthur and Balazs 2008). Six juveniles tracked in the Kawainui Marsh Estuary of Kailua Bay foraged in the bay and rested along the channel and ledge (Francke *et al.* 2013). Balazs (1987) also studied foraging areas off Kawela Bay, Maunalua Bay, West Beach, and Sandy Beach for their current or historic importance to foraging green turtles or their unique or representative ecology. Numerous turtles forage within Kawela Bay (North shore) but rest further offshore, where turtles are likely to find deeper depths or to avoid human disturbance within the bay (e.g., boating, fishing, and in-water recreation; Balazs *et al.* 1987). They appear to forage at night (primarily on the non-native red macroalgae, *A. spicifera*) and rest during the day (Balazs *et al.* 1987). Turtles also forage off Laniakea Beach, which is an important basking beach (Rice and Balazs 2008; Van Houtan *et al.* 2015). Balazs (1980) describes turtles foraging along Bellows Beach, where algae (*Codium* and *Ulva* spp.) concentrate along sandy bottoms 25 to 100 m from shore, due to wave action and currents. Green turtles also forage in streams, including the Anahulu River, where 968 green turtle sightings were made over nine evening and two morning observation sessions (Clarke *et al.* 2012).

On Kaua‘i Island, Princeville, the northwestern coastal areas of Na Pali, and southern coastal areas from Kukuiula to Makahuena Point contain foraging and refugia EFs for resident adult turtles (Balazs 1980).

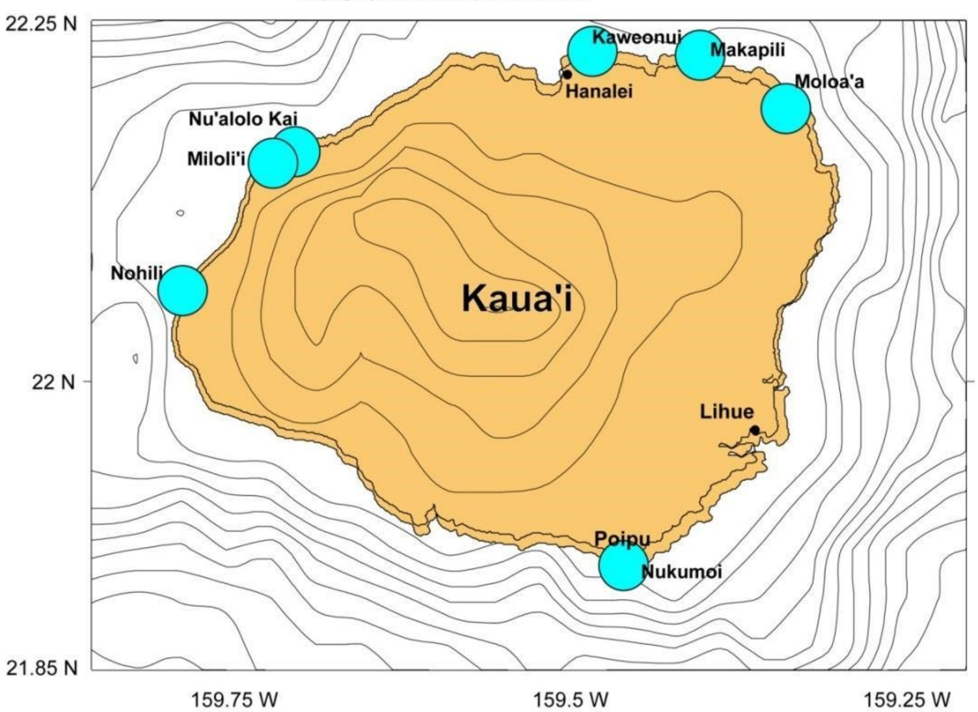
In the PMNM, sea turtles have been sighted throughout the monument. Resident aggregations of adults and juveniles forage at Mokumanamana/Necker Island, Lalo/French Frigate Shoals Atoll, Kapou/Lisianski Island, Manawai/Pearl and Hermes Atoll, and to a lesser extent at Kamole/Laysan, Kuaihelani/Midway Atoll, and Hōlanikū/Kure Islands (Balazs 1980). Juveniles and adults (at least 50, as estimated in 1977) forage throughout Mokumanamana/Necker Island's neritic waters; Shark Bay is an especially important foraging area (Balazs 1977). Stomach contents of three juveniles revealed foraging on *Caulerpa* spp. (Balazs 1977). At Lalo, resident juveniles forage on algae (*Caulerpa* spp. and *Codium* spp.) and anthozoans growing on calcareous reef structures, and reproductive adults feed throughout the breeding season (Balazs 1980). At Kuaihelani/Midway Atoll, turtles forage in algal and partial seagrass habitat (Balazs and Chaloupka 2004). Benthic-foraging juvenile turtles, as small as 6 kg (i.e., greater than 6 years of age; Balazs and Chaloupka 2004) are regularly found around Kamole/Laysan Island, Kapou/Lisianski Island, Kuaihelani/Midway Atoll, and Hōlanikū/Kure Atoll (Balazs 1976). A substantial number of turtles in this size category are observed throughout the year in waters off Lalo (Balazs 1976). Turtles smaller than 12 kg are rarely observed in the MHI (Balazs 1976). Therefore, the PMNM may serve as an important foraging habitat for this early stage of development (Balazs 1976).

Throughout the Hawaiian Archipelago, benthic-foraging areas for green turtles are spatially and behaviorally linked in proximity to terrestrial locations where basking occurs (Figure 58; PIFSC unpublished data 2015; Roberson *et al.* 2016). In the mid-1970's numerous study sites were selected for long-term ocean capture tagging and related research. In the early 1990s resident turtles at these locations, including ones tagged during prior study visits, began to display non-reproductive terrestrial emergence behavior (or 'basking') ashore. Basking in the simplest of terms is an alternate and more energy-efficient strategy to resting underwater after bouts of foraging. Green turtles bask on beaches for rest, thermoregulation, digestion, and predator avoidance (Balazs 1977; Wittow and Balazs 1982; Rice and Balazs 2008; Van Houtan *et al.* 2015). The distances between foraging sites and basking/underwater resting sites are most often within 300 to 500 meters and rarely over 1 km (George Balazs, pers. comm., September 21 2016; Balazs and Chaloupka 2004; Balazs *et al.* 2015). Therefore, we conclude that the neritic areas surrounding basking beaches provide the benthic-foraging and resting EFs and that these areas are of high conservation value.



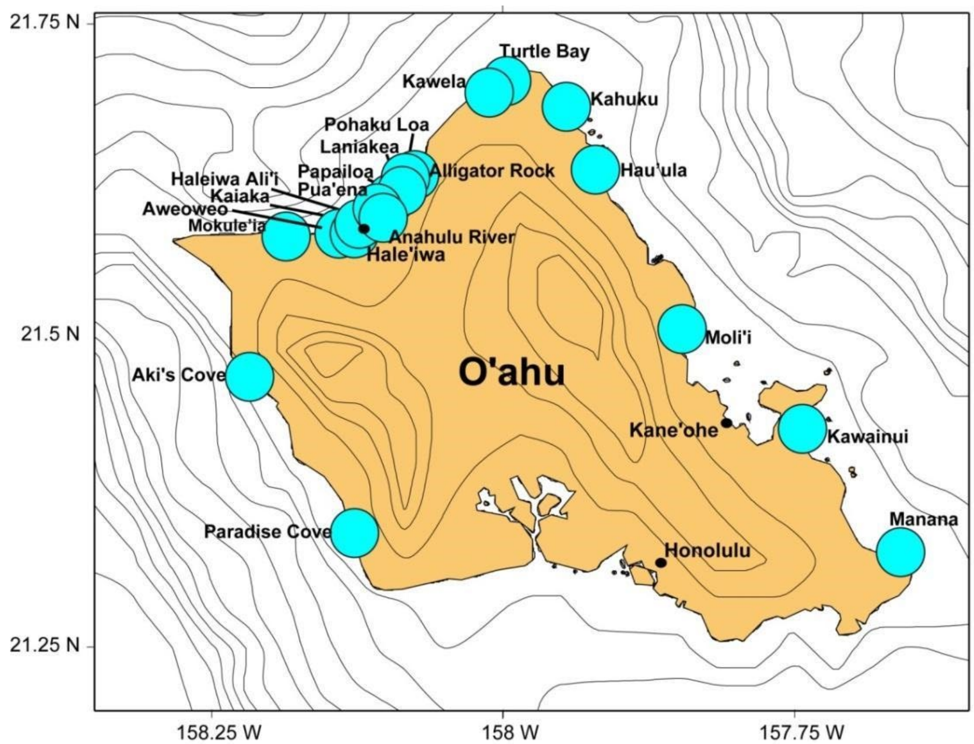
Foraging areas proximal to green turtle basking by location in the NWHI

GMT map created by Denise Parker JIMAR-PIFSC
Topographic lines represent 500m



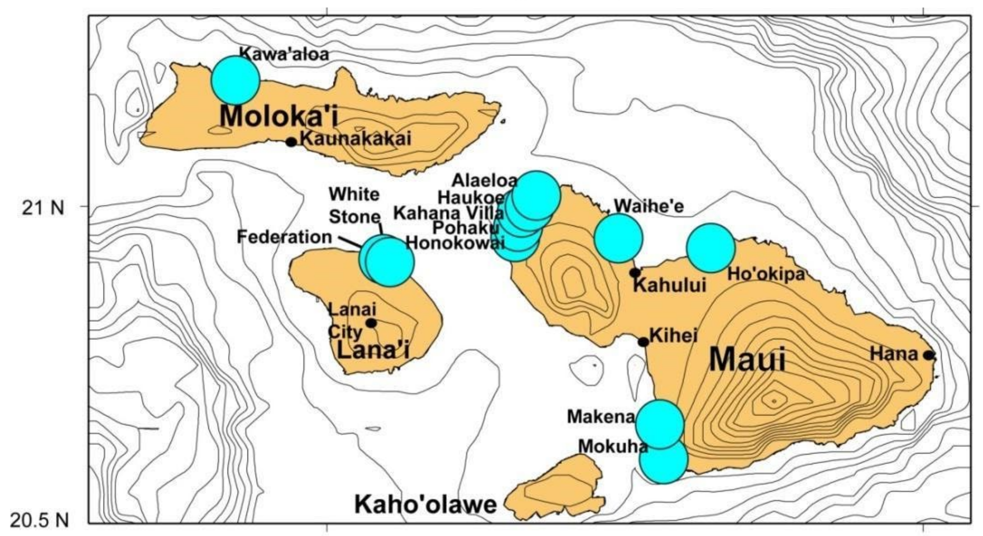
Foraging area proximal to green turtle basking by location on the Island of Kaua'i

GMT map created by Denise Parker JIMAR-PIFSC
Topography lines represent 250m



Foraging areas proximal to green turtle basking by location on the Island of O'ahu

GMT map created by Denise Parker JIMAR-PIFSC
Topography lines represent 250m



Foraging areas proximal to green turtle basking by location in Maui County

GMT map created by Denise Parker JIMAR-PIFSC
Topography lines represent 250m

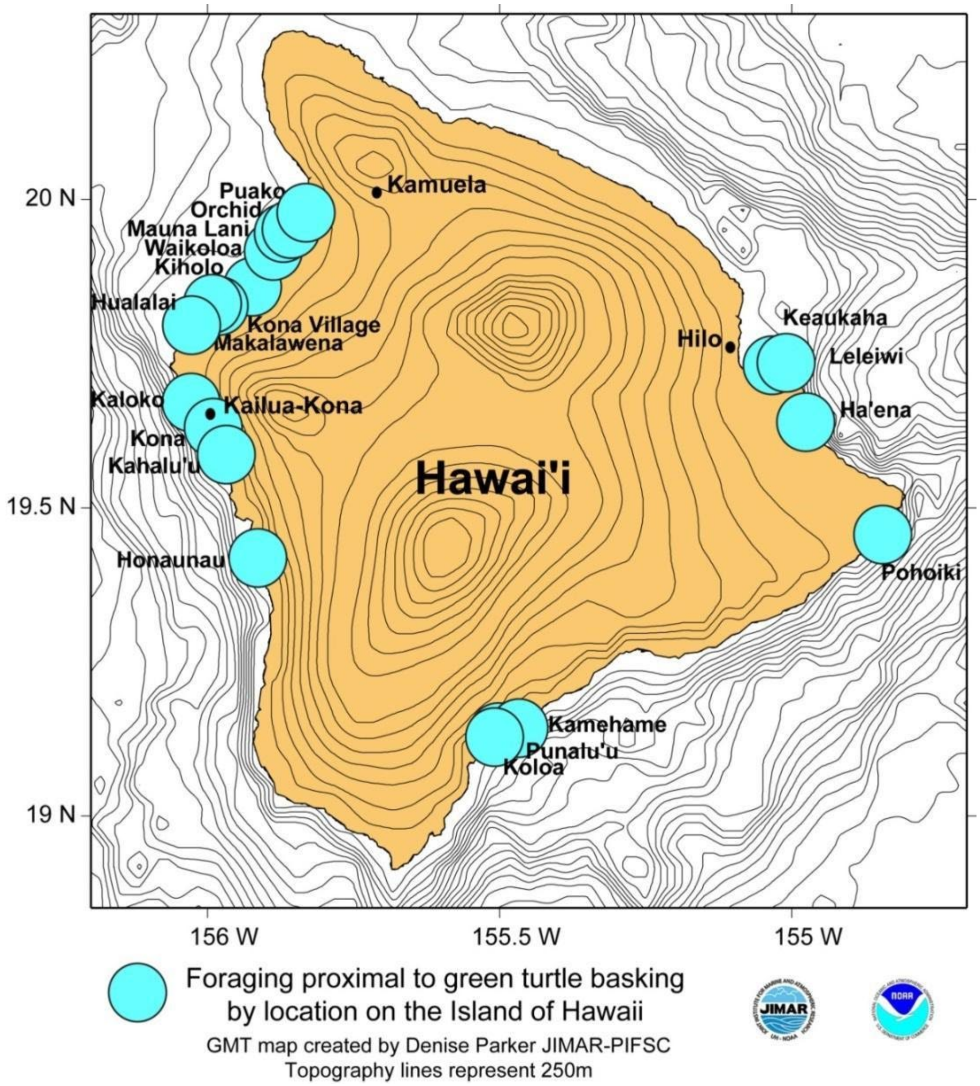


Figure 58. Foraging areas located in proximity to basking sites in the Hawaiian Archipelago
Blue circles represent foraging areas near basking beaches (PIFSC unpublished data 2015)

Adults and benthic-foraging juveniles forage in the neritic waters surrounding Johnston Atoll (Balazs 1985). Most turtles occur off the southern shore of Johnston Island, where they forage on algae, including *Bryopsis pennata* and *C. racemosa* (Balazs 1985). During 28 days of effort in 1983, 21 turtles were captured in this area; 60 percent of the captured turtles were adults (Balazs 1985). Only three turtles were sighted during 26 diving surveys; the low number may be attributed to poor underwater visibility (from 1.5 to 10 m); in addition, there were eight sightings at the water's surface (Balazs 1985). These survey data are corroborated by reports of green turtle abundance (i.e., up to 30 turtles in one hour of observation) along the southern shores of Johnston Island (Balazs 1985). The primary foraging habitat for turtles at Johnston Atoll consists of a narrow band of heterogeneous algal pastures immediately off and along the southern shore of the island (Balazs 1985). Near this area, two possible refugia sites were identified (Balazs 1985). NMFS CREP conducted towed diver surveys in the neritic waters around Johnston Atoll and identified green turtles along the southern shores (Figure 59: NMFS CREP, unpublished data 2016).

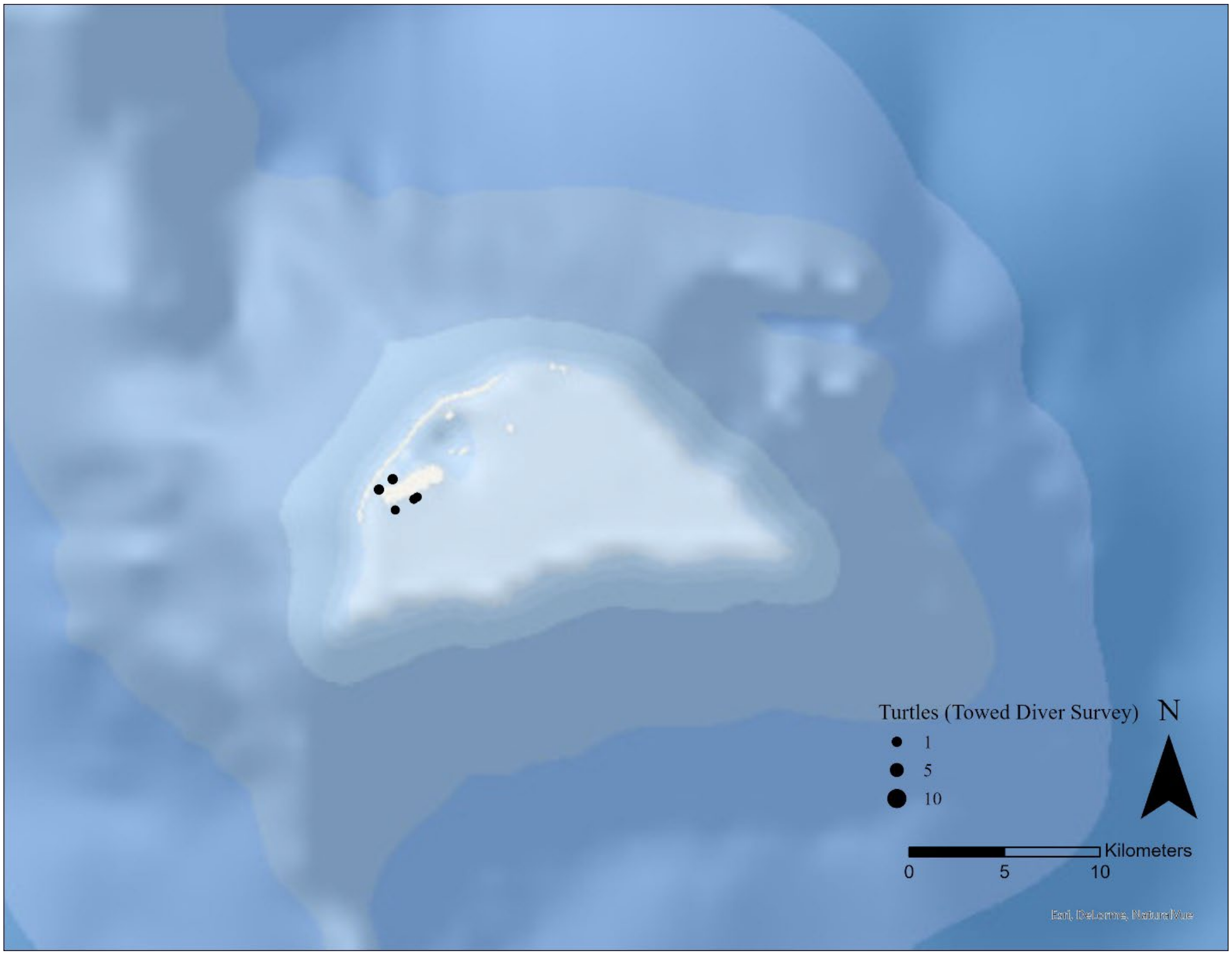


Figure 59. In-water green turtle observations at Johnston Atoll
Data collected during towed-diver surveys (black dots represent green turtle sightings) (NMFS CREP, unpublished data 2016).

7.3 Value to the Central North Pacific DPS

In Figure 60, we summarize the areas containing EFs essential to the conservation of the Central North Pacific DPS that may require special management consideration or protection. Where we had sufficient data to do so, we also include a qualitative rating (high, medium, or low) of the conservation value that each area provides to the DPS (Figure 60; Table 9). All areas containing reproductive EFs are of high conservation value because they are directly linked to population growth and recovery. For the foraging areas, we rated areas based on green turtle usage and abundance. We considered foraging areas with a high density (≥0.10 green turtles/km) of foraging individuals to be of high value to the DPS. All areas off basking beaches are also of high conservation value because turtles must have access to the beaches for adequate rest, thermoregulation, and digestion. We considered all other foraging areas, for which we had sufficient data to provide a rating, to be of low conservation value to the DPS. We did not rate areas where there were data deficiencies or a high degree of uncertainty.

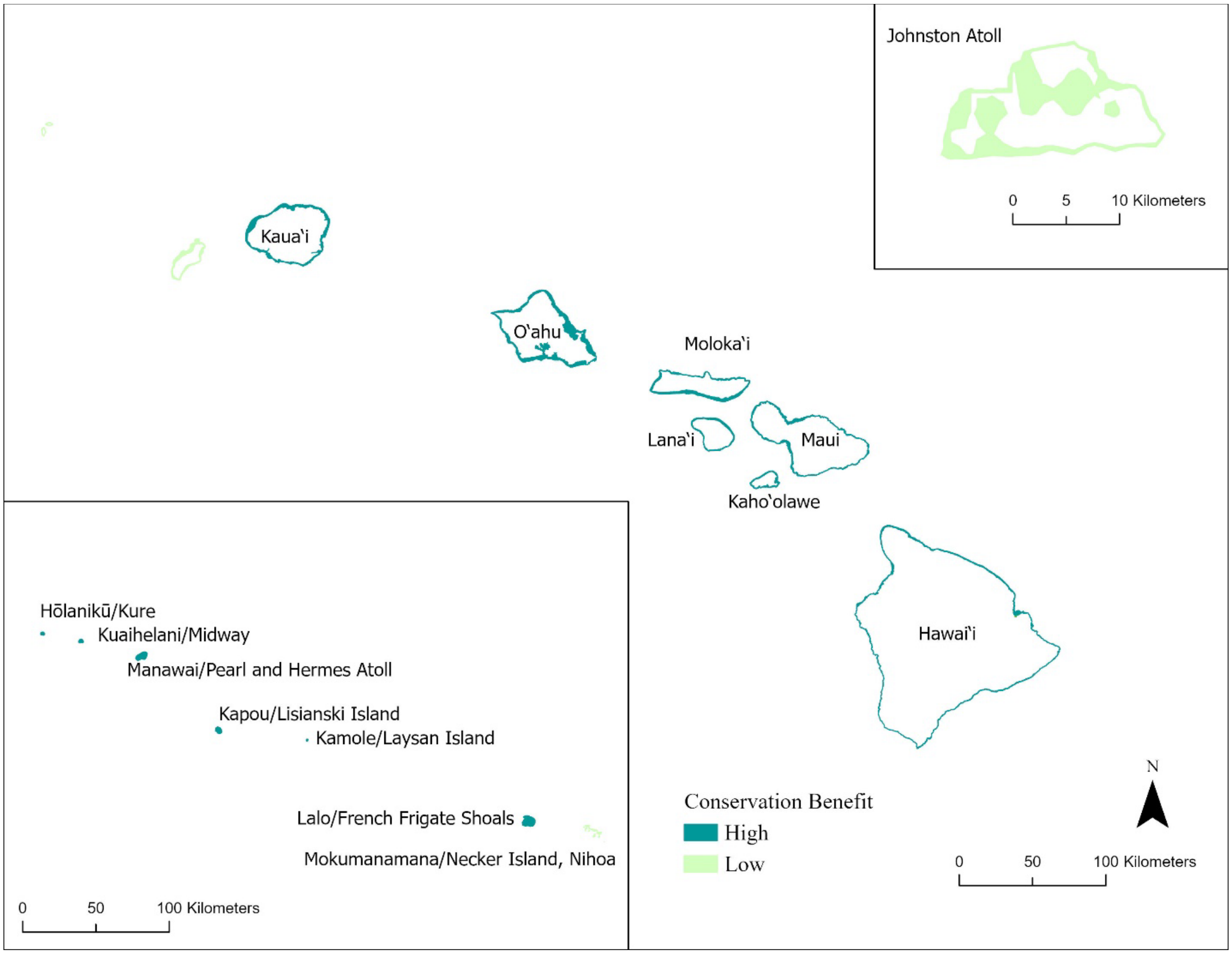


Figure 60. Areas containing the EFs essential to the conservation of the Central North Pacific DPS

Dark green represents high conservation value areas from mean high water to 20 m depth; light green represents low conservation value areas from mean high water to 20 m depth.

Table 9. Areas containing the EFs and their conservation value to the Central North Pacific DPS

Area	**Value to DPS**	**Rationale**
Johnston Atoll	Low	Foraging/resting EFs; low density foraging turtles (Becker *et al*. 2019)
Hawaiian Archipelago		
Hawai'i Island	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)

Maui	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)
Kaho‘olawe	High	Reproductive and foraging/resting EFs; high density foraging turtles (King 2007)
Lana‘i	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)
Moloka‘i	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)
O‘ahu	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)
Kaua‘i	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)
Niihau	Low	Low density foraging turtles (Becker *et al*. 2019)
Nihoa	Low	Low density foraging turtles (Becker *et al*. 2019)
Mokumanamana/Necker Island	Low	Low density foraging turtles (Becker *et al*. 2019)
Lalo/French Frigate Shoals	High	Reproductive and foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)
Kamole/Laysan Island	High	Reproductive and foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)
Kapou/Lisianski Island	High	Reproductive and foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)
Manawai/Pearl and Hermes Atoll	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019)

Kuaihelani/Midway Atoll	High	Reproductive and foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)
Hōlanikū/Kure Atoll	High	Reproductive and foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)
Other areas (Hawaiian Archipelago)	Low	Foraging/resting EFs; basking; low density foraging turtles (Becker *et al*. 2019)

8. CENTRAL SOUTH PACIFIC DPS

8.1 Geographical Area Occupied by the Central South Pacific DPS

The Central South Pacific DPS is defined as green turtles originating from the Central South Pacific Ocean, including those hatching from nests on the beaches of American Samoa and Palmyra Atoll. The range of the DPS is bounded by the following coordinates: 9° N., 175° W. in the northwest; 9° N., 125° W. in the northeast; 40° S., 96° W. in the southeast; 40° S., 176° E. in the southwest; and 13° S., 171° E. in the west. This area includes waters outside of U.S. jurisdiction. If we apply the U.S. EEZ to the DPS boundary, we are left with the range of the DPS within U.S. jurisdiction (Figure 61).

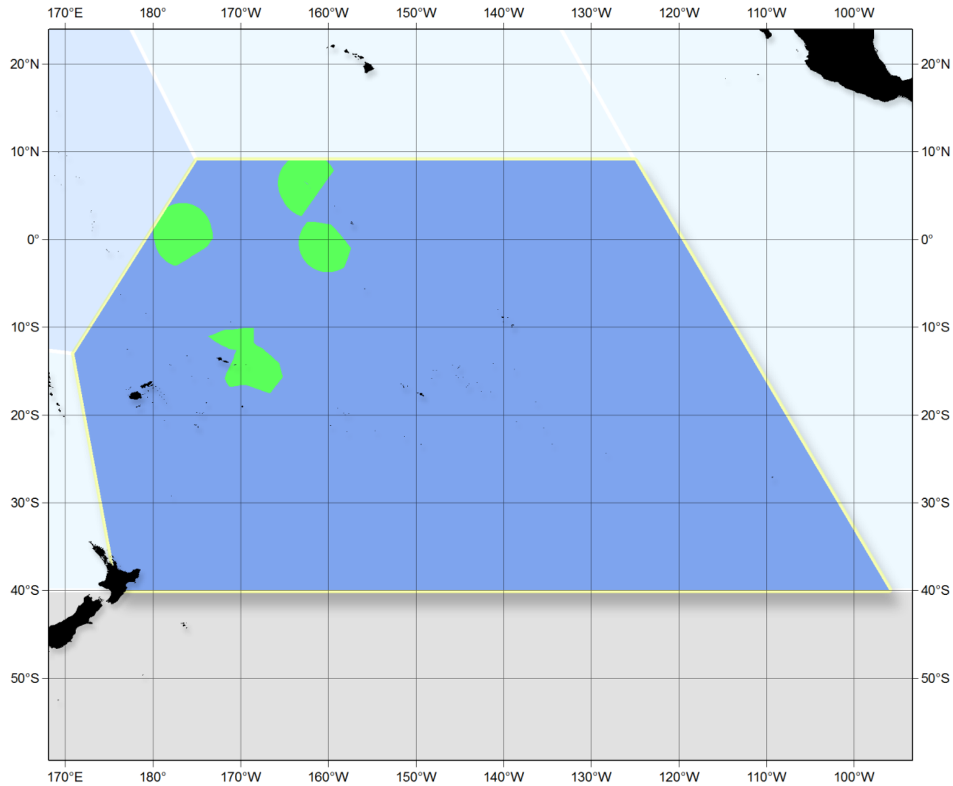


Figure 61. Range of the Central South Pacific DPS within U.S. jurisdiction
Blue indicates the defining boundaries of the DPS; green indicates the range of the DPS within the U.S. EEZ.

American Samoa consists of five high, volcanic islands (Tutuila, Aunu'u, Ofu, Olesega, and Ta'u) and two low-lying atolls (Rose Atoll and Swains Island). With the exception of Swains Island and Rose Atoll, which is a Marine National Monument, all islands are inhabited by people. Other uninhabited areas within the range of the DPS and under U.S. jurisdiction include Baker Island, Howland Island, Jarvis Island, Kingman Reef, and Palmyra Atoll (which hosts a research station with temporary occupants). These islands are part of the Pacific Remote Islands Marine National Monument.

8.2 Essential Features

A recovery plan, with associated recovery criteria, has yet to be developed for the Central South Pacific DPS. To identify the EFs for the Central South Pacific DPS, we referenced the objectives and activities identified in the 1998 Recovery Plan for U.S. Pacific Populations of the Green Turtle (NMFS and USFWS 1998b), which includes the South Pacific DPS within U.S. jurisdiction and is described in Section 7.2.

8.2.1 Reproduction

The recovery of the DPS is dependent on successful reproduction. While nesting occurs on beaches (i.e., terrestrial habitat, under USFWS jurisdiction), the marine areas surrounding the nesting beaches are essential for mating, movement of reproductive females on and off nesting beaches, internesting, and the swim frenzy of post-hatchlings.

8.2.1.1 Reproductive EFs Essential to the Conservation of the Central South Pacific DPS

The following reproductive EFs are essential to the conservation of the Central South Pacific DPS: In depths up to 20 m, sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date) to allow for the transit, mating, and internesting of reproductive individuals, and the transit of post-hatchlings

To identify the EFs, we used information on the life history of the species (Section 3) and the following information. Nesting occurs from August to March at Rose Atoll (Tuato'o-Bartley *et al.* 1993; Craig and Balazs 1995; Craig *et al.* 2004; B. Peck, USFWS, pers. comm. 2018) and from October to February at Ofu Island (DMWR, unpublished data 2015). Possible nesting has been observed at Palmyra Atoll between May and November (Sterling *et al.* 2013), with less than 10 suspected nests per season (S. Kropidlowski, USFWS, pers. comm. 2019; A. Gaos, NMFS, pers. comm. 2022). Seven satellite-tagged nesting females remained at or around Rose Atoll for approximately 2 months before departing to foraging grounds in late December (Craig *et al.* 2004). Three tagged females returned to Rose Atoll after periods of 4, 5, and 9 years (Tuato'o-Bartley *et al.* 1993; B. Peck pers. comm. 2019).

8.2.1.2 Special Management Considerations or Protection

The EFs may require special management considerations or protection to maintain unobstructed access to and from nesting beaches and disturbance-free neritic areas for post-hatchling movement away from shore towards brighter open ocean horizon, mating and internesting at Rose Atoll, Swains Island, Ofu Island, and Ta'u Island. The following may impede access to and from nesting beaches: offshore and nearshore structures (including seawalls), construction, lighting, pollution including marine debris, power generating activities, fishing, recreational activities, dredging, aquaculture, and noise pollution from construction (on land and in water), shipping, and military activities. In American Samoa, we are especially concerned about ship groundings and proposed construction projects near nesting beaches and their adjacent marine waters. For example, a ship grounded at Rose Atoll in 1993, damaging reef habitat and spilling 100,000 gallons of fuel and other contaminants (Marine Conservation Institute 2022). This likely would have impeded females from accessing nesting beaches and hatchlings from entering the sea, or risk being oiled in the process, but no assessments were made at the time. Construction includes an Ofu Island airport resurfacing project from 2020 to 2022 and proposed expansion, which would extend the runway onto nesting beaches. Resulting pollution, noise, and lighting may impede movement on and off nesting beaches. At Swains Island, there is a proposal to create a channel via blasting and dredging, which would reduce available nesting and reproductive habitat. In addition, climate change has the potential to negatively impact green turtle nesting and reproductive habitat via changes in sand temperatures (Santos *et al.* 2017), water temperatures (Crear *et al.* 2016), wave climate (Friedlander *et al.* 2008), and available habitat due to sea level rise (Fish *et al.* 2005).

8.2.1.3 Areas Containing the Reproductive EFs

Green turtle nesting in American Samoa occurs primarily at Rose Atoll, with additional nesting at Swains, Ofu, and Ta'u Islands. Nesting also occurs at Palmyra Atoll. USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat within American Samoa and Palmyra Atoll, which will be published as a proposed rule in the Federal Register. For each of the nesting areas, we identified the associated marine area, from the shoreline to the 20 m depth contour, as containing the reproductive EFs essential to the conservation of the DPS that may need special management consideration or protection.

We are not aware of (and FWS did not identify) any nesting sites at Baker Island, Howland Island, Jarvis Island, and Kingman Reef; therefore, we cannot identify areas containing the reproductive EFs essential to the conservation of the DPS.

8.2.2 Migration

The recovery of the DPS requires that adult turtles forage and reproduce. Because foraging and reproduction are geographically separated, the recovery of the DPS requires turtles to successfully migrate between these areas. Adults migrate long distances between foraging and reproductive areas in the South Pacific. Craig *et al.* (2004) satellite tracked seven post-nesting females at Rose Atoll; six migrated west towards foraging grounds in Fiji and the seventh migrated east to Raiatea, French Polynesia. Green turtles tagged at Palmyra were later captured (and killed) at Kiritimati, Northern Line Islands, and Kosrae, Micronesia (Naro-Maciel *et al.* 2018).

To consider migratory EFs, we evaluated satellite tracking data for post-nesting females tracked from Rose Atoll between 2013 and 2018 (Figure 62; PIFSC unpublished data 2022). Of 53 females tracked, most migrated to foraging areas in Fiji (n = 39); individuals also migrated to Western Samoa (n = 5), New Caledonia (n = 4), Vanuatu (n = 1), Solomon Islands (n = 1), Papua New Guinea (n = 1), Cook Islands, (n = 1), and French Polynesia (n = 1; PIFSC unpublished data 2022).

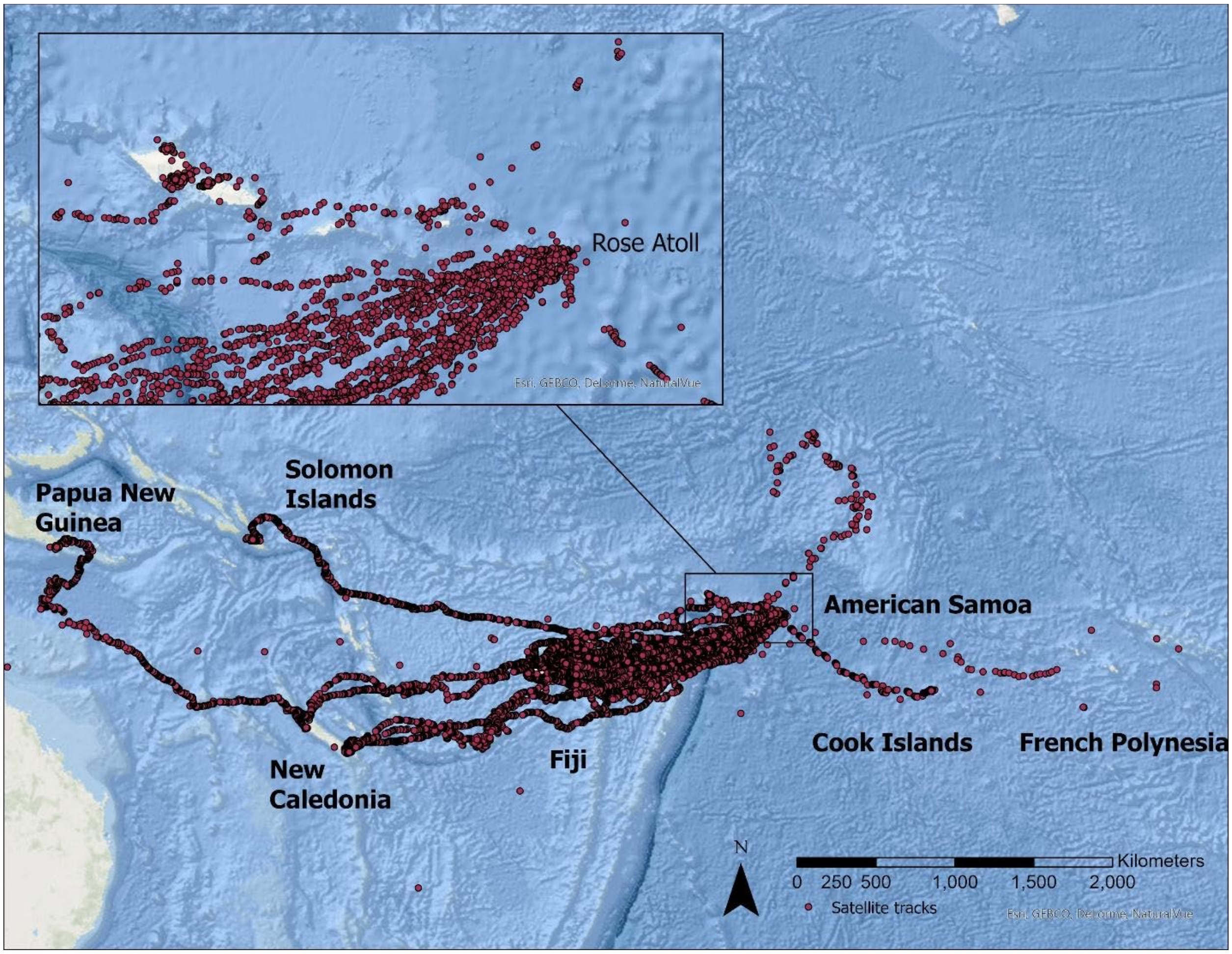


Figure 62. Satellite tracking of post-nesting females from Rose Atoll, American Samoa
Inset shows an enlargement of the Samoan Archipelago. Red dots represent geographic coordinates of satellite tracked turtles (n = 53) (PIFSC unpublished data 2022).

Given these data, we concluded that green turtles of this DPS do not use a narrow, constricted migratory corridor. Instead, they use multiple oceanic migratory paths. We were unable to identify a particular depth or distance from shore used by adult green turtles to migrate between reproductive and benthic foraging/resting areas. We were also unable to identify any other physical or biological feature used by migrating turtles because the best available data demonstrate variation among movement patterns of individuals in oceanic habitats. That is to say that migration is not constricted or confined by a continental shelf, current, or other feature, but rather occurs over a large, oceanic environment without defining features (such as depth or distance from shore). Therefore, while migration between reproductive and benthic foraging/resting habitats is essential to the conservation of the DPS, we were unable to identify or define a migratory feature for this DPS.

8.2.3 Foraging/resting

The recovery of the DPS requires successful survival, growth and development of juvenile life stages and the successful survival and reproduction of adults. Foraging and refugia provide the food resources and resting areas necessary for green turtles to survive, develop, grow, and reproduce.

8.2.3.1 Foraging and Resting EFs Essential to the Conservation of the Central South Pacific DPS

The following foraging and resting EFs are essential to the conservation of the Central South Pacific DPS: In depths up to 20 m, underwater refugia (e.g., rocks, reefs, and troughs), and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles and adults.

To identify the EFs, we used information on the life history of the species (Section 3) and the following information to provide additional specificity. The majority of green turtles foraging in Fiji originated from nesting beaches in American Samoa (Piovano *et al.* 2019). These adult and neritic-stage juvenile green sea turtles forage on invertebrates (40 percent), fishes (31 percent), and marine plants (including seagrass and algae; 29 percent) that occur within Fijian waters (Piovano *et al.* 2020). Using stable isotope analysis on skin samples of 110 juvenile green turtles, Piovano *et al.* (2020) confirmed that seagrass pastures serve as both a primary food source and essential habitat hosting other primary food sources. To the east of Fiji (e.g., areas within the U.S. EEZ) exhibit less shallow-water foraging habitat, species diversity, and vegetative biomass (Craig *et al.* 2004). However, 237 algal species and two seagrass species occur in the waters of American Samoa (Skelton 2003), and juvenile green turtles are observed foraging in these waters year-round. In Palmyra, adults and juveniles forage on macroalgae and turf algal communities at depths of less than 50 m (Naro-Maciel *et al.* 2018). Turf algae species include *Jania*, *Cladophora*, and *Spyridia* (McFadden *et al.* 2014). Macroalgae species include *Bryopsis*, *Turbinaria*, *Halimeda* (calcareous green algae), *Lobophora* (brown algae), *Dictyosphaeria* (green algae), and *Galaxaura* and *Dichotomaria* (red algae) (Braun *et al.* 2009). Satellite telemetry (n = 15 males, 1 female, 2 subadults) demonstrated high site fidelity and small home ranges (0.8 to 3.6 km), with turtles remaining close to their capture sites in waters ≤ 50 m deep over 4076 transmission days (mean = 227, range = 37 to 633); five turtles were tracked more than a year, but none left Palmyra on annual breeding migrations (Naro-Maciel *et al.* 2018).

The Recovery Plan includes two criteria for foraging habitats: existing foraging areas are maintained as healthy environments, and foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region (NMFS and USFWS 1998). Though little information is available regarding the health of foraging areas or the size of the foraging populations, it is clear that multiple benthic foraging areas are needed for the conservation of this DPS.

We were unable to identify any EFs for surface-pelagic foraging juveniles due to lack of data on this developmental life stage and its habitat requirements. Between 2006 and 2019, 45 surface-pelagic juveniles were incidentally captured by the American Samoan high-seas longline fishery (Western Pacific Regional Fishery Management Council 2020) across a broad range of the fishing area (i.e., bycatch was not clustered; P. Dutton, SWFSC pers. comm. 2022). While the South Pacific convergence zone may concentrate foraging and refugia resources, without any additional information, we were unable to identify the EFs targeted by surface-pelagic foraging juveniles within this oceanic area. Therefore, we focus on the benthic-foraging and refugia EFs, for which data are available.

8.2.3.2 Special Management Considerations or Protection

Neritic habitats may require special management considerations to protect food resources and underwater refugia for benthic-foraging green turtles. The Recovery Plan (NMFS and USFWS 1998) indicates that protection is needed to prevent the degradation of marine habitats due to construction, dredging, disposal, pollution, coastal erosion, fishing, and vessel activities (e.g., groundings and anchoring). Coral reefs, an important feeding ground for green turtles (Becker *et al.* 2019), are highly sensitive to and threatened by overfishing, terrestrial runoff, and climate change (Dutra *et al.* 2021). Oil spills and other discharges are also a concern. Construction may result in increased siltation and reduced food availability.

Naro-Maciel *et al.* (2018) described the high quality of habitat and resources available to green turtles at Palmyra Atoll and the fundamental importance of continuing to protect this area because it sustains these endangered green turtles that spend most of their lives within its waters and effectively shields them from threats. USFWS has reviewed proposals to restore hydrodynamic flow in the lagoons at Palmyra Atoll. Such activities may create toxic plumes from pollutants left by the military during World War II and load large amounts of sediment into the marine environment (Collen *et al.* 2009), potentially degrading the lagoon and reef flat habitats used by foraging green turtles (Sterling *et al.* 2013).

In American Samoa, development results in silt-laden runoff and the sedimentation of coastal habitat (Aeby *et al.* 2008). Direct or indirect disposal of anthropogenic waste and nutrients may increase reef eutrophication and threaten reef health (Dailer *et al.* 2010; Smith *et al.* 2010; Swarzenski *et al.* 2017) or introduce contaminants into green turtle foraging habitats (NMFS and USFWS 1998). Pago Pago Harbor in American Samoa is polluted, and uncontrolled effluent contaminants have impaired water quality in other coastal waters (Aeby *et al.* 2008). Proposed construction projects (including channel blasting and dredging at Swains Island and a power plant at Ofu and Olosega) would reduce available foraging and refugia habitat. Marine debris presents a threat to green turtles and the quality of their foraging habitat in American Samoa (Aeby *et al.* 2008; Tagarino *et al.* 2008). Ship groundings (e.g., at Rose Atoll in 1993) damage reef habitat and spill fuel and other contaminants (Marine Conservation Institute 2022). Climate change also has the potential to negatively impact food resources via changes in water temperatures, ocean acidification, and coral reef habitat (Friedlander *et al.* 2008).

8.2.3.3 Areas Containing the Foraging and Resting EFs

Within the range of the Central South Pacific DPS within U.S. jurisdiction, many areas contain food resources and underwater refugia. We rely on the occurrence of green turtles to determine which of these areas contain sufficient resources to support their survival, development, growth, and/or reproduction.

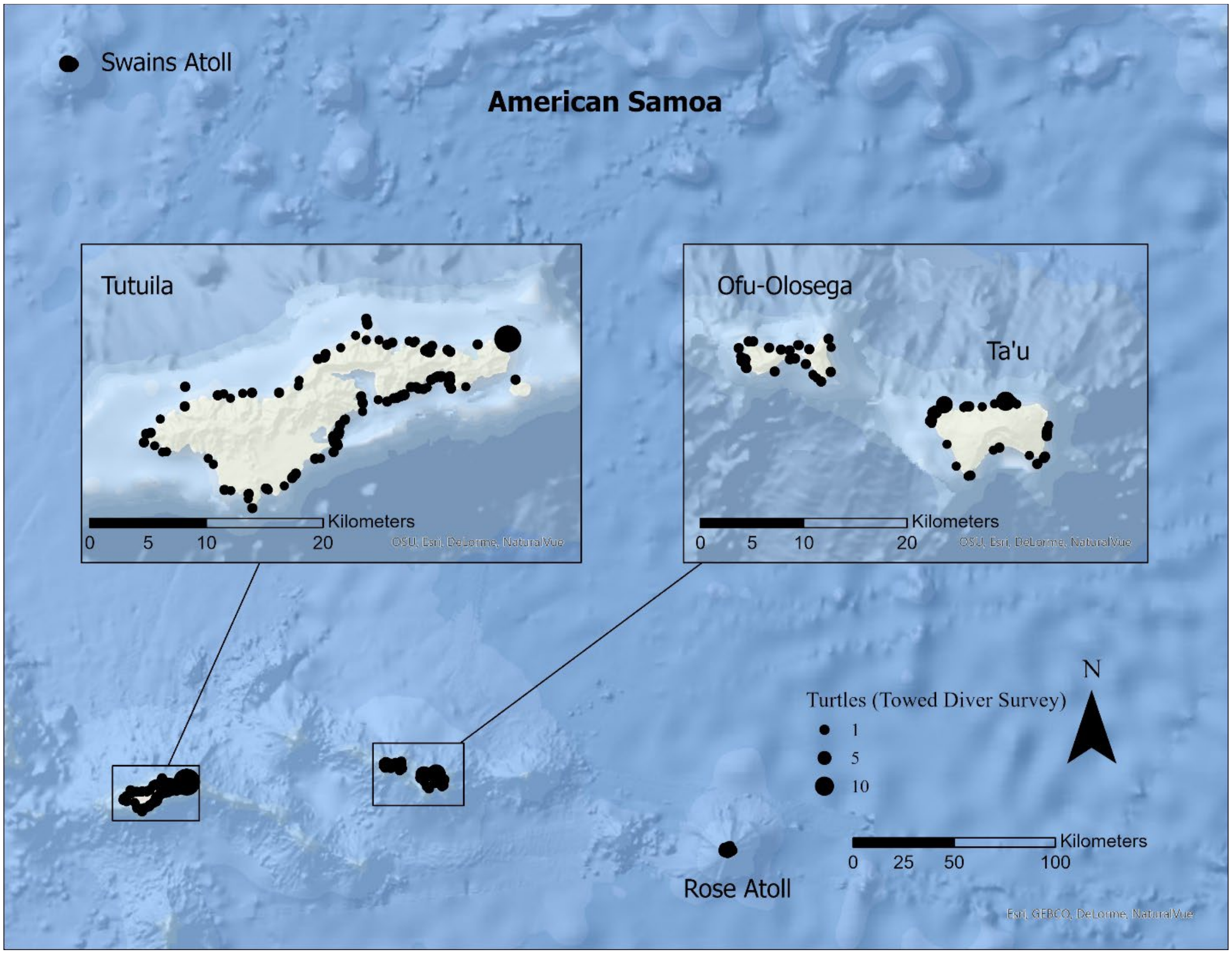
Throughout the range of the DPS, the best available data were gathered during biennial or triennial nearshore towed-diver surveys that compared green turtle densities in the month of

April from 2002 to 2015 (Table 10; Becker *et al.* 2019). The highest densities in the entire survey were found at Jarvis. There were also high densities (i.e., ≥ 0.30 green turtles/km) in Palmyra, Baker and Howland. In American Samoa, Becker *et al.* (2019) found high densities of turtles at Taʻū, Tutuila, Swains, and Rose Atoll; they found low densities (i.e., < 0.30 green turtles/km) at Ofu and Olosega.

Table 10. Density of green turtles in American Samoa and the Pacific Remote Islands
Table modified from the supplemental materials from Becker *et al.* (2019). Density represents the number of green turtles per 1,000 tow segments or kilometer.

Survey location		Green turtles per 1000 tow segments	Green turtles per km
Region	Island/Atoll		
Pacific Remote Island Areas	Jarvis	822	3.62
	Baker	267	1.21
	Palmyra	238	1.05
	Howland	177	0.80
	Kingman	14	0.06
American Samoa	Ta'u	145	0.63
	Swains	82	0.38
	Tutuila	72	0.34
	Rose	68	0.31
	Ofu and Olosega	35	0.15
	South Bank	0	0.00

We mapped these data and an additional two years of unpublished data (Figure 63; Coral Reef Ecology Program, PIFSC unpublished data 2022). The towed diver survey data demonstrate the presence of benthic foraging and resting EFs throughout the nearshore waters throughout American Samoa and the Pacific Remote Islands.


Swains Atoll
American Samoa
Tutuila
Kilometers
0 5 10 20
Ofu-Olosega
Ta'u
Kilometers
0 5 10 20
Turtles (Towed Diver Survey)
1
5
10
N
Kilometers
0 25 50 100
Rose Atoll
Esri, GEBCO, DeLorme, NaturalVue

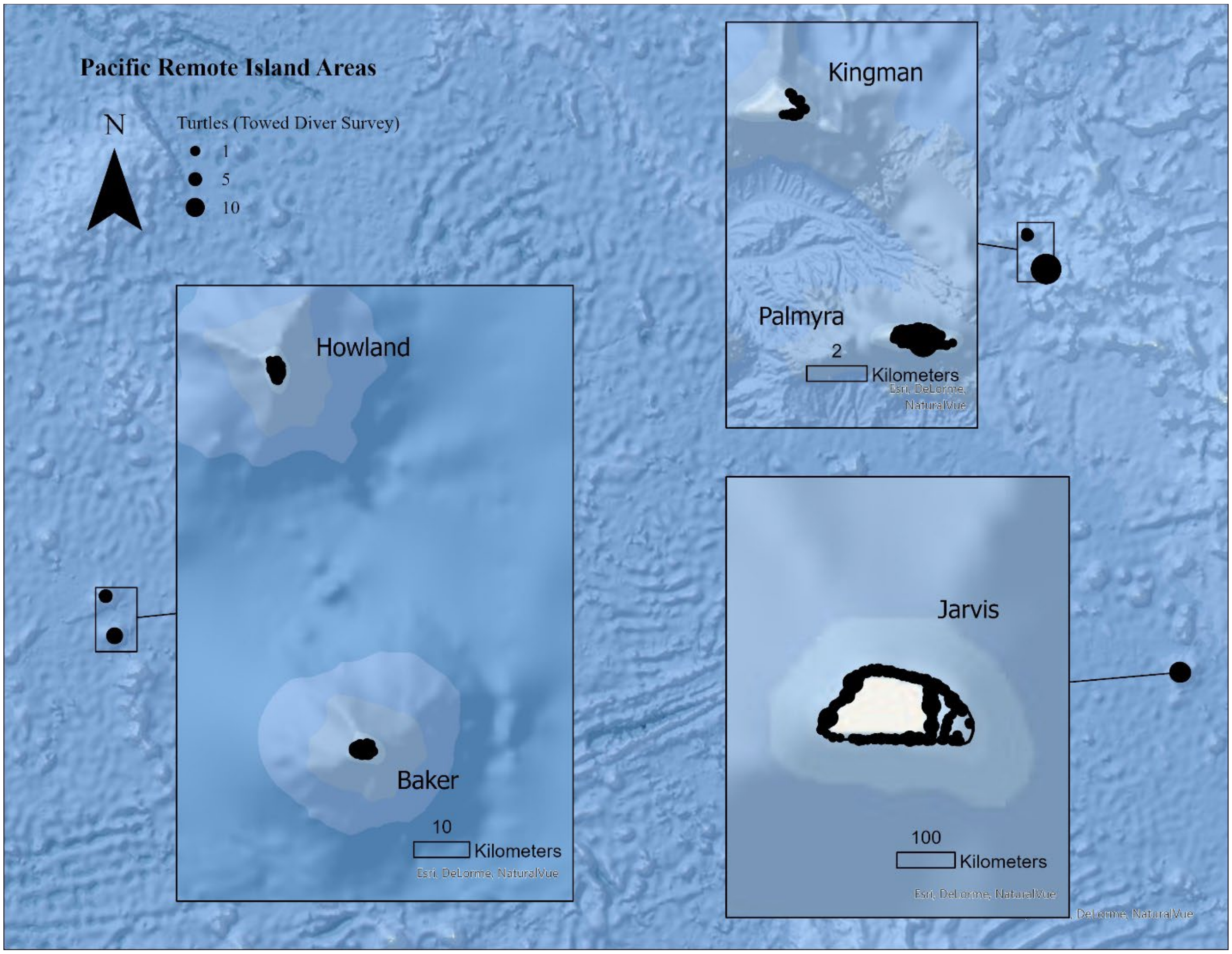


Figure 63. Green turtles identified during towed diver surveys
Black dots represent green turtle sightings during towed diver surveys with size indicating number of turtles encountered during 220 m tow segments (Coral Reef Ecology Program, PIFSC unpublished data 2016).

Site-specific studies also demonstrate the presence of green turtles (and the benthic foraging/resting EFs) in neritic waters of coral reef ecosystems around Tutuila, Ofu, Olosega, Ta'u, and Swains Islands (NMFS and USFWS 1998; Tagarino *et al.* 2008; Tagarino and Utzurrum 2010; Maison *et al.* 2010). Grant *et al.* (1997) described seven juvenile green turtles in the waters around Tutuila and three juveniles at Rose Atoll, indicating utilization of the area by multiple life-history stages. From 2004 to 2008, DMWR recorded 84 green turtle sightings in neritic waters near the following areas (with the number of green turtle sightings in parentheses): Fagaalu (23), Olosega Beach (6), Coconut Point (4), Nuuuli (4), Utulei (3), Aoa (3), Ofu Beach (2), airport (2), Alofau (1), Aua (2), Fagasa (1), Fagatogo (1), Fogagogo (2), Leone (1), Masefau (1), Mataae (1), Mu Point Asili (1), Niuloa Point (1), Pago Harbor (1), Vatia (1), and Rose Atoll (1). More recently DMWR has documented foraging turtles on the following islands and atolls (DMWR unpublished data 2015):

- Tutuila Island: Coconut Point, Masefau, Fagaitua, and Aua
- Ofu Island: Toaga Beach, harbor channel
- Rose Atoll

- Swains Island

The Palmyra foraging/resting area is used almost exclusively (97 percent) by green turtles of the Central South and Central West DPSs (Naro-Maciel *et al.* 2014). A total of 555 green turtles were captured between 2008 and 2013 of which 123 (22.2 percent) were adults (CCL ≥ 85 cm), 193 turtles (34.8 percent) were subadults, and 239 (43 percent) were juveniles (Naro-Maciel *et al.* 2018). High-use areas included the Southern, Northern, and Eastern Lagoon and Flats, and larger turtles were found at the Western and Central Lagoon and Flats (Figure 64; Sterling *et al*. 2013). Turtles generally remained within Palmyra nearshore waters year-round (Figure 65; Naro-Maciel *et al*. 2018).

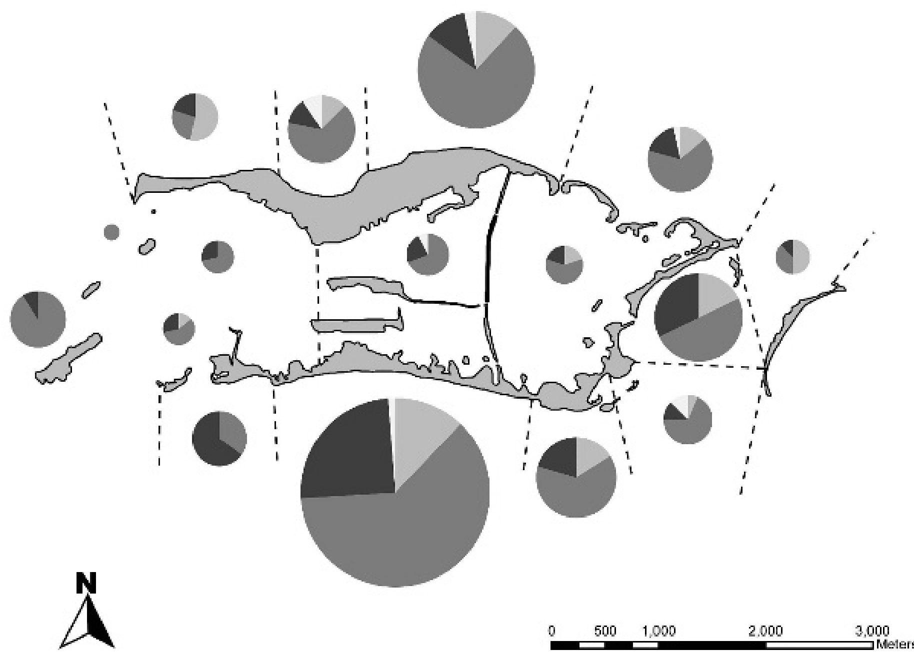


Figure 64. Green turtles captured in neritic waters of Palmyra Atoll by zone
The size of the sphere reflects the number of juvenile (light grey; n = 239), subadult (medium grey; n = 193), adult (dark grey; n = 123), and unknown (white; n = 211) green turtles; dotted lines represent zones where transects were conducted (Sterling *et al.* 2013).

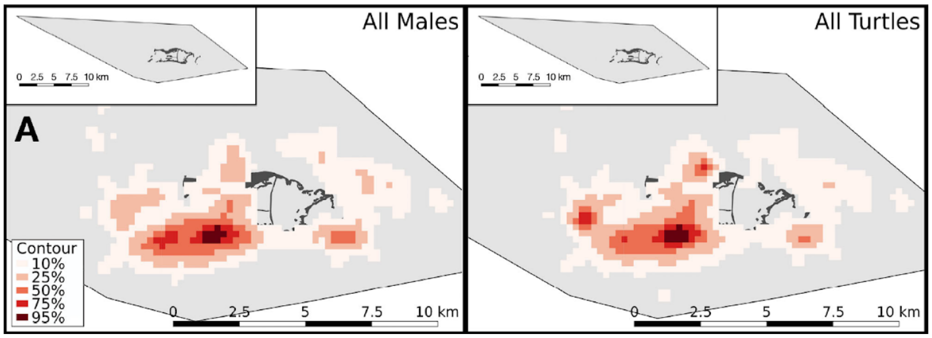


Figure 65. Satellite-tracked green turtles at Palmyra Atoll
Shading represents areas of use including minimum convex polygon (gray) and kernel density (color) (Map A from Naro-Maciel *et al.* 2018).

8.3 Value to the Central South Pacific DPS

In Figure 66, we summarize the areas containing EFs essential to the conservation of the Central South Pacific DPS that may require special management consideration or protection. Where we had sufficient data to do so, we also include a qualitative measure (high, medium, or low) of the conservation value that these areas provide to the DPS (Table 11). We did not rate areas where there were data deficiencies or a high degree of uncertainty. All areas containing reproductive EFs are of high conservation value because they are directly linked to population growth and recovery. Females must use these areas to reach the nesting beaches considered for proposed critical habitat designation by USFWS. These areas are also essential for successful mating and post-hatchling swim frenzy. For the foraging areas, we rated areas based on available data on green turtle usage and abundance. We relied heavily on density estimates (Table 10; Becker *et al.* 2019) from the towed diver surveys, which provided a standard, objective measure of conservation value to the DPS. Because of the large geographic scale and “snapshot” temporal scale of the survey, and without additional data, we were unable to rate the conservation value at a finer scale, beyond relatively high (i.e., many foraging/resting turtles compared to other areas with the U.S. EEZ inhabited by this DPS) or low (i.e., few turtles). Jarvis, Palmyra, Baker, Howland, Tutuila, Ta'u, and Rose hosted high densities (≥ 0.30 green turtles/km) of foraging/resting green turtles and thus provide a high conservation value. Kingman and Ofu and Olosega (< 0.30 green turtles/km)hosted low densities of foraging/resting green turtles, and where no reproductive EFs were present, provide a low conservation value (areas with reproductive EFs provide a high conservation value). We did not rate areas where there were data deficiencies or a high degree of uncertainty.

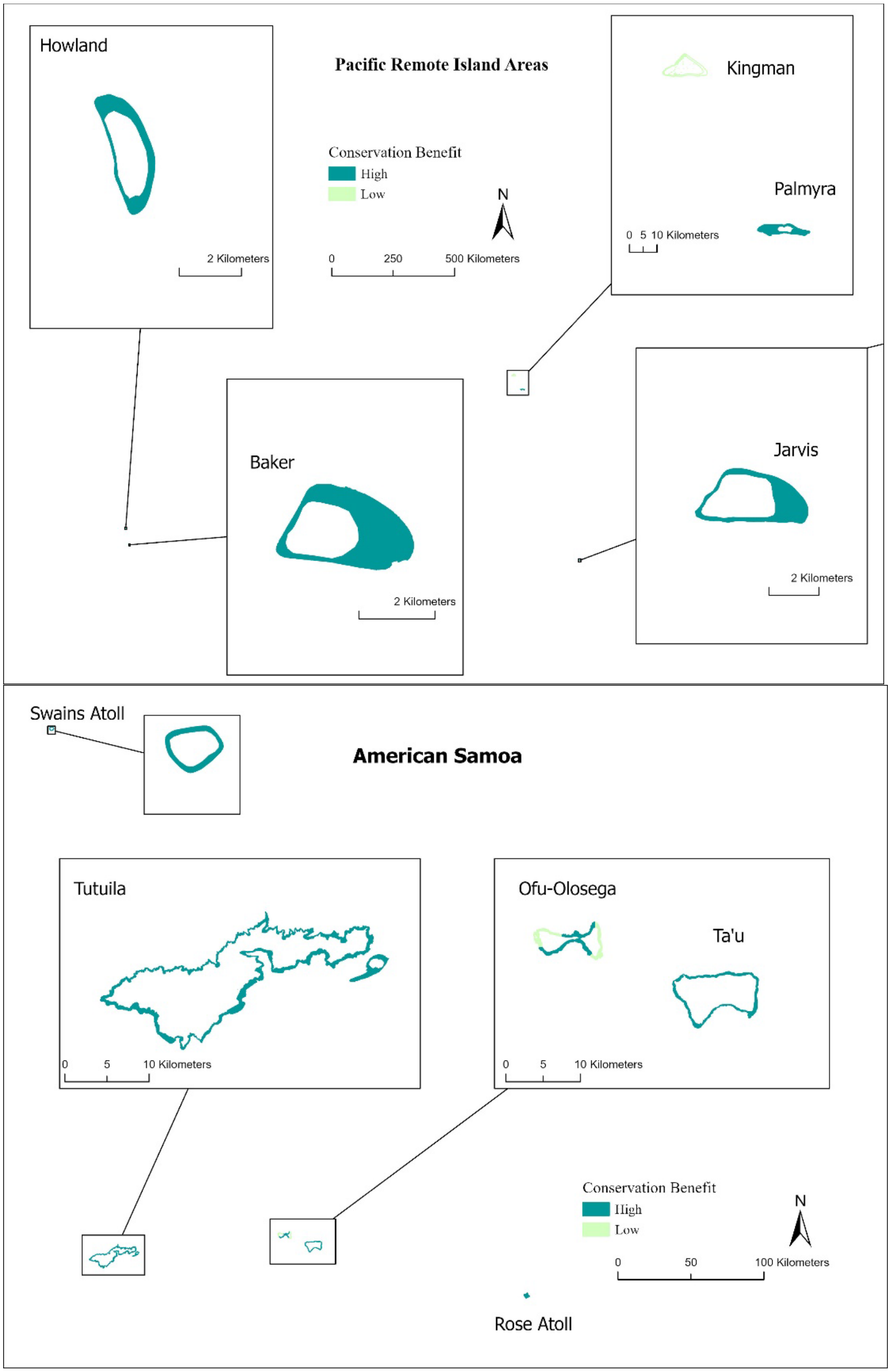


Figure 66. Areas containing the EFs essential to the conservation of the Central South Pacific DPS

Top map shows areas in American Samoa. Bottom maps shows areas in Pacific Remote Island Areas. Dark green represents high conservation value areas from mean high water to 20 m depth; light green represents low conservation value areas from mean high water to 20 m depth.

Table 11. Areas containing the EFs and their conservation value to the Central South Pacific DPS

Area	Value to DPS	Rationale
Rose Atoll (Motu o Manu)	High	Reproductive and foraging/resting EFs; primary nesting site in American Samoa (Seminoff *et al.* 2015; PIFSC unpublished data 2021; USFWS unpublished data 2022); high density of foraging individuals (Becker *et al*. 2019).
Swains Island	High	Reproductive and foraging/resting EFs; documented nesting (Seminoff *et al.* 2015; USFWS unpublished data 2022); high density of foraging individuals (Becker *et al*. 2019).
Ofu Island		
Airport, Matasina, Vaoto, Fatauana, Toaga Beaches	High	Reproductive and foraging/resting EFs; documented nesting (DMWR unpublished data 2015; USFWS unpublished data 2022); low density of foraging individuals (Becker *et al*. 2019).
Asagatai, Mafafa, Tuafanua Beaches	High	Reproductive and foraging/resting EFs; documented nesting (DMWR unpublished data 2015; USFWS unpublished data 2022); low density of foraging individuals (Becker *et al*. 2019).
Other areas (Ofu)	Low	Foraging/resting EFs; low density of foraging individuals (Becker *et al.* 2019).
Olosega Island		
Olosega, Faiava/Sili/Lalomoana Beaches	High	Reproductive and foraging/resting EFs; documented nesting (DMWR unpublished data 2015; USFWS unpublished data 2022); low density of foraging individuals (Becker *et al*. 2019).
Other areas (Olosega)	Low	Foraging/resting EFs; low density of foraging individuals (Becker *et al.* 2019).
Ta'u Island	High	Reproductive and foraging/resting EFs; documented nesting (DMWR unpublished data 2015; USFWS unpublished data 2022); high density of foraging individuals (Becker *et al*. 2019).
Tutuila Island	High	Foraging/resting EFs; high density of foraging individuals (DMWR unpublished data 2015; Becker *et al*. 2019).
Baker Island	High	Foraging/resting EFs; high density of foraging individuals (Becker *et al*. 2019).
Howland Island	High	Foraging/resting EFs; high density of foraging individuals (Becker *et al*. 2019).
Jarvis Island	High	Foraging/resting EFs; high density of foraging individuals (Becker *et al*. 2019).
Kingman Reef	Low	Foraging/resting EFs; low density of foraging individuals (Becker *et al.* 2019).
Palmyra Atoll	High	Reproductive and foraging/resting EFs; documented nesting (Sterling *et al.* 2013; USFWS unpublished data 2022); high density of foraging adults and

Area	Value to DPS	Rationale
		juveniles in nearshore waters (Naro-Maciel *et al*. 2018; Becker *et al.* 2019).

9. CENTRAL WEST PACIFIC DPS

9.1 Geographical Area Occupied by the Central West Pacific DPS

The Central West Pacific DPS is defined as green turtles originating from the Central West Pacific Ocean, including those hatching from nests on the beaches of Guam and CNMI and those found in the waters of Wake Island. The range of the DPS is bounded by the following coordinates: 41° N., 146° E. in the northwest; 41° N., 169° E. in the northeast; 9° N., 175° W. in the east; 13° S., 171° E. in the southeast; along the northern coast of the island of New Guinea; and 4.5° N., 129° E. in the west. This area includes waters outside of U.S. jurisdiction. Applying the U.S. EEZ provides the range of the DPS within U.S. jurisdiction (Figure 67).

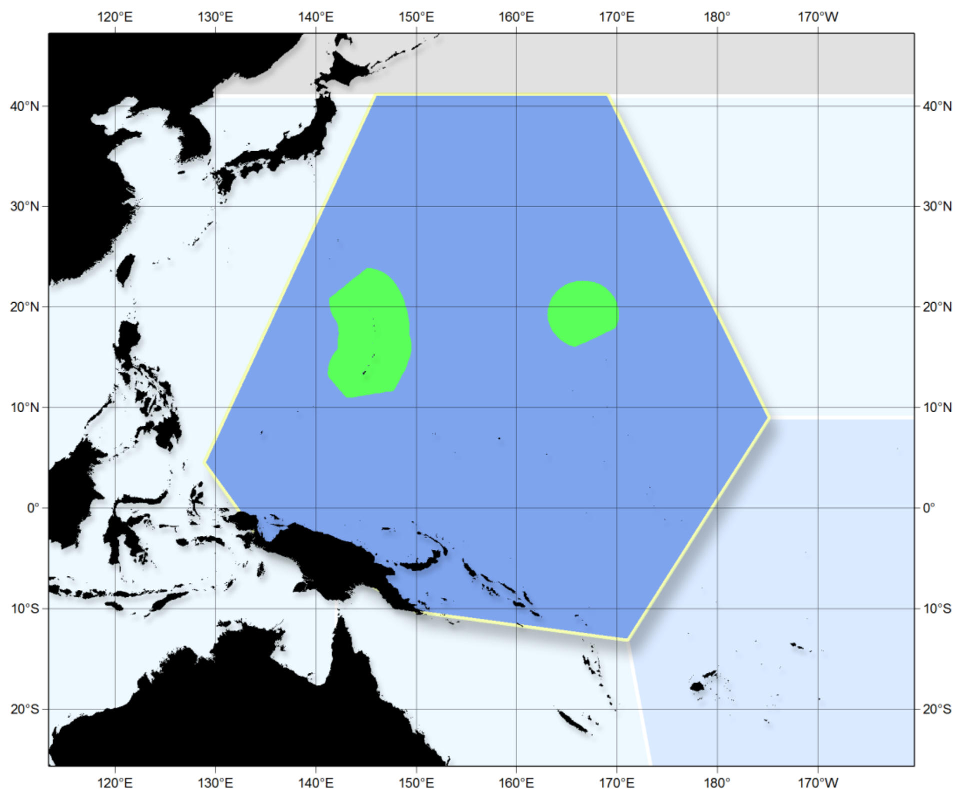


Figure 67. Range of the Central West Pacific DPS within U.S. jurisdiction
Blue indicates the defining boundaries of the DPS; green indicates the range of the DPS within the U.S. EEZ.

The U.S. range of the Central West Pacific DPS includes beaches and waters of Wake Island, the Mariana Archipelago (which includes Guam and CNMI), and the U.S. EEZ. The Mariana Archipelago consists of numerous islands and submerged reefs, located from 13º to 20.5° N. and 144.5º to 146° E. (Figure 68; Kolinski *et al.* 2005). The inner, northern arc includes the volcanically active or recently active islands of Farallon de Pajaros (Uracas), Maug, Asuncion, Agrihan, Pagan, Alamagan, Guguan, Sarigan and Anatahan. The frontal, southern arc islands are capped or surrounded by limestone terraces and include Farallon de Medinilla, Saipan, Tinian, Aguijan, Rota, and Guam (Kolinski *et al.* 2004). Within the Mariana Archipelago, there are also numerous isolated reef systems; however, we do not discuss these areas in this report because surveys of seven such reefs revealed few green turtles (i.e., 3 turtles observed in approximately 80 survey hours; Kolinski *et al.* 2005).

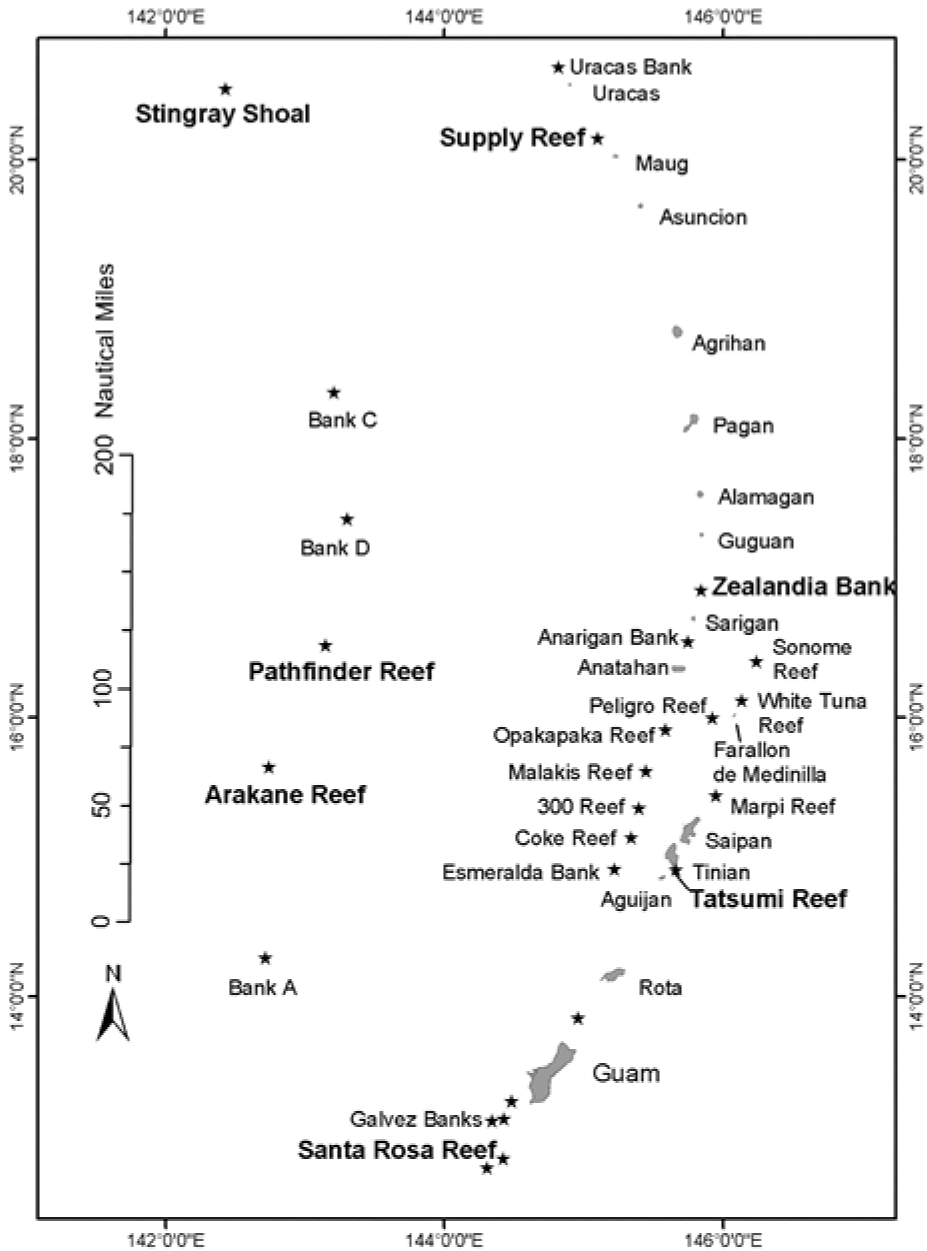


Figure 68. The Mariana Archipelago
(Kolinski *et al.* 2005)

9.2 Essential Features

A recovery plan, with associated recovery criteria, has yet to be developed for the Central West Pacific DPS. To identify the EFs for the Central West Pacific DPS, we referenced the objectives and activities identified in the 1998 Recovery Plan for U.S. Pacific Populations of the Green Turtle (NMFS and USFWS 1998b), which includes the West Pacific DPS within U.S. jurisdiction and are described in Section 7.2.

9.2.1 Reproduction

The recovery of the DPS is dependent on successful reproduction. While nesting occurs on beaches (i.e., terrestrial habitat, under USFWS jurisdiction), the marine areas surrounding the nesting beaches are essential for mating, movement of reproductive females on and off nesting beaches, internesting, and the swim frenzy of post-hatchlings.

9.2.1.1 Reproductive EFs Essential to the Conservation of the Central West Pacific DPS

The following reproductive EFs are essential to the conservation of the Central West Pacific DPS: In waters up to 20 m depth, sufficiently dark and unobstructed neritic waters, directly adjacent to nesting beaches considered for proposed critical habitat by the USFWS (to be published in the Federal Register at a future date) to allow for the transit, mating, and internesting of reproductive individuals, and the transit of post-hatchlings.

To identify the EFs, we used the natural history summary for the species (Section 3 of this report). In addition, we used the following information to provide additional specificity. Genetic analyses of females nesting in Guam and CNMI indicate similarity and a lack of population differentiation within the Mariana Archipelago (PIFSC unpublished data 2016). Nesting occurs year-round with a peak from March to July (Guam DAWR, unpublished data 2014; Summers *et al.* 2018; Muñoz *et al.* unpublished data 2022). Between 2018 and 2022, 38 nesting females were tagged (Guam DAWR unpublished data 2022; Muñoz *et al.* unpublished data 2022).

The Status Review estimated approximately 22 nesting females in Guam (Seminoff *et al.* 2015). Guam DAWR (unpublished data 2014) reported 473 green turtle nests on Guam between 1975 and 2013, which likely represents 21 to 46 nesting females. Guam DAWR tagged 29 turtles between 1975 and 2013, during nesting, strandings, and poaching attempts. Six turtles were recaptured while nesting and one turtle was recaptured during a poaching attempt (Guam DAWR unpublished data 2014).

The Status Review estimated approximately 57 nesting green turtles in CNMI (Seminoff *et al.* 2015). In CNMI, Summers *et al.* (2018) estimated a total of 55 (with an annual average of 12) females nesting at monitored beaches on Saipan, Tinian, and Rota (Table 12), which host approximately 6 percent of the nesting sites for the DPS. Summers *et al.* (2018) estimated an average internesting interval of 11.4 days and an average clutch frequency of seven nesting events per season. The average remigration interval for 39 tagged females was 4.6 years (Summers *et al.* 2018). Females appeared to return to the same nesting beach; however, a few switched to different nesting beaches within a season if they were disturbed by humans or experienced difficulty finding suitable habitat (Summers *et al.* 2018).

Table 12. Green turtles nesting annually on monitored Saipan, Tinian, and Rota beaches from 2006 to 2016

(Summers *et al.* 2018)

Island	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Saipan	**8**	**4**	**1**	**6**	**5**	**6**	**9**	**8**	**8**	**12**	**11**	**78**
Tinian	**1**	**N/A**	**N/A**	**5**	**0**	**1**	**3**	**2**	**2**	**5**	**6**	**25**
Rota	**N/A**	**N/A**	**N/A**	**2**	**0**	**1**	**3**	**5**	**0**	**3**	**3**	**14**

The Recovery Plan for the U.S. Pacific Populations that includes the following criteria for each population: an average of 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually over 6 years; and stable or increasing nesting populations (over a 25-year monitoring period) at "source beaches" (NMFS and USFWS 1998). Estimated total nesting abundance is likely less than 100 nesting females in the Mariana Archipelago (Seminoff *et al.* 2015). Therefore, a considerable increase in the nesting population is essential to the conservation of the DPS, and this requires unobstructed access to nesting beaches.

9.2.1.2 Special Management Considerations or Protection

The essential reproductive feature may require special management considerations or protection because of the importance of maintaining disturbance-free marine habitats off nesting beaches. The following activities may impede access to and from nesting beaches, interrupt mating, or disturb internesting females: offshore and nearshore structures, construction, artificial lighting, oil and gas activities, power generating activities, fishing nearshore with submersible lights, dredging, aquaculture, and noise pollution from construction (on land and in water), shipping, and military activities (NMFS and USFWS 1998; Summers *et al.* 2018). Human disturbances prevented females from emerging onto nesting beaches, causing them to nest on adjacent (smaller) pocket beaches with sub-optimal habitat or to return to the original nesting beach after the threat had abated (Summers *et al.* 2018). Summers *et al*. (2018) recorded at least one type of disturbance during eight percent (40 of 485) of their nocturnal surveys of Saipan.

The most valuable land on Pacific islands is often located along the coastline, particularly when it is associated with a sandy beach (Seminoff *et al.* 2015). In Guam, construction and development due to increased tourism threatens turtles (NMFS and USFWS 1998; Project GloBAL 2009a). U.S. military expansion in this region includes relocation of thousands of military personnel to Guam and increased training exercises in CNMI (CNMI Coastal Resources Management Office 2011).

In CNMI, coastal erosion and exotic vegetation has been identified as a high risk to sea turtles (CNMI Coastal Resources Management Office 2011). Construction and associated lighting on the islands of Saipan, Tinian, and Rota may result in loss or degradation of green turtle nesting habitat (NMFS and USFWS 1998; Tetratech 2014). The majority of the nesting beaches on Tinian are on military-leased land, where the potential for construction impacts exists (CNMI Coastal Resources Management Office 2011). For these reasons, the reproductive EFs may require special management considerations or protection.

9.2.1.3 Areas Containing the Reproductive EFs

Nesting occurs at beaches on Guam, especially along the northern coast and on the uninhabited Cocos Island along the southern coast. In CNMI, nesting occurs mainly on Saipan, Tinian, and Rota, Pagan, and Agrihan. USFWS provided us with a list of beaches, which met their criteria for green turtle terrestrial critical habitat within the Marianas Archipelago and which will be published as a proposed rule in the Federal Register. For each of the areas, we identified the associated marine area, from the shoreline (mean high water line) to 20 m depth, as containing the reproductive EFs essential to the conservation of the DPS and which may need special management consideration or protection.

We are not aware of (and FWS did not identify) any nesting sites at Wake Island; therefore, we cannot identify areas containing the reproductive EFs essential to the conservation of the DPS.

9.2.2 Migration

The recovery of the DPS requires that adult turtles forage and reproduce. Because foraging and reproduction are often geographically separated, the recovery of the DPS requires turtles to successfully migrate between these areas. When considering migration of the Central West Pacific DPS, we reviewed the natural history summary for the species (Section 3 of this report), and satellite tracking data of post-nesting females (Figure 69; PIFSC unpublished data 2022). A total of 26 post-nesting female green turtles have been satellite tagged in the Mariana Archipelago (nine in Guam and 17 in CNMI). Most post-nesting females migrated thousands of miles to foraging areas outside the Marianas, in nearshore waters of the Philippines (n=13), Japan (n=5), Taiwan (n=1), Spratly Islands (n=1), Palau (n=1), FSM (n=1) and Indonesia (n=1) (PIFSC unpublished data 2022). For example, one female turtle satellite tagged near Agana, Guam was tracked to the Panguataran Island Group, Philippines, a total distance of 3,457 km (PIFSC unpublished data 2022). Females satellite tagged in Saipan traveled 2,391 km to Tagun Bay, Philippines, and the other traveled 2,441 km to Okinawa, Japan (Summers 2011). Such long-distance migratory patterns are common to turtles within this DPS, including those tracked from Yap (Kolinski 1995), Ulithi Atoll (Kolinski *et al.* 2014), and the Marshall Islands (Parker *et al.* 2015). However, some post-nesting females remain in the Mariana Archipelago: after nesting, one female remained in Saipan to forage (Summers *et al.* 2017), and one female that nested on Rota migrated to the neighboring island of Saipan to forage (PIFSC unpublished data 2022).

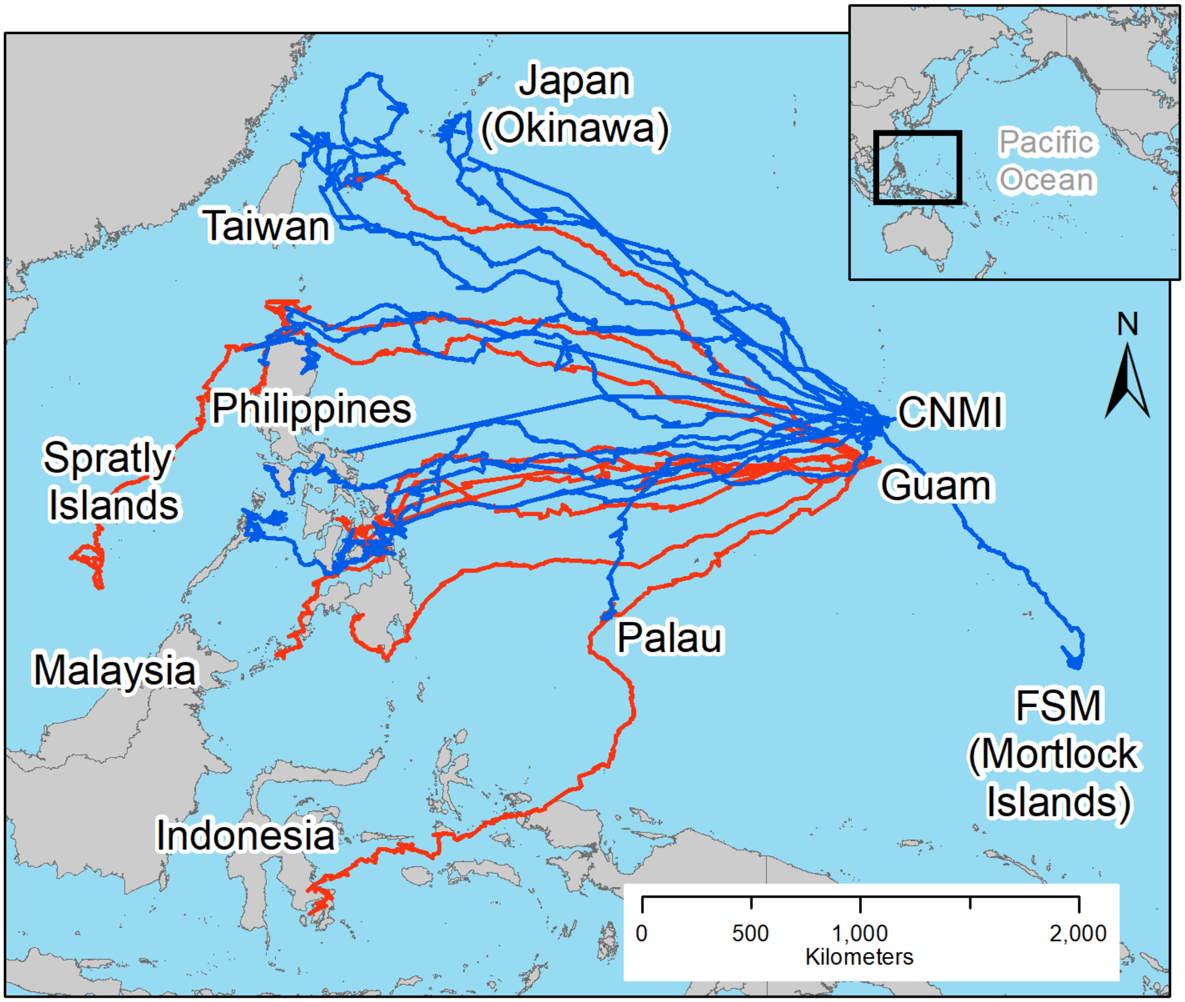


Figure 69. Satellite tracking of post-nesting females of the Central West Pacific DPS
Blue tracks represent females tagged on CNMI nesting beaches; red tracks represent nesting females tagged on Guam nesting beaches (PIFSC unpublished data 2022).

Given these data, we concluded that green turtles of this DPS do not use a narrow, constricted migratory corridor. Instead, they use multiple oceanic migratory paths. We were unable to identify a particular depth or distance from shore used by adult green turtles to migrate between reproductive and benthic foraging/resting areas. We were also unable to identify any other physical or biological feature used by migrating turtles because the best available data demonstrate variation among movement patterns of individuals in oceanic habitats. That is to say that migration is not constricted or confined by a continental shelf, current, or other feature, but rather occurs over a large, oceanic environment without defining features (such as depth or distance from shore). Therefore, while migration between reproductive and benthic foraging/resting habitats is essential to the conservation of the DPS, we were unable to identify or define a migratory feature for this DPS.

9.2.3 Foraging/resting

The recovery of the DPS requires successful survival, growth and development of juvenile life stages and the successful survival and reproduction of adults. Foraging and refugia habitats provide the food resources and resting areas necessary for green turtles to survive, develop, grow, and reproduce.

9.2.2.1 Foraging and Resting EFs Essential to the Conservation of the Central West Pacific DPS

The following foraging and resting EFs are essential to the conservation of the Central West Pacific DPS: In depths up to 20 m, underwater refugia (e.g., rocks, reefs, and troughs) and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction of benthic-foraging juveniles and adults.

To identify the EFs, we used information on the natural history of the species (Section 3) and information collected during surveys of the neritic waters off CNMI, Guam, and Wake Island (Kolinski *et al.* 2001; Kolinski *et al.* 2004; Kolinski *et al.* 2005; Kolinski *et al.* 2006; Guam DAWR 2011; Jones and Van Houtan 2014; Tetratech 2014; Martin *et al.* 2016; Summers *et al.* 2017; Becker *et al*. 2019; Gaos *et al*. 2020a; Gaos *et al*. 2020b; CNMI DLNR unpublished data 2016; NMFS CREP unpublished data 2022; PIFSC unpublished data 2022). These studies demonstrate that predominantly juveniles and some adults forage and rest in neritic habitats in the Mariana Archipelago and Wake Island. Genetic analyses indicate that the majority of foraging juveniles in Guam and CNMI originate from nesting beaches in the Republic of the Marshall Islands (~89 percent), with smaller contributions (~4 percent) from Yap, Federated States of Micronesia (which are included in the defining boundaries of the Central West Pacific DPS), and to a lesser extent from other regions, including Lalo, which is within the defining boundaries of the Central North Pacific DPS (PIFSC unpublished data 2022).

Between 2013 and 2019, Gaos *et al.* (2020a; 2020b) conducted in-water surveys in Guam (N=9), Saipan (N=6), and Tinian (N=4) for a total of 47 days. They encountered 258 green turtles, 97 of which were captured and equipped with satellite tags (Gaos *et al.* 2020a; Gaos *et al.* 2020b). Captured green turtles ranged from 36.9 cm to 85.6 cm SCL (mean = 53.8, sd = 9.5 cm, N=197), and all but six appeared to be juveniles and sub-adults (Gaos *et al.* 2020a; Gaos *et al.* 2020b), consistent with earlier analyses. Between 2006 and 2014, Summers *et al.* (2017) captured 493 green turtles in nearshore habitats of Saipan (N=447), Tinian (N=12), and Rota (N=34); all but four were juveniles (mean SCL = 50.7 cm). An additional 12 adults were observed between 2008 and 2014 (Summers *et al.* 2017). These studies revealed limited movement (0.5 to 3 km^2) and high foraging and resting site fidelity (Summers *et al.* 2017; Gaos *et al*. 2020a; Gaos *et al*. 2020b) of foraging juveniles, with an estimated mean residency of 17 years (Summers *et al.* 2017).

Dive data of green turtles (n=84) in the Marianas Archipelago indicated that green turtles spent the majority (98 percent) of their time in waters shallower than 25 m (Figure 70; Gaos *et al.* 2020a). Diel dive comparisons suggested that green turtles remain in deeper waters during daylight hours (average depth 13.2 m) and move to shallower depths during the night (average depth 8.7 m; Gaos *et al*. 2020a). To capture the essential foraging and resting features essential to the conservation of the DPS, we use a depth contour of 20 m, which accounts for the vast majority of available data.

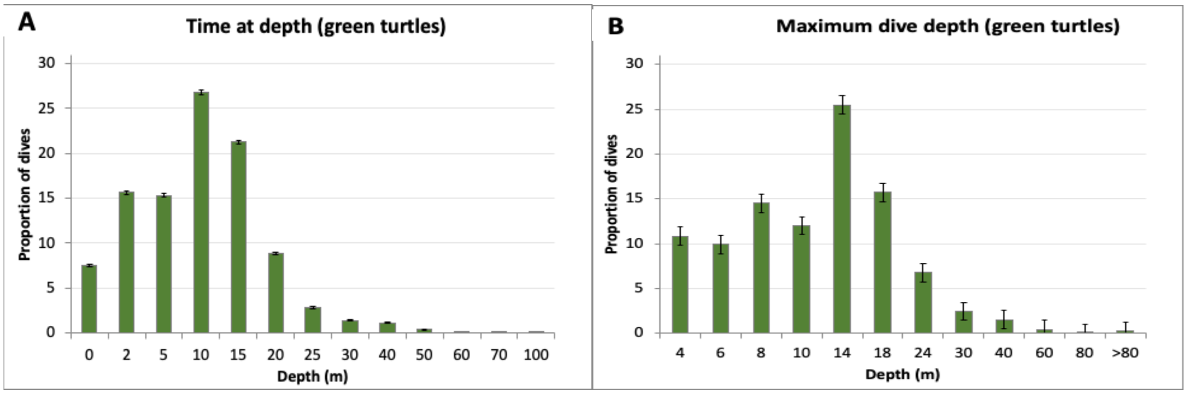


Figure 70. Dive depths of turtles in the Mariana Archipelago
Proportion of time-at-depth profiles (A) and Maximum dive depth profiles (B) for 84 green turtles on Guam and CNMI. Adapted from Gaos *et al.* 2020a.

The nearshore waters of CNMI provide developmental and foraging habitat for juveniles (Summers *et al.* 2017). Juveniles spent most of their time foraging and resting in neritic waters 30 to 2,000 m from shore (Summers *et al.* 2017; Gaos *et al.* 2020). Foraging and resting habitats included coral, coralline algae, turf, and sandy (5 percent) substrates (Summers *et al.* 2017). Turtles were observed resting (60.7 percent), foraging (26.3 percent), swimming (12.3 percent), and hovering at cleaning stations (0.7 percent) (Summers *et al.* 2017).

Adult turtles of the Central West Pacific DPS also forage in these waters. Although the majority of post-nesting females turtles equipped with satellite tags on Guam and CNMI migrate to waters further west (e.g., Philippines, Indonesia), some females use the nearshore habitats of the Mariana Archipelago as post-nesting foraging grounds (Summers *et al.* 2017). One adult female was recaptured 215 days after her final nesting event for the previous season, only 15.8 km from the nesting beach (Summers *et al.* 2017). One female nesting on Rota subsequently migrated to foraging grounds on the neighboring island of Saipan (NOAA MTBAP unpublished data 2021).

Known green turtle food resources found in CNMI include two seagrass species (i.e., *Halodule uninervis* and *Halophila ovalis*) and approximately 30 algal species (Kolinski *et al.* 2001; Kolinski *et al.* 2004; Kolinski *et al.* 2006). Algae is more prevalent than seagrass in CNMI, especially in areas of high turtle density; however, stomach contents of a single turtle and reports of cropped blades indicate foraging on seagrass as well (Kolinski *et al.* 2004). Analyzing samples from the oral cavity of 44 turtles, Summers *et al.* (2017) identified the following algal genera: *Amansia* (found in 95.7 percent of the samples)*, Gelidiella* (12.8 percent)*, Hypnea,* and *Ceramium.*

We did not include EFs for surface-pelagic juveniles because we did not have adequate data to identify such EFs (i.e., no data on surface-pelagic juveniles are available for this DPS).

9.2.2.2 Special Management Considerations or Protection

The 1998 Recovery Plan, which we use for reference, includes two criteria for foraging habitats: existing foraging areas are maintained as healthy environments; and foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region (NMFS and USFWS 1998). To support foraging turtles in Guam and CNMI, multiple areas with the foraging and resting EFs (food resources and refugia) are needed for the conservation of this DPS.

Foraging sites and underwater refugia may require special management considerations to protect food resources and resting areas for green turtles. Recent studies indicate that juveniles depend upon local resources for their growth and development, remaining within a 0.5 to 3 km^2 area for up to 17 years (Summers *et al.* 2017; Gaos *et al.* 2020). This suggests that they would need to relocate to another area if such resources were modified or destroyed, and other foraging areas (e.g., those used by adults) would require migrating thousands of kilometers. Green turtles appear to be most abundant where there are preferred seagrass and algal species, complex topography for resting habitat, and limited human disturbance (Kolinski *et al.* 2001; Jones and Van Houtan 2014; Martin *et al.* 2016; Summers *et al.* 2017). Thus, special management considerations may be required to protect food resources and limit human disturbance in these areas.

The following activities may reduce the availability of food resources and resting habitat: construction, discharges, dredging, fishing methods that destroy bottom habitat or food resources, and commercial harvest of algae. Impacts to the nearshore marine environment also include shoreline development, sediment-laden runoff, pollution, invasive species, and years of poorly treated wastewater effluent (Hapdei 2020; Kelly and Cayanan 2020). Coral reefs, an important feeding ground for green turtles, are highly sensitive to and threatened by overfishing, terrestrial runoff, and climate change (Becker *et al.* 2019). Coastal development in Guam has resulted in sedimentation, which has damaged Guam's coral reefs and, presumably, food sources for turtles (NMFS and USFWS 1998). Coastal erosion has also been identified as a high risk in the CNMI due to the existence of concentrated human population centers near erosion-prone zones, coupled with the potential increasing threat of erosion from sea level rise (CNMI Coastal Resources Management Office 2011). Direct or indirect disposal of anthropogenic waste and nutrients may increase reef eutrophication thereby affecting reef health and green turtle foraging habitats (Dailer *et al.* 2010; Smith *et al.* 2010; Swarzenski *et al.* 2017). Although seagrasses around Tinian and Rota Islands are in good condition, those around Saipan have been reported as being degraded by hotels, golf courses, and general tourist activities (Project GloBAL 2009b). Climate change is also likely to lead to altered water temperatures, ocean acidification, and coral reef habitat (Friedlander *et al.* 2008), which are likely to affect seagrass and algal distribution.

9.2.2.3 Areas Containing the Foraging and Resting EFs

Within the range of the Central West Pacific DPS, many areas contain food resources and underwater refugia. We rely on the occurrence of green turtles to determine which of these areas contain sufficient resources to support their survival, development, growth, and/or reproduction. We identified areas containing the EFs, where green turtles have been documented in published scientific research studies and unpublished data (e.g., aerial and in-water surveys).

Archipelago-wide, the best available data were gathered during biennial or triennial nearshore towed-diver surveys that compared green turtle densities in the month of April from 2002 to 2015 (Becker *et al.* 2019). Becker *et al.* (2019) found high densities of green turtles (≥ 0.33 green turtles/km) at Guam, Saipan, Tinian, Rota, Sarigan, Alamagan, Pagan, and Aguijan (Table 13).

Table 13. Density of green turtles in the Mariana Archipelago

Table modified from the supplemental materials provided by Becker *et al.* (2019). Density represents the number of green turtles per 1,000 tow segments or kilometer.

Survey location		Green turtles per 1000 tow segments	Green turtles per km
Region	**Island/Atoll**		
Wake	**Wake**	**49**	**0.23**
Guam	**Guam**	**148**	**0.65**
CNMI	**Tinian**	**392**	**1.77**
	Saipan	**344**	**1.60**
	Rota	**138**	**0.64**
	Sarigan	**98**	**0.48**
	Alamagan	**80**	**0.38**
	Pagan	**67**	**0.33**
	Aguijan	**77**	**0.34**
	Guguan	**59**	**0.30**
	Asuncion	**45**	**0.22**
	Maug	**47**	**0.23**

Survey location	Green turtles per 1000 tow segments	Green turtles per km
Agrihan	**43**	**0.21**
Farallon de Pajaros	**22**	**0.11**
Anatahan	**0**	**0.00**
Arakane	**0**	**0.00**
Pathfinder	**0**	**0.00**
Santa Rosa	**0**	**0.00**
Stingray	**0**	**0.00**
Supply	**0**	**0.00**
Tatsumi	**0**	**0.00**

Throughout the Mariana Archipelago, published and unpublished data have been gathered during PIFSC in-water captures from 2013 to 2019, CNMI DLNR in-water captures from August 2006 to July 2016, and NMFS CREP towed-diver surveys from October 2000 to April 2017 (Figure 71). Although not every neritic area has been surveyed, green turtles were observed foraging or resting in all surveyed areas (CNMI DLNR unpublished data 2022; NMFS CREP unpublished data 2022; Becker *et al*. 2019; Gaos *et al*. 2020a; Gaos *et al*. 2020b). These data, combined with stranding data (CNMI DLNR unpublished data 2022) indicate the presence of foraging green turtles throughout neritic waters of the Mariana Archipelago.

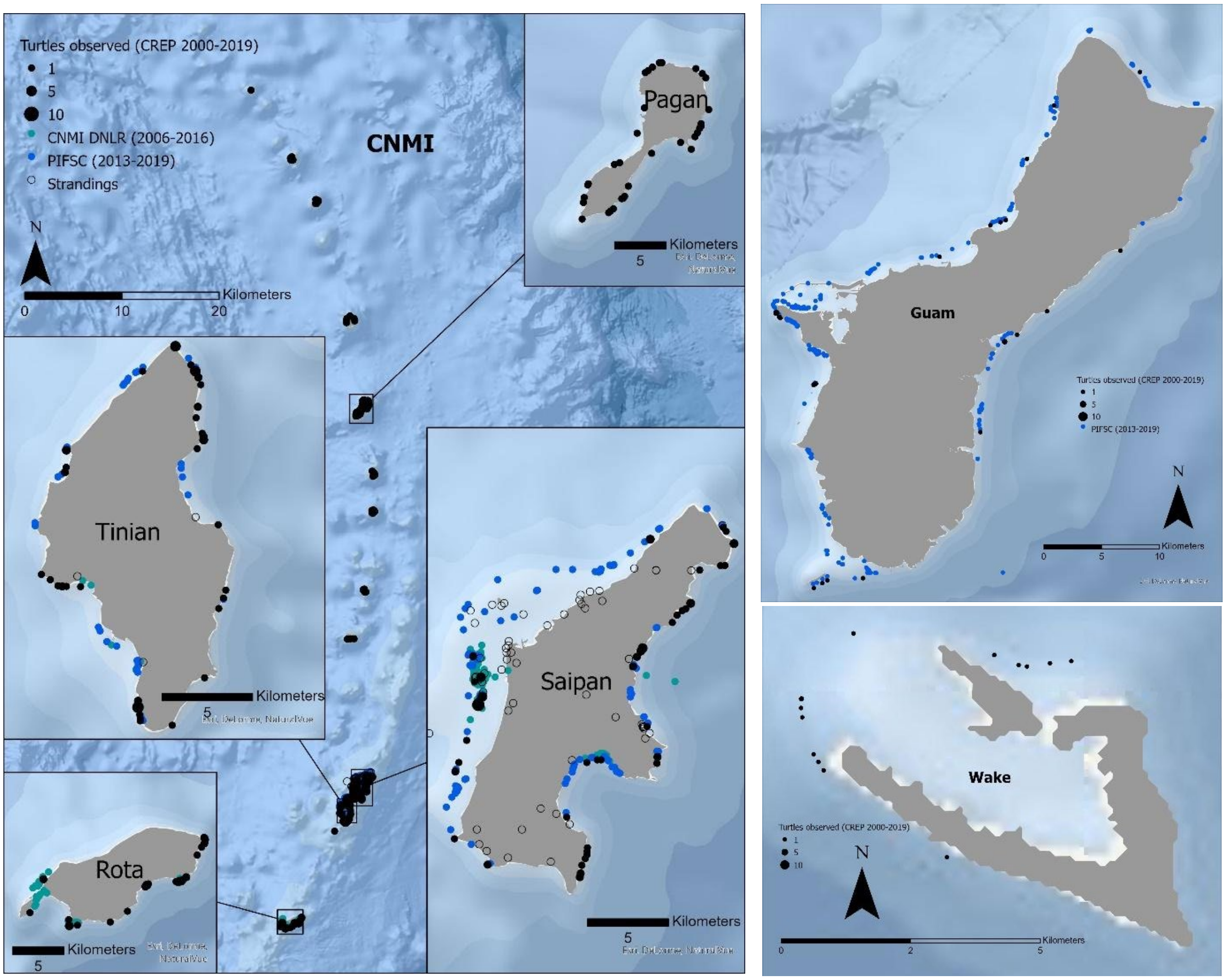


Figure 71. CNMI, Guam and Wake inwater green turtle data

Black dots are turtle sightings, scaled to number observed (NMFS CREP unpublished data 2022); green dots are turtle sightings (CNMI DLNR unpublished data 2022); blue dots are captured turtles (PIFSC unpublished data 2022); and black circles are stranded turtles (CNMI DLNR unpublished data 2022).

In Guam, green turtles forage and rest throughout neritic waters, as demonstrated by aerial, in-water surveys, and satellite telemetry. Guam DAWR has conducted coastal aerial surveys semimonthly (24 surveys per year under ideal conditions) during three time periods: 1963 to 1965 1975 to 1979, and 1989 to 2012 (Martin *et al.* 2016). Mean number of green turtles increased from 31 (range 8 to 61) in 1963 through 1965 to 299 (range 242 to 355) in 2008 through 2012 (Martin *et al.* 2016). Increases mainly occurred on the southern and northern coasts of Guam (Figure 72, zones 8 and 12; Martin *et al.* 2016). The increase in zone 8 is correlated with the implementation of the Achang Reef Flat Preserve, a marine protected area, in 1999; zone 8 also contains extensive seagrass beds (Martin *et al.* 2016). The surveys also indicate consistent usage of zone 5 (the area around Apra Harbor) over time, which is supported by in-water surveys (e.g., Figure 77) identifying abundant seagrass beds, coral reefs, and foraging turtles in the area (Gaos *et al*. 2020a, 2020b).

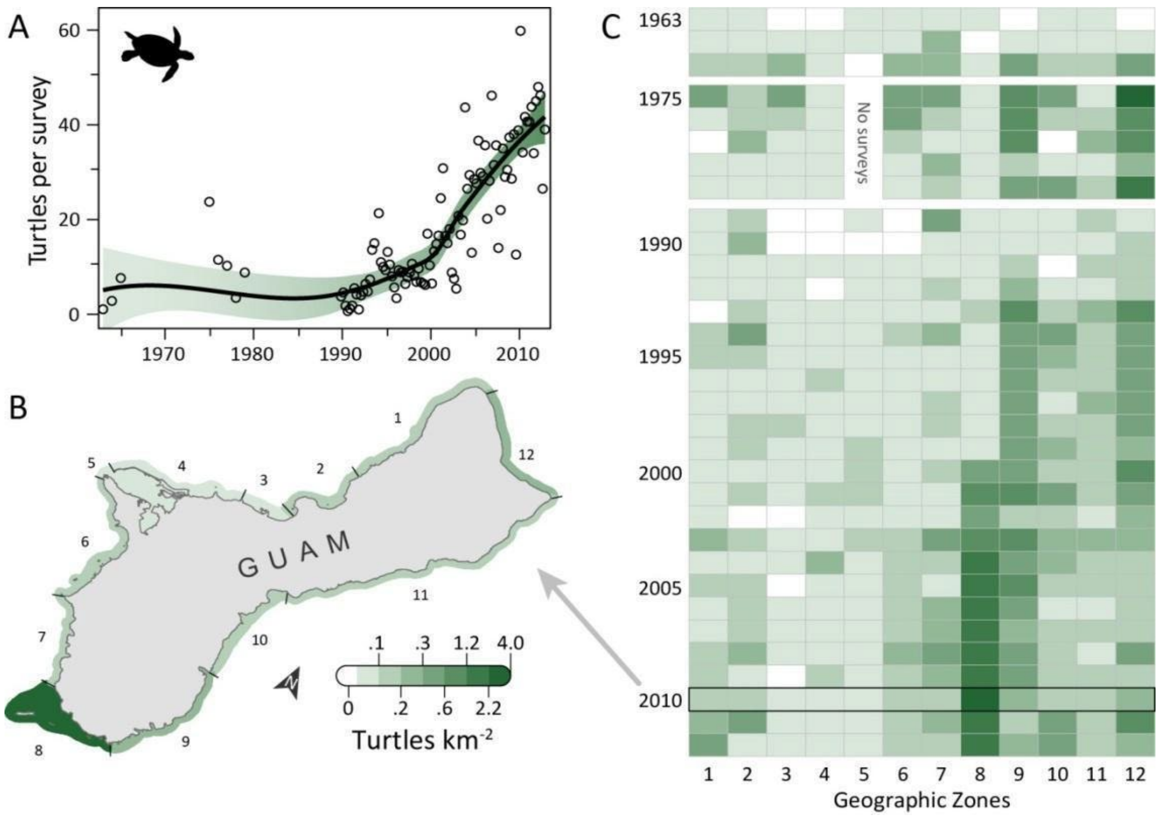


Figure 72. Aerial survey data of in-water green turtles around Guam

Eight-fold increase in observed sea turtles on Guam's reefs in the last five decades. (A) Trend in turtle observations per survey (open circles); smoothed line is a model fit, with 95 percent confidence interval shaded. (B) Map of 12 geographic survey zones; shading depicts observed densities for 2010, when annual observations were highest. (C) Trends in densities for the 12 zones. Zone 5 was closed to surveys in 1975-1979 due to military restrictions. (Figure 1 from Martin *et al.* 2016).

PIFSC observed and captured green turtles at numerous locations around Guam at sites consisting of rock, coral, and sandy substrate, including Piti Bomb Holes, Apra Harbor, Orote Point, Dadi Beach, Sella Bay, Cocos Island, Achang Reef Flat, Talo'fo'fo, Pago Bay, Ritidian, Tarague, Tumon Bay, and Tanguisson (Gaos *et al.* 2020a, 2020b). They tracked foraging green turtles (n = 46) via satellite telemetry at several locations around Guam (Figure 73 and Figure 74). They identified 50 percent (core home range) and 95 percent (overall home range) volume contours for turtles pooled by general geographic locations (Gaos *et al.* 2020a, 2020b). Tags transmitted an average of 146 days (±85.5 days), during which turtles tended to remain within restricted home ranges, with average core home ranges of 0.15 km^2 ±0.13km^2 and overall home ranges of 1.08 km2 ±0.78 km2 (Gaos *et al.* 2020a). It is important to note that the in-water surveys were designed to capture turtles in specific locations, and therefore they do not reflect systematic sampling of all reef areas around Guam, but efforts were made to survey as many areas as possible (Gaos *et al.* 2020a). It appears green turtles forage throughout the neritic waters of Guam (Martin *et al.* 2016; Gaos *et al*. 2020a, 2020b).

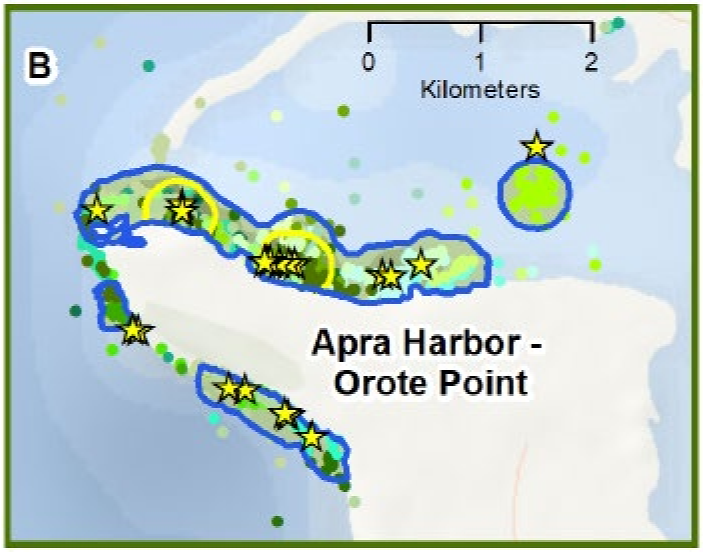


Figure 73. Kernel density estimates of satellite tracked turtles around Apra Harbor - Orote Point, Guam
(Gaos et al. 2020b).

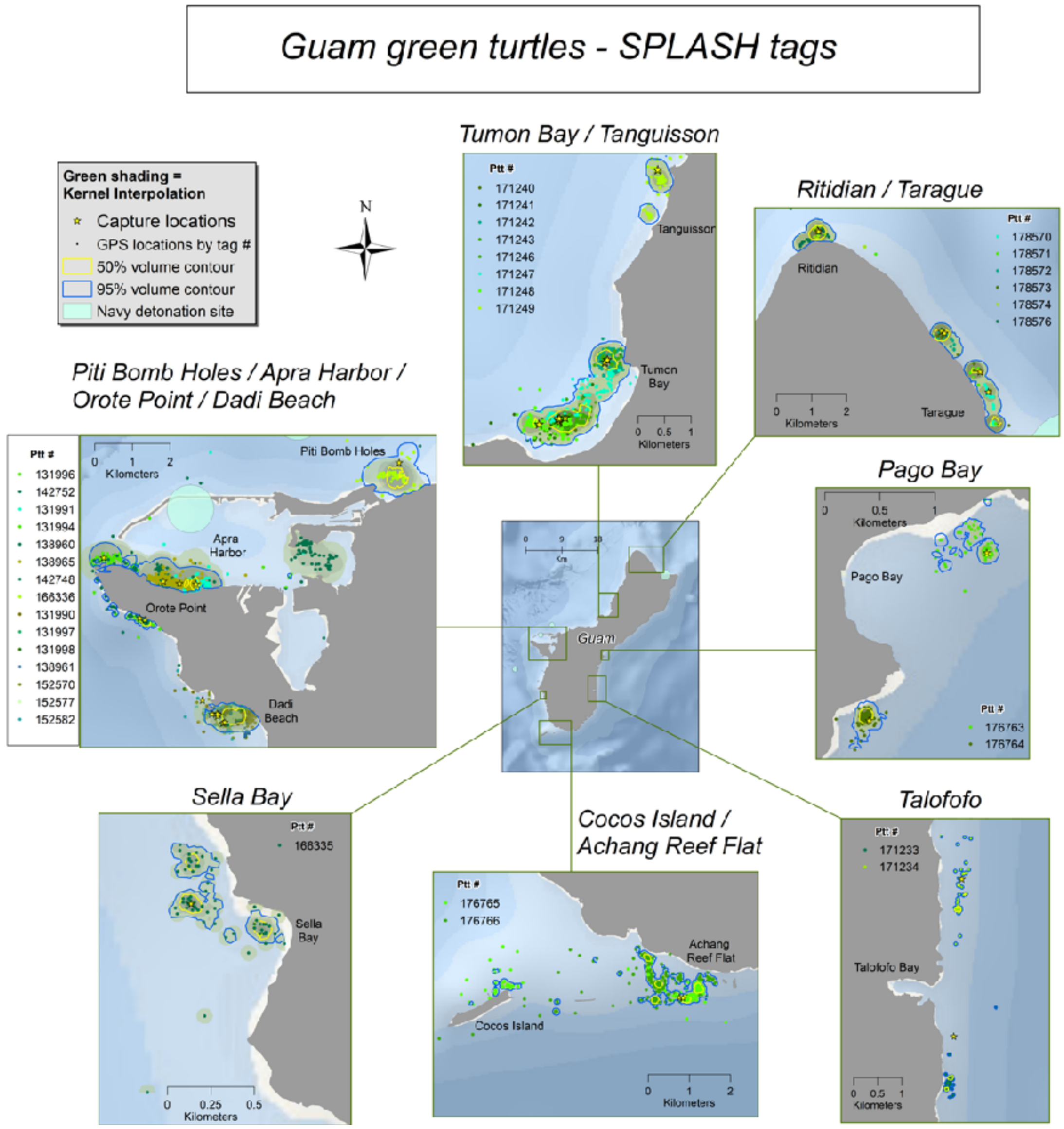


Figure 74. Core home and foraging ranges in Guam
(Gaos *et al.* 2020b).

In CNMI, green turtles forage and rest throughout neritic waters as shown in Figure 71 and as demonstrated by numerous studies. The numbers of turtles described below do not represent relative abundance because the type and amount of effort differs at each location; however, we use these data to demonstrate the presence of resident juvenile turtles that utilize the EFs in each area. Between 2006 and 2014, Hapdei (2020) captured 493 foraging or resting green turtles (mostly juveniles) in the nearshore habitats of Saipan, Tinian, and Rota. Surveying Saipan from 2006 to 2016, CNMI DLNR (Summers et al. 2017; unpublished data through 2016) identified the following foraging locations (the total number of unique individuals captured is in parentheses): Balisa (576); LaoLao Bay (35); Chalan Kanoa Reef (3); Cow Town (1); and Spotlight (1). Summers *et al.* (2017) captured foraging and resting turtles at: Laguna Garapan (Balisa), Lao Lao Bay, Barcinas Cove, Tachungnya Bay, Tinian Harbor, Dumpcoke, Turtle Cove, Fleming Point, Sasanlagu or Pinatang, Teteto, Sasanhaya Bay (including Jerry's Reef), and Puntan Poña

(Figure 71). During a 10-day in-water survey conducted in 2005, Ilo *et al.* (2005) observed 30 juveniles and one adult female between Naftan Point and Banzai Cliff (including the reefs of Chalan Kanoa, Chalan Laulau, and Tanapag Lagoons). Ilo *et al*. (2005) also observed 37 green turtles (including 26 juveniles) during shoreline and cliff-side assessments of the eastern shore of Saipan, conducted in July of 2005.

During their in-water and cliff-side surveys of Saipan, Kolinski *et al.* (2001) encountered most foraging turtles (60 percent) along the relatively uninhabited east coast, where human access is limited, the benthos is topographically complex, and a variety of food resources occur; they also observed turtles at Central Naftan, Forbidden Island (north of the isthmus), North Naftan, the Kingfisher Golf Course, and Balisa. Kolinski *et al.* (2001) identified the following foraging locations on Saipan (the total number of turtles estimated is in parentheses): Puntan Laggua to Puntan Makpe (17); Banzai Cliff (6); Grotto, Puntan I Maddok (6); Bird Island (Isleta Maigo Fahang) (7); Kingfisher Golf course, Sabanan Fiiang (12); Forbidden Island, North of Isthmus (19); Forbidden Island, South of Isthmus (2); Laulau Bay Golf Course, Bahia Laulau (7); North Naftan (17); Central Naftan (31); Puntan Agingan (7); Agingan to Puntan Naftan (3); Coral Ocean Point Golf Course, 7th tee and hole, Agingan (2); Puntan Naftan (3); Tanapag Lagoon Entrance, towards Puntan Flores (2); Red Bouy No. 10 (3); Puntan Muchot Patch Reefs, Garapan (5); Outer Reef Matrix, Balisa Area, Garapan (18); Chalan Kanoa to San Antonio (5); Puntan Susupi to Puntan Afetna (2).

PIFSC in-water surveys and satellite telemetry between 2013 and 2019 have confirmed the residency of juvenile green turtles within much of the neritic habitat around Saipan, including Balisa, Fishing Basin, Chalan Kanoa (CK) Reef, Coral Ocean Point, Dan Dan, Lao Lao Bay, Tank Beach, Forbidden Island, Spotlight, Cowtown, Pau Pau Beach, and Aqua Reef (Figure 75 and Figure 76; Gaos *et al*. 2020a). A total of 33 satellite tags were deployed on green turtles and transmitted for an average of 154 days, ±142 days. Nearly all turtles remained within restricted foraging areas during tracking and had average core and overall home ranges of 0.22 km^2, ± 0.2 km^2 and 1.45 km^2, ±1.3 km^2 respectively. One turtle relocated from its initial foraging habitat to another foraging site approximately 10 km away, while a second turtle relocated from its initial foraging habitat to another site approximately 6 km away, but then returned to the original foraging site. Lastly, one very small juvenile that established a foraging habitat in northern Saipan was originally captured and tagged on northern Guam, a distance of approximately 200 km. Turtles of this size class represent recent recruits to neritic habitats. It is likely that this turtle had very recently recruited to neritic areas after spending itsfirst years of life in the pelagic habitat (i.e., the “lost years”) and had still not settled in a fixed foraging habitat, and the approximately 200 km migration north to Saipan represented the turtle’s ongoing search for a suitable location to settle (Gaos *et al*. 2020a).

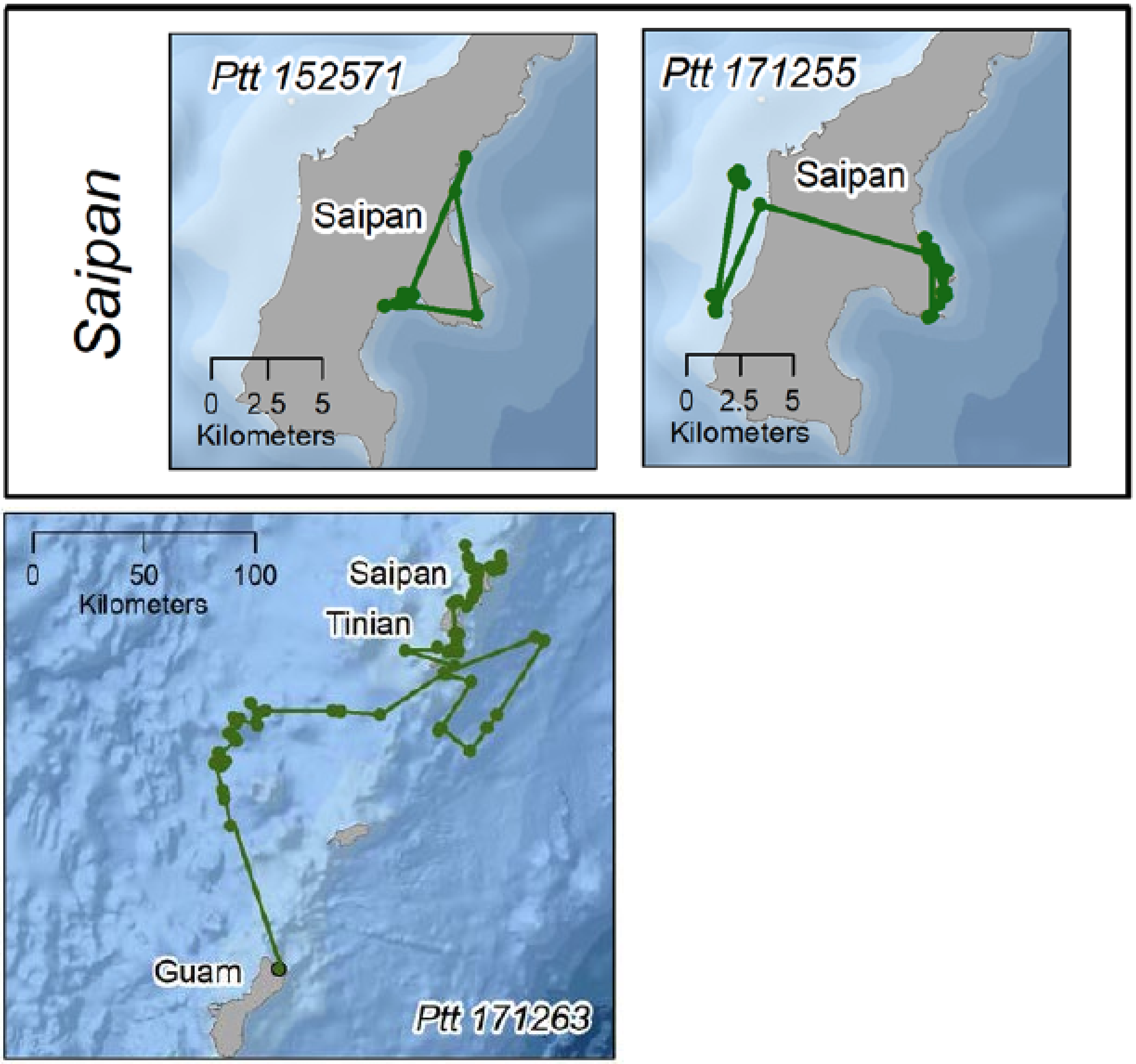


Figure 75. Satellite tracking of foraging turtles

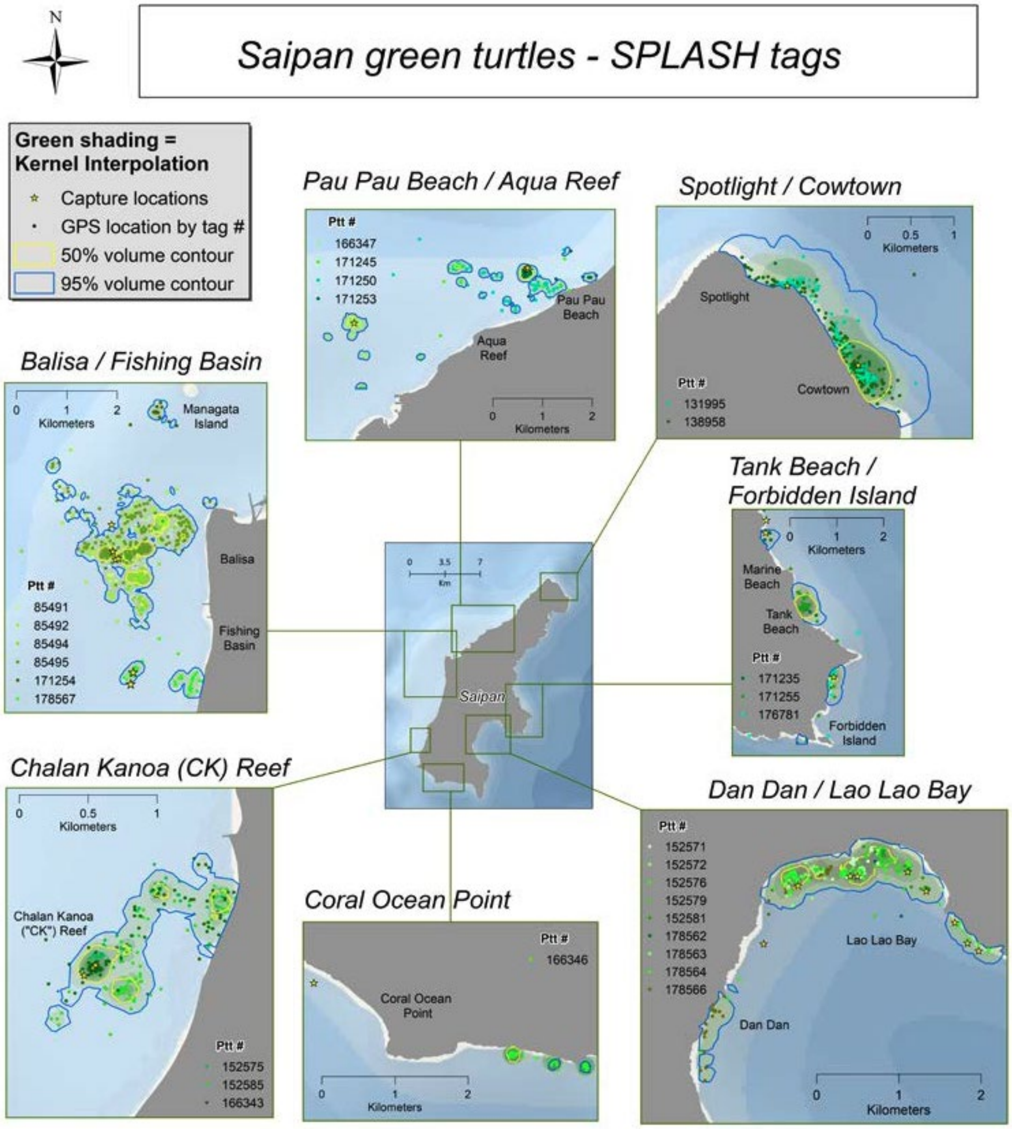


Figure 76. Core home and foraging ranges in Saipan
(Gaos *et al.* 2020a)

In Saipan, recreational divers observed green turtles at the following locations (number of sightings in parentheses): Agingan (3); Dimple (4); Grotto (79); Ice Cream (3); Laulau (93); Naftan (20); Obyan (6); Talafofo (4); and Wing (29).

Tinian also hosts a large resident population of green turtles. From 2006 to 2016, CNMI DLNR (unpublished data 2016) identified the following foraging locations on Tinian (the total number of individuals captured is in parentheses): Dumpcoke (5); Fleming Point (6); Red Wall (Puntan Carolinas to Horseshoe Reef; 8); and Turtle Cove (2).

NOAA MTBAP in-water surveys and satellite telemetry between 2013 and 2019 have confirmed the residency of juvenile green turtles at several sites around Tinian, specifically at Dumpcoke Cove, Fleming Point, Tinian Harbor, Tachungnya Bay, Red Wall, Tohgong, Dangkolo, and

Chulu (Figure 71 and Figure 77; Gaos et al 2020a). A total of 17 satellite tags were deployed on green turtles around the island and the tags transmitted for an average of 154 days, ±82.1 days. All turtles remained within restricted foraging areas during tracking and had average core and overall home ranges of 0.57 km^2, ± 0.19 km^2 and 3.09 km, ±0.78 km^2, respectively (Figure 77).

Around Tinian, Kolinski *et al.* 2001 reported that most turtles are juvenile and occur along the relatively uninhabited east coast and identified the following foraging locations on Tinian (the total number of turtles individuals estimated is in parentheses): Puntan Tahgong to Lamlam (northwest; 1); Puntan Tahgong (Cross Point; 10); Tahgong (northeast;13); Abas Point, Sabanetan Tahgong (18); Blowhole, Sabanetan Chiget (4); Sabanetan Asiga (10); North Masalok (12); Unai Masalok (2); Pina (32); South Pina (46); Suicide Cliff (10); East Puntan Carolinas (7); Target Area, Puntan Carolinas (35); Target Area to Puntan Carolinas (14); Puntan Carolinas to Horseshoe Patch Reef (3); Horseshoe Patch Reef (5); Inner Tinian Harbor (2); Outside Tinian Harbor (34); Leprosarium and Barcinas (49); Puntan Lamanibot Sanhilo to Puntan Diablo (33); Flemming Point (2); Puntan Lamanibot Sanhilo (8); Lamlam to Puntan Lamanibot Sanhilo (9).

In-water and cliff-side surveys of Tinian waters, contracted by the Navy and conducted over several weeks in 2013, were used to estimate a population size of 795 to 1,107 green turtles (Tetratech 2014). Foraging has also been observed at South Tachungnya Bay to North Turtle Cove, Dumpcoke Cove, and Blow Hole. Recreational divers in Tinian also observed green turtles at the following locations (number of sightings in parentheses): Dumpcoke Cove (19); Fleming (4); Tinian Grotto (2); and Tinian Two Corals (2).

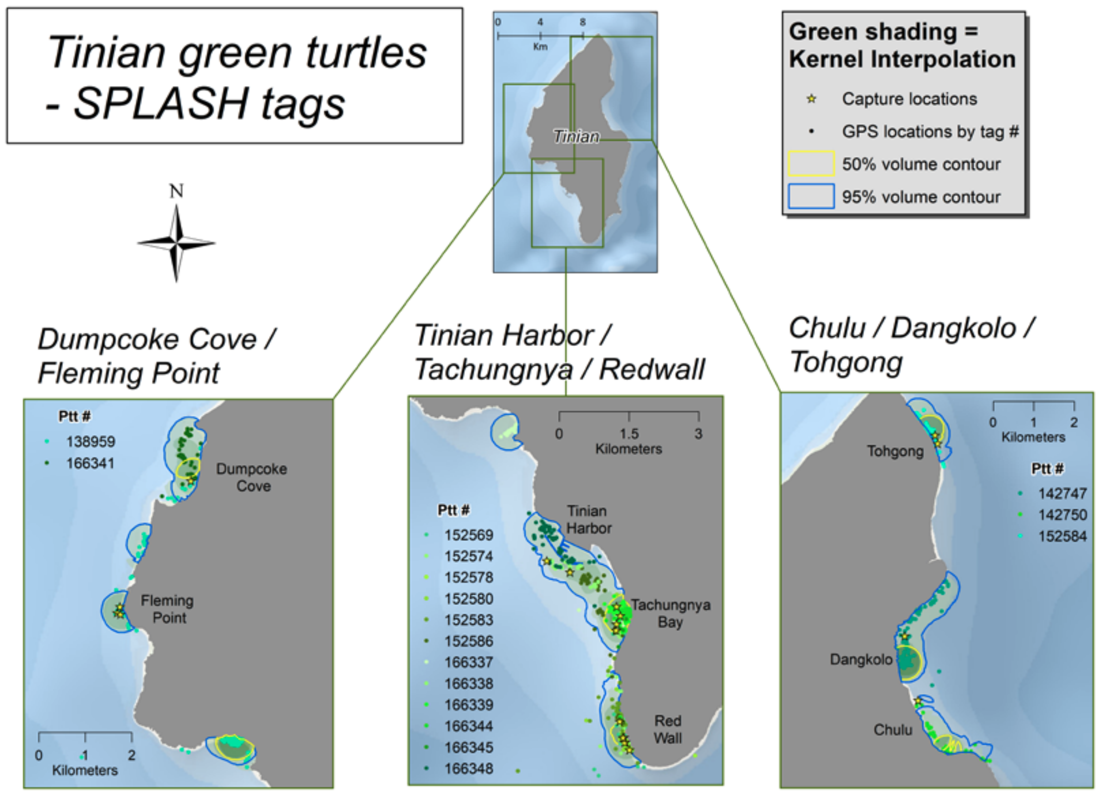


Figure 77. Core home and foraging ranges in Tinian
(Gaos *et al.* 2020a).

Rota also hosts a large resident population of green turtles. From 2006 to 2016, CNMI DLNR (unpublished data 2016) identified the following foraging locations on Rota (the total number of individuals captured is in parentheses): Jerry's Reef (11); Pinatang (9); and Puntan Pona (24); Bird Sanctuary (1); Sasanhaya Bay (including East Harbor; anecdotal sightings, T. Summers, pers.comm.); and Sasanlagu (including West Harbor; anecdotal sightings, T. Summers, pers.comm.).

During surveys covering 67 percent of Rota's shoreline, Kolinski *et al.* (2006) observed an estimated 73 green turtles (Kolinski *et al.* 2006). While these estimates are based on two days of surveys in a single year, the results are comparable to previous surveys conducted by Ilo and Manglona (2001), who surveyed 94.4 percent of Rota's shorelines, observed 56 turtles, and projected a total of 92 green turtles. The similarity of estimates suggests short-term stability in turtle abundance at Rota (Kolinski *et al.* 2006). It also increases our confidence in the data as an indicator of resident abundance, rather than a temporal anomaly. Similar to the other islands, the majority of turtles were observed on the east coast (55 percent). Turtle concentrations were highest from Lalayak to Alaguan (Kolinski *et al.* 2006; Ilo and Manglona 2001). There appears to be stability in turtle utilization of habitat (Kolinski *et al.* 2006). Kolinski *et al.* (2006) identified the following foraging locations on Rota (the total number of turtles estimated is in parentheses): I Batko to Lalayak (2); Lalayak to Mochong (5); Mochong to Maya (2); Mochong

(3); Puntan Fina Atkos (4); Puntan Fina Atkos to As Dudo (3); As Dudo to Puntan; As Fani (7); I Chiugai to Puntan Saguagahga (26); Puntan Saguagahga to Taksunok (4); Alaguan to Payapai (6); Agatasi to Gaonan (2); Guaa to Gagani (1); South Puntan Pona (1); Puntan Pona to Poddong (1); Aila to Puntan Taipingot (3); Taipingot to Puntan Taipingot (2); Puntan Taipingot to Liyo (2)**;** Songsong to Sailigai Papa (1)**;** Sailigai Papa to Puntan Saligai (2). Foraging has also been observed at Sasanlagu, Sasanhaya Bay, and Pona Point.

In Rota, recreational divers observed green turtles at the following locations (number of sightings in parentheses): Point off Wall (6); Rota Harbor (1); Coral Garden (11); Paupau Hotel (2); East Habor (22); Fireworks (5); Joannes Reef (6); Pearlman Tunnel (518); Pinatang (11); Pona Point (4); Senhanom (35); Shelf Wall (59); Table Top (6); West Harbor (47); and Asmotmos (2). These data are informative regarding the presence of turtles at popular dive sites; however, the lack of diver observation may reflect the absence of a popular diving site, rather than the absence of turtles.

Kolinski *et al.* (2006) discussed whether Rota is "key" to green turtle utilization of regional neritic habitats because it appears to support only six percent of the resident CNMI green turtle population (whereas Tinian and Saipan support approximately 92 percent). Although they concluded that its contribution appears minor and indistinct, they highlight its potential importance to population expansion "because the capacity for increasing turtle numbers may be great[est] where they are least abundant, assuming that appropriate habitat is available" (Kolinski *et al.* 2006).

In-water and cliff-side surveys of Pagan waters contracted by the Navy and conducted over several weeks in 2013 were used to estimate a population size of 297 green turtles (Tetratech 2014). Foraging has been observed at Leeward South, South (Jurassic Park), Green, and Blue beaches.

At Aguijan and Farallon de Medinilla Islands, 14 and 9 green turtles respectively were observed during marine surveys covering 95 percent of the islands in 2001 (Kolinski *et al.* 2004).

Between 25 August and 28 September 2003, Kolinski *et al*. (2005) conducted 36 hours of surface surveys and 34 hours of submerged surveys (tow-board and dive) throughout seven reef systems throughout the Archipelago: Stingray Shoal, Supply Reef, Zealandia Bank, Pathfinder Reef, Arakane Reef, and Tatsumi Reef. They observed a total of three turtles (one each at Supply Reef, Zealandia Bank and Arakane Reef); two were juveniles, and one was juvenile/adult (Kolinski *et al.* 2005). The authors attributed the low abundance to low recruitment rates, inadequate habitat range and resources, increased exposure to predation, and/or increased effort required to remain on location (Kolinski *et al.* 2005).

At Wake Island, aggregations of resident green turtles are present (Balazs 1982; PIFSC unpublished data 2022). During a 1998 terrestrial survey, multiple turtles were observed in neritic and lagoon waters at Wake Island (Huizenga *et al.* 2007). Green turtles are regularly sighted in the waters surrounding Wake Island (PRSC 2017).

Based on these data, which we consider to be the best available, we conclude that, from the mean high water line to 20 m depth, the neritic waters surrounding Guam, Saipan, Tinian, Rota, Pagan, and Wake Island contain the benthic-foraging and resting EFs that may require special management considerations or protections. Other islands within CMNI also contain the benthic-foraging and resting EFs; however, Becker *et al*. (2019) found low green turtle densities at these locations (Table 13).

9.3 Value to the Central West Pacific DPS

In Figure 78, we summarize the areas under U.S. jurisdiction that contain EFs essential to the conservation of the Central West Pacific DPS that may require special management consideration or protection. Where we had sufficient data to do so, we also include a qualitative rating (high, medium, or low) of the conservation value that each area provides to the DPS (Table 14). We did not rate areas where there were data deficiencies or a high degree of uncertainty. All areas containing reproductive EFs are of high conservation value because they are directly linked to population growth and recovery. Females must use these areas to reach the nesting beaches considered for proposed critical habitat designation by USFWS. These areas are also essential for successful mating and post-hatchling swim frenzy. For the foraging areas, we rated areas based on available data on green turtle usage and abundance. We relied heavily on density estimates (Table 15; Becker *et al.* 2019) from the towed diver surveys, which provided a standardized, objective measure of value to the DPS. Because of the large geographic scale and "snapshot" temporal scale of the survey, and without additional data, we were unable to rate the conservation value at a finer scale, beyond high (i.e., many turtles) or low (i.e., few turtles). Guam, Tinian, Saipan, Rota, Pagan, Sarigan, Alamagan, and Aguijan (Table 13) hosted high densities of green turtles (≥ 0.30 green turtles/km), and thus provide a high conservation value. Wake Island and other islands of CNMI hosted low densities of turtles and provide a low conservation value. We did not rate areas where there were data deficiencies or a high degree of uncertainty.

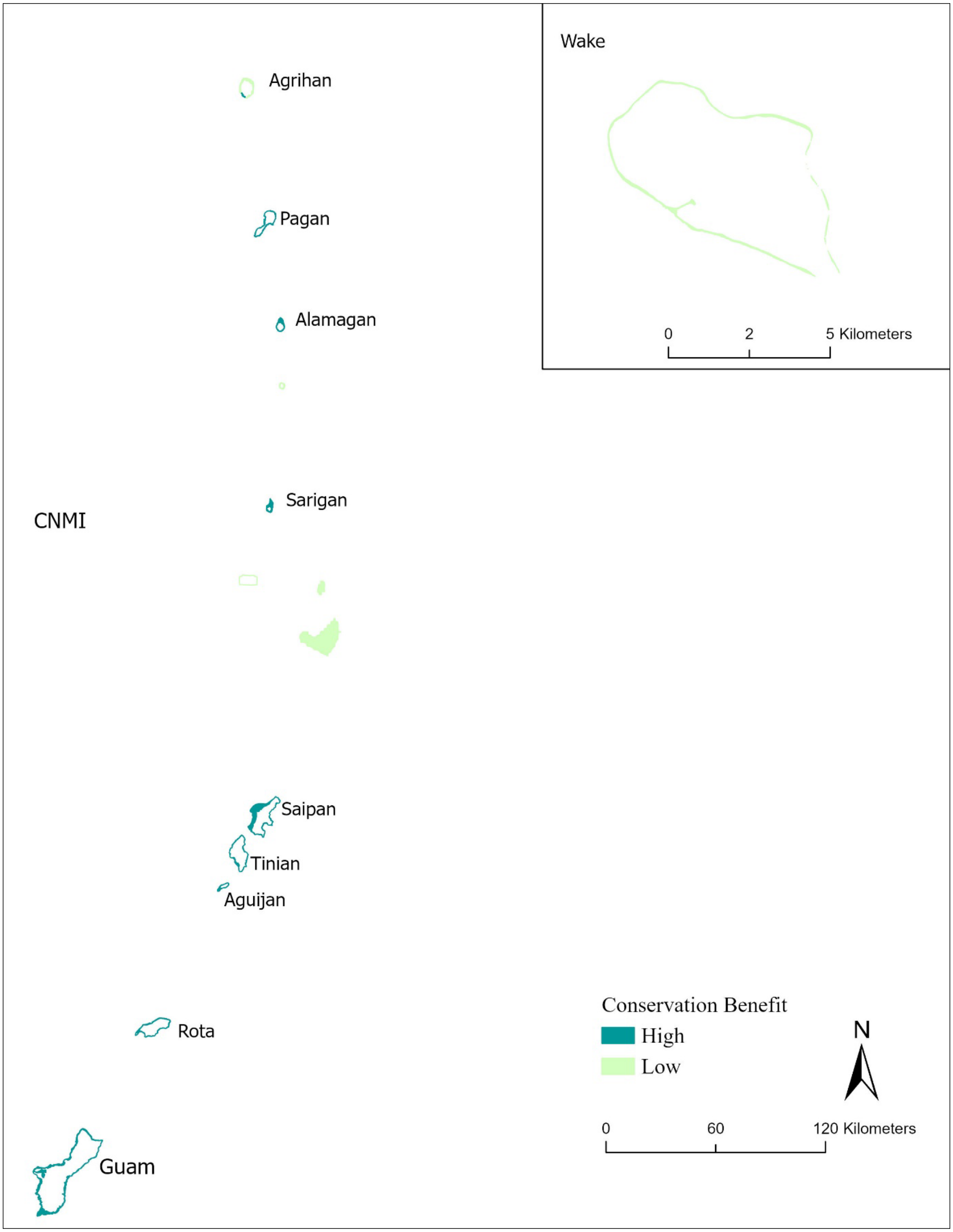


Figure 78. Areas containing the EFs essential to the conservation of the Central West Pacific DPS

Dark green represents high conservation value areas from mean high water to 20 m depth; light green represents low conservation value areas from mean high water to 20 m depth.

Table 14. Areas containing the EFs and their conservation value to the Central West Pacific DPS

Area	Value to DPS	Rationale
Guam	High	Reproductive and foraging/resting EFs; basking; high density foraging turtles (Becker *et al*. 2019; Gaos *et al*. 2020b; PIFSC unpublished data 2022)
CNMI		
Saipan	High	Reproductive and foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019; Gaos *et al*. 2020a; PIFSC unpublished data 2022)
Tinian	High	Reproductive and foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019; Gaos *et al*. 2020a; PIFSC unpublished data 2022)
Rota	High	Reproductive and foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019)
Pagan	High	Foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019)
Sarigan	High	Foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019)
Alamagan	High	Foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019)
Aguijan	High	Foraging/resting EFs; high density foraging turtles (Becker *et al*. 2019)
Agrihan (nesting beach)	High	Reproductive EFs; high density nesting
Other Islands (CNMI)	Low	Foraging/resting EFs; low density foraging turtles (Kolinski *et al.* 2004; Kolinski *et al.* 2005; Becker *et al*. 2019)

Wake	Low	Foraging/resting EFs; low density foraging turtles (Becker *et al*. 2019)

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