OCS Study
BOEM 2017-084

Review of Sea Turtle Entrainment Risk by Trailing Suction Hopper Dredges in the US Atlantic and Gulf of Mexico and the Development of the ASTER Decision Support Tool

ASTER
Analyzing Sea Turtle Entrainment Risk

US Department of the Interior
Bureau of Ocean Energy Management
Headquarters (Sterling, VA)

BOEM
Bureau of Ocean Energy Management

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DISCLAIMER

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ABOUT THE COVER

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Abbreviations and Acronyms

ACCSTR	Archie Carr Center for Sea Turtle Research
ADEOS-1	Advanced Earth Observing Satellite 1
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AOI	Area of interest
ARIES	ARtificial Intelligence for Ecosystem Services
ASTER DST	Analyzing Sea Turtle Entrainment Risk Decision Support Tool
AVHRR	Advanced Very High Resolution Radiometer
AVISO MADT	Archivage, Validation et Interprétation des données des Satellites Océanographiques Maps of Absolute Dynamic Topography
BASS	Bayesian Analysis for Spatial Siting
Bio-ORACLE	Ocean Rasters for Analysis of Climate and Environment
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
C	Celsius

CGSC	Coastal Geospatial Services Contract
cm	centimeter(s)
CSCV	Coastal Zone Color Scanner
DDC	Denver Data Center
DOI	Department of the Interior
DoN	Department of the Navy
DPS	distinct population segment
DQM	National Dredging Quality Management
DST	decision support tool
EAG	executive advisory group
EEZ	Exclusive Economic Zone
EIS	environmental impact statement
EMDS	Ecosystem Management Decision Support
EMU	Ecological Marine Unit
ESA	Endangered Species Act
ESPIS	Environmental Studies Program Information System
ETOPO1	Earth Topographic Database
fGDB	File geodatabase
ft	foot/feet
FWS	US Fish and Wildlife Service
GADM	Global Administrative Areas
GEBCO	General Bathymetric Chart of the Oceans
GHRSST-PP	GODAE High-Resolution Sea Surface Temperature Pilot Project
GIS	geographic information system
GODAE	Global Ocean Data Assimilation Experiment
GOT	Global Ocean Tide Model
GPS	global positioning systems
GRBO	Gulf of Mexico Regional Biological Opinion
GSFM	global seafloor geomorphic features map
GSHHG	Global Self-consistent, Hierarchical, High-resolution Geography Database
GSM	Garver-Siegel-Maritorena
HYCOM	HYbrid Coordinate Ocean Model
in	inch(es)
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
ITS	incidental take statement
IUCN	International Union for Conservation of Nature
km	kilometer(s)
LiDAR	Light Detection and Ranging
m	meter(s)
m^3	cubic meters
MEC	munitions of explosive concern
mg	milligram(s)
MGET	Marine Geospatial Ecology Tools
MIMES-MIDAS	Multi-scale Integrated Model of Ecosystem Services Marine Integrated Decision Analysis System
MMIS	Marine Minerals Information System
MMP	Marine Minerals Program
MOA	memoranda of agreement
MODIS	Moderate Resolution Imaging Spectroradiometer
NEFSC	Northeast Fisheries Science Center
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NOMES	New England Offshore Mining Environmental Study
NPS	National Park Service
NTIS	National Technical Information Service
OBIS	Ocean Biogeographic Information System
OBIS-SEAMAP	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations
OCLC	Online Computer Library Center
OCM	Office of Coastal Management
OCS	Outer Continental Shelf
OCTS	Ocean Color and Temperature Scanner
ODESS	Operations and Dredging Endangered Species System
OWASP	Open Web Application Security Project
PAR	Photosynthetically Available Radiation
PDF	Portable document format
PIT	passive integrated transponder
QSI	Quantum Spatial, Inc.
RPA	reasonable and prudent alternative
RPM	reasonable and prudent measure
s	second(s)
SARBO	South Atlantic Regional Biological Opinion
SEAMAP	Southeast Area Monitoring and Assessment Program
SeaWiFS	Sea-Viewing Wide Field of View Sensor
SLAMM	Sea Level Affecting Marshes Model
SRTM30_PLUS	Shuttle Radar Topography Mission Global Coverage, 30 seconds
SST	sea surface temperature
STAT	Satellite Tracking and Analysis Tool
T&C	terms and conditions
TSHD	trailing suction hopper dredge
UGMP	USACE GRBO Management Protocol
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
USACE	US Army Corps of Engineers
USGS	United States Geological Survey
USMP	USACE SARBO Management Protocol
UXO	unexploded ordnance
VHF	very high frequency
yd	yard(s)

1 Introduction

1.1 Background of the Study

The United States (US) Outer Continental Shelf Lands Act (43 USC 1331) authorizes the use of marine minerals on the outer continental shelf (OCS) which consists of federal waters beyond the Submerged Lands Act boundary (generally delimited as 3 nautical miles from the coastline with the exception of 9 nautical miles for Texas and the Gulf coast of Florida). Public Law 103-426 (43 USC 1337(k)(2)) authorizes the US Department of the Interior (DOI), Bureau of Ocean Energy Management (BOEM) to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects, funded in whole or part, by or authorized by, the Federal government. The BOEM Marine Minerals Program (MMP) is tasked with negotiating agreements for OCS sand, gravel, and shell resources for use in beach nourishment and coastal restoration projects in an environmentally responsible way. One of the environmental concerns associated with these projects is the potential for entrainment and mortality of Federally protected sea turtles when using trailing suction hopper dredges (TSHDs). Because all sea turtles within US waters are currently endangered or threatened, Section 7 of the US Endangered Species Act (ESA) requires consultations between the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and BOEM for all OCS activities where sea turtles may be affected (i.e., lethal and nonlethal takes defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting). BOEM seeks to minimize adverse environmental effects related to project-specific dredging operations, through deliberate project planning efforts and implementation of relevant and effective mitigation measures.

Historically, the US Army Corps of Engineers (USACE), dredging industry, academia, and other partners have made significant investments in improving protective measures and best management practices (BMPs), principally focusing on dredging windows, the use of sea turtle deflecting dragheads, dredging operational parameters, and relocation trawling. However, there has been little effort to analyze existing data and subsequently tailor mitigation strategies on a finer scale (i.e., at the project and/or geographic-specific level). BOEM believes that direct coordination with both sea turtle and dredging industry experts is required to leverage existing information on sea turtle distributions/behavior and dredging operations to better identify associated dredging entrainment risk parameters. Past sea turtle entrainment analyses associated with TSHDs in offshore borrow areas (mostly conducted by the USACE) suggest that other factors linking increased risk of take beyond presence/absence assumptions may include information on: 1) the temporal and spatial relationship of sea turtle behavior (e.g., foraging, migrating, breeding, resting, and overwintering) within the water column, relative to draghead operating parameters, and 2) borrow area design relative to turtle deflecting draghead efficacy (D. Dickerson and D. Piatkowski 2016, personal communication). By considering all risk factors within the project-specific context, targeted mitigation strategies may be more appropriate than conservative presence/absence-based dredging windows. These data, along with continuous interactions with experts, can inform a standardized decision support tool (DST) for analyzing sea turtle entrainment risk (herein called the ASTER DST) by TSHDs across regional scales, and improving the effectiveness of mitigation planning decisions.

1.2 Report Organization

This report contains seven sections, with figures, tables, and appendices. Section 1 is an introduction to the overall project, with details on the background, goals and objectives, and methods. Section 2 summarizes available information on US Atlantic and Gulf of Mexico sea turtles, including current legal status, relative risk to TSHDs, general biological and ecological information throughout the life cycle, important datasets that can be utilized for assessing sea turtle risks in nearshore waters (telemetry and others), and feedback of stakeholders from the sea turtle research community. Section 3 summarizes available information on TSHDs, including a general description of TSHD operations; risks specific to sea turtles, mitigation measures considered, recommended, and currently implemented in the US South Atlantic and Gulf of Mexico; available data on US Atlantic and Gulf of Mexico TSHD projects; and feedback of stakeholders from the dredging industry community. Section 4 discusses the development of the ASTER DST, data gaps and limitations of the tool, and potential improvements for the application. Section 5 includes any research recommendations pertaining to sea turtles and TSHDs, such as directions to fill gaps on knowledge, challenges to be addressed, questions/discussion topics for the technical expert meetings, and general conclusions. Section 6 is the literature cited within the review text. The seventh section contains the appendices: a subject bibliography of all of the literature found and reviewed, sea turtle telemetry datasets and data provider contacts, summaries of the sea turtle research community and dredging industry expert workshops and list of participants, details on the ASTER DST technical architecture, the ASTER DST user manual, and other applicable DSTs.

1.3 Project Goals and Objectives

The overall objectives of this project were to:

1) Compile a bibliography and conduct a review of all available literature pertinent to the history of sea turtle entrainment associated with TSHDs in the US Atlantic and Gulf of Mexico waters, sea turtle telemetry datasets within the region, sea turtle biology and other datasets related to dredging operations, and environmental variables important to sea turtle habitat and distributions
2) Evaluate and document entrainment risk parameters for dredging activities in the US Atlantic and Gulf of Mexico OCS, within the US exclusive economic zone (EEZ; Figure 1)
3) Identify and leverage existing sea turtle telemetry data and document future telemetry needs to better understand the space use conflicts and interaction of sea turtles with TSHD use in the OCS
4) Assess and evaluate the existing mitigation suite currently implemented to reduce entrainment risk and solicit ideas for modifying, removing, and/or adding mitigation measures
5) Solicit from sea turtle research experts input regarding the current state of science with respect to temporal and spatial distribution of sea turtles in the water column, relative to OCS sand resources and TSHD entrainment risk
6) Solicit from dredging industry representatives specific information pertaining to the various parameters that may impact the efficacy of current TSHD operational mitigation measures to reduce the entrainment risk of sea turtles when dredging OCS sand resources
7) Solicit from technical experts specific risk reduction methodologies when dredging OCS areas
8) Identify and prioritize critical parameters to be incorporated in the ASTER DST
9) Develop the ASTER DST, a standardized geographically and temporally based DST for use by multiple practitioners in the Atlantic and Gulf region to assess project-specific dredging entrainment risk within a common framework.

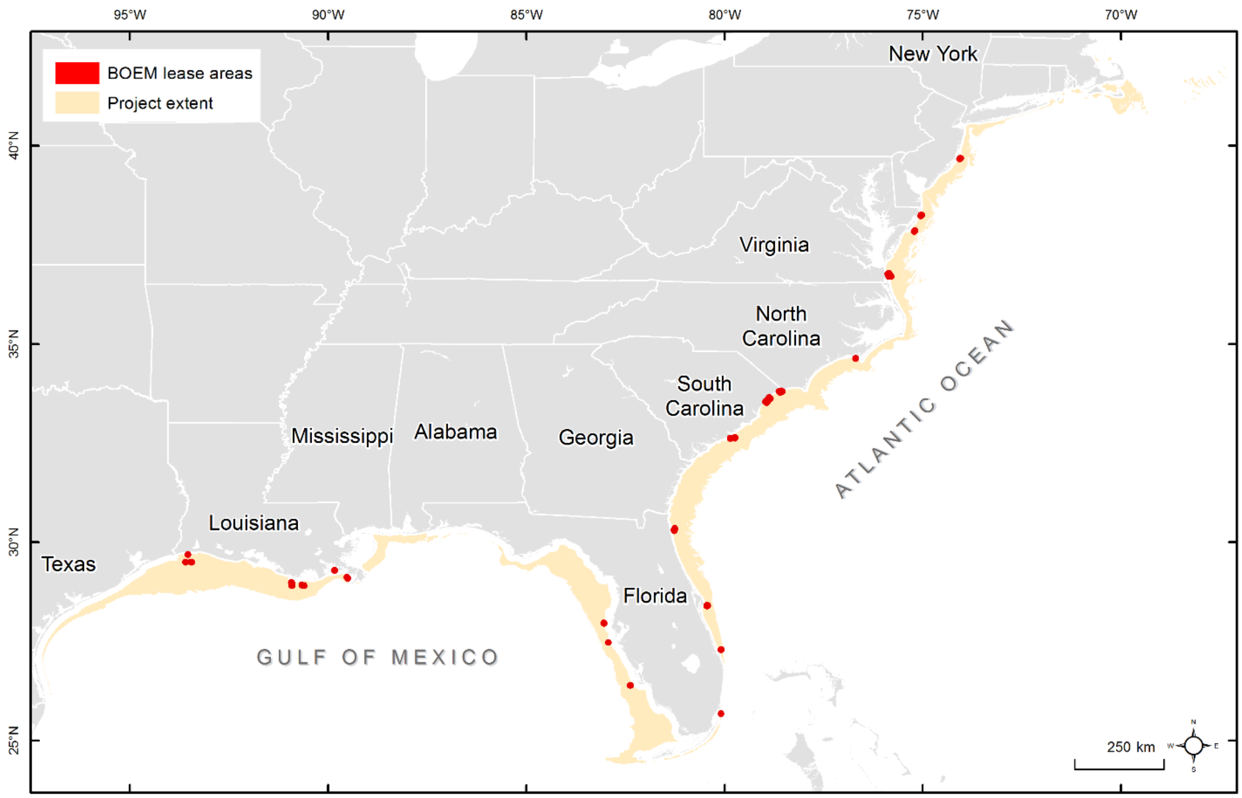

Figure 1. The focus area of the literature review
Beige areas show where hopper dredges may operate in the OCS in association with BOEM lease areas, delineated by using bathymetry data (Amante and Eakins 2009) clipped to cells less than or equal to 90 ft (27 m) deep within Federal waters (US EEZ); land and state borders are from GADM (2015). BOEM lease areas (in red) are magnified on the map to delineate areas on the OCS where negotiated noncompetitive lease or memoranda of agreement (MOA) were, are, or may be in place between the DOI, acting through BOEM, and another Federal agency or a state or local government agency for use of sediment deposits found at or below the surface of the seabed (MMIS 2015).

1.4 Study Methods

This literature and data review synthesized existing information regarding sea turtle entrainment risk associated with TSHDs within the US Atlantic and Gulf of Mexico, up to and including waters less than 90 ft (27 m) deep, where TSHDs primarily operate. The assessment of existing data related to dredging and sea turtle biology as well as a summary of knowledge gaps were presented. This synthesis includes information on:

- Biological and physical risk factors
- Mitigation measures previously considered, currently implemented, and recommended for future consideration
- Historic and current reasonable and prudent measures (RPMs) and associated terms and conditions (T&Cs) identified by NMFS in US ESA Section 7 consultation documents to minimize/avoid the risk of entrainment
- Current TSHD contract specifications implementing RPMs and T&Cs
- Details (e.g., location, borrow area design, physical/biological parameters, and protected species observer reports) of operational circumstances for documented sea turtle takes

An inventory of available datasets (sea turtle telemetry and relevant environmental datasets), related DSTs, and bibliographies were compiled after reviewing existing literature, including peer-reviewed publications, technical reports, US ESA Section 7 consultation documents, conference abstracts, and presentations pertinent to the history of sea turtle entrainment associated with TSHDs in the US Atlantic and Gulf of Mexico waters. With the assistance of several electronic databases subscribed to by Duke University, the primary search engines, tools and services used to search multiple databases for information, up to June 2016, included:

- Google
- Google Scholar
- Web of Science
- WorldCat
- US National Technical Information Service (NTIS)
- Online Computer Library Center (OCLC) ArticleFirst
- BOEM Environmental Studies Program Information System (ESPIS)
- USACE Sea Turtle Data Warehouse/Operations and Dredging Endangered Species System (ODESS)
- National Oceanic and Atmospheric Administration (NOAA) Library and associated web pages,
- seaturtle.org document library
- seaturtle.org satellite tracking and analysis tool (STAT)/WildlifeTracking.org project pages,
- Archie Carr Center for Sea Turtle Research (ACCSTR) at the University of Florida Sea Turtle online bibliography
- Duke University's Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) dataset pages
- United Nations Educational, Scientific and Cultural Organization's (UNESCO's) OBIS,
- Dalhousie University's Ocean Tracking Network Data Portal, NatureServe's Ecosystem-Based Management Tools Database
- US General Services Administration's Data.gov

Reference databases gathered from previous reviews on dredging activities and sea turtle research were also reviewed and literature were included if determined as relevant to this study (e.g., Godley et al. 2008; Stokes 2011; Michel 2013; Michel et al. 2013; Hussey et al. 2015). References were not searched comprehensively after June 2016, but limited numbers of additional relevant references were included when necessary, up until December 2017.

Appendix A includes a bibliography of literature on TSHDs, the history of sea turtle interactions with TSHDs, sea turtle telemetry datasets within the region, sea turtle biology and other datasets related to dredging operations, environmental variables important to sea turtle habitat and distributions, and related DSTs. Over 850 references were compiled into an EndNote database (version X8) and organized into broad subject groups such as "background information" (n = 114), "dredging" (n = 277), "environment" (n = 100), "sea turtle biology" (n = 468), "sea turtle telemetry datasets" (n = 232), and "tools" (n = 28). References were placed in multiple groups, when appropriate. Over 90% of the references had digital copies (e.g., portable document format [PDF]) and these were linked within the EndNote database. The complete EndNote reference library (n = 859 references) is archived in the BOEM MMP and in the Duke University Nicholas School of the Environment Marine Geospatial Ecology Lab.

In addition, databases housing sea turtle telemetry data, environmental datasets, or metadata on other relevant data, were queried for any available datasets within the region, with greater emphasis toward areas less than 90 ft deep where hopper dredges usually operate. Details for a subset of satellite telemetry data and potential environmental/habitat covariates that were relatively accessible/available online were further assessed. DSTs were also searched broadly online and in the literature, with the focus on reviewing marine spatial planning tools applicable to assessing sea turtle entrainment risks in TSHDs. Many tools were evaluated and the ones included in this report were considered to have a high potential of being leveraged in the development of the ASTER DST based on the degree to which a tool could incorporate multiple objectives, be spatially explicit, analyze alternative scenarios, be publicly accessible, and be currently available and supported.

Initial results from this literature and data review identified important issues, data gaps, and associated questions/discussion topics for the technical expert meetings involving the sea turtle research and dredging industry community, which were conducted as a component of this study. All information gathered for the literature and data review served as a working background document that was distributed before the two separate stakeholder meetings. Feedback gathered from those working groups has been incorporated into the development and implementation of the ASTER DST. As the ASTER DST development progressed, data gaps and limitations were uncovered, and potential future work that would improve the tool was identified.

2 US Atlantic and Gulf of Mexico Sea Turtles

2.1 Legal Status and Relative Risk

The protection of all sea turtles globally has been considered a high priority for decades, with much of the research effort directed toward improvements in monitoring and management for population recovery (Hamann et al. 2010). Most global populations of sea turtles are currently decreasing, while the populations of loggerhead and leatherback sea turtles in the US Atlantic were recently found to be increasing (Table 1). However, all sea turtle species still should be considered as conservation-reliant (Tiwari et al. 2013; Ceriani and Meylan 2015), in that self-sustaining wild populations can be maintained with continued successful conservation management (Scott et al. 2005). Species-specific intervention is likely needed on the long-term for increasing sea turtle populations, much like other delisted or reclassified conservation-reliant species (Scott et al. 2010). Because all sea turtles within US waters are currently listed under the US ESA as endangered or threatened and in need of conservation (Table 1), Section 7 of the US ESA requires consultations between NMFS and BOEM for all OCS activities where sea turtles may be affected.

Within the US Atlantic and Gulf of Mexico waters, critical habitat has been designated for the loggerhead (off the southeastern coast and Gulf of Mexico), green (near Puerto Rico), hawksbill (near Puerto Rico), and leatherback (near the US Virgin Islands) sea turtles; these areas were determined essential for the recovery of sea turtle populations (NMFS 1979; 1998; FWS 2014; NMFS 2014a; 2014d). However, overlaps only occur among the current study extent and several areas designated as loggerhead critical habitat, mostly near North Carolina, eastern Florida, and the Gulf of Mexico (Figure 2). Consultations with NMFS are required for Federal activities within designated marine critical habitats and any negative impacts to the physical and biological features within the areas need to be avoided/minimized (NMFS 1979; 1998; 2014a; NMFS and FWS 2016).

Table 1. Conservation status of sea turtle species in the US Atlantic and Gulf of Mexico waters

Species	US ESA Status	IUCN Redlist Status	Population Trend	References
Loggerhead *Caretta caretta*	Endangered	Vulnerable[2]	Decreasing[3]	Casale and Tucker (2015)
Green *Chelonia mydas*	Endangered[1]	Endangered	Decreasing	Seminoff (2004)
Leatherback *Dermochelys coriacea*	Endangered	Vulnerable[2]	Decreasing[3]	NMFS and FWS (2013b); Wallace et al. (2013)
Hawksbill *Eretmochelys imbricata*	Endangered	Critically Endangered	Decreasing	Mortimer and Donnelly (2008); NMFS and FWS (2013a)
Kemp's ridley *Lepidochelys kempii*	Endangered	Critically Endangered		Marine Turtle Specialist Group (1996); NMFS and FWS (2015)

[1]North Atlantic distinct population segment, including breeding green sea turtles in Florida are listed as "Threatened" (Seminoff et al. 2015; NMFS and FWS 2016)
[2]Northwest Atlantic subpopulations are listed as "Least Concern" (Tiwari et al. 2013; Ceriani and Meylan 2015)
[3]Northwest Atlantic subpopulations are increasing (Tiwari et al. 2013; Ceriani and Meylan 2015)

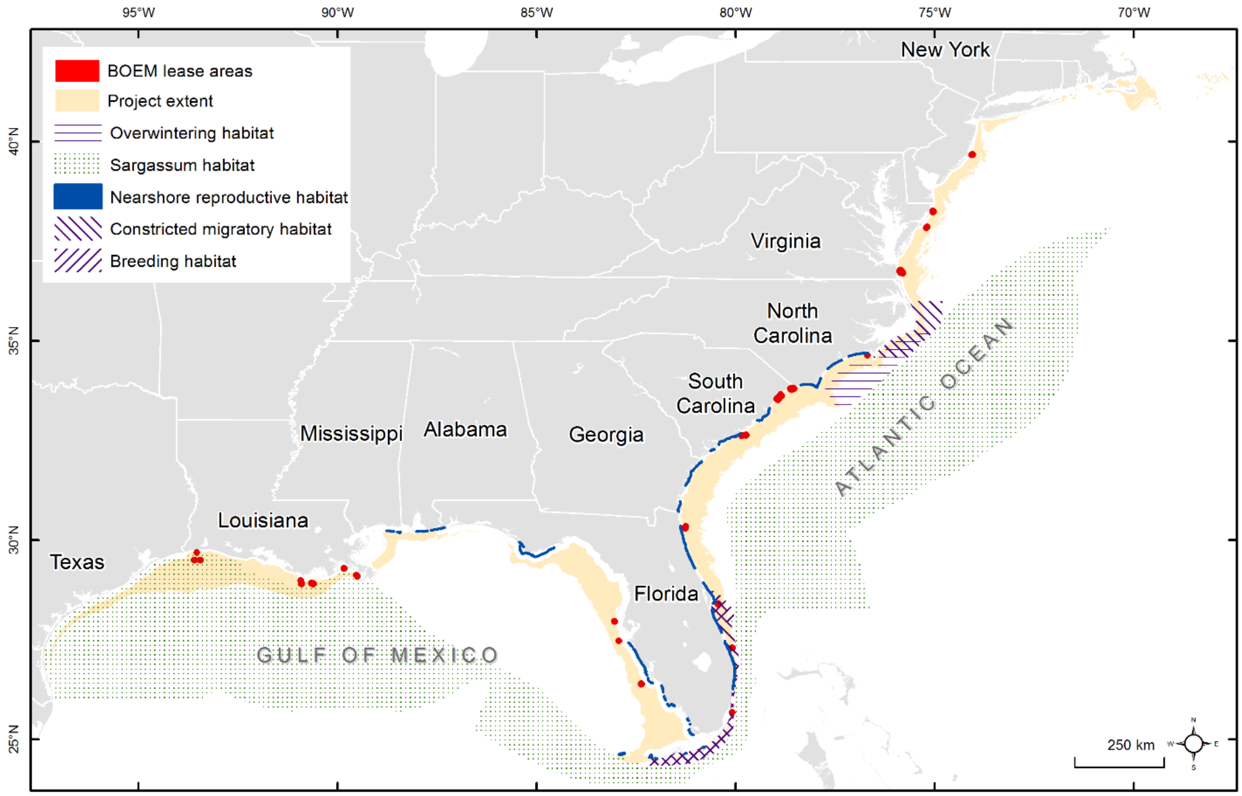

Figure 2. Northwest Atlantic Ocean loggerhead *Caretta caretta* critical habitat and the extent within the Atlantic and Gulf of Mexico OCS where hopper dredges may operate in association with BOEM lease areas
The loggerhead sea turtle critical habitat is shown as designated by NMFS (NMFS 2014d; FWS 2016). Beige areas show where hopper dredges may operate in association with BOEM lease areas, delineated by using bathymetry data (Amante and Eakins 2009) clipped to cells less than or equal to 90 ft (27 m) deep within Federal waters (US EEZ); land and state borders are from GADM (2015). BOEM lease areas (in red) are magnified on the map to delineate areas on the OCS where negotiated noncompetitive lease or MOA were, are, or may be in place between the DOI, acting through BOEM, and another Federal agency or a state or local government agency for use of sediment deposits found at or below the surface of the seabed (MMIS 2015).

Six of the seven world's sea turtle species are generally found within the US Atlantic and Gulf of Mexico EEZ, all of which have the potential of being affected by TSHD activities (Dickerson et al. 2008a; Dickerson et al. 2008d). The loggerhead, green, and Kemp's ridley sea turtles have the greatest risk of being affected by TSHDs based on their general ecology and habitat preferences (Studt 1987; Nelson et al. 1989; Dickerson et al. 1990). Hawksbill and leatherback sea turtles may also be affected by TSHDs, given their presence within coastal waters (Dickerson et al. 2004). Hawksbills can sometimes be found in bays and channels (Meylan et al. 2011) but are less likely to be affected (NMFS 2012d) because they are mostly foraging on reefs and uncolonized hard bottom habitats (Blumenthal et al. 2009) instead of sand bottom habitats commonly dredged to support beach nourishment projects. Mortalities of leatherback and olive ridley *Lepidochelys olivacea* sea turtles by hopper dredge have been documented in other regions of the Atlantic (Goldberg et al. 2015), but these species have historically not been considered at high risk of entrainment in the US Atlantic and Gulf of Mexico (e.g., NMFS 2016). Currently, there have not been any documented leatherback sea turtle entrainments by TSHDs within US waters (D. Piatkowski and D. Dickerson 2016, personal communication). Leatherbacks are present in shallow nearshore waters only during the nesting season (NMFS and FWS 2007) and their mostly pelagic life history and size lowers their risk of entrainment. However, because they still can be found in coastal waters (Schroeder and

Thompson 1987; Thompson and Huang 1993) and have been captured by relocation trawling operations conducted to mitigate entrainment risk during TSHD activities (Dickerson et al. 2007; Dickerson et al. 2008d), leatherback sea turtles will still be included in this review. Similarly, olive ridley sea turtles have not been documented as being affected by TSHD activities in US waters. Unlike the leatherback, though, olive ridleys are rarely in US Atlantic and Gulf of Mexico waters, with their range only overlapping a small portion of the US EEZ south of Florida (Wallace et al. 2010). Therefore, olive ridleys were not considered in this review.

2.2 General Distribution and Habitat Utilization

Loggerhead, green, Kemp's ridley, hawksbill, and leatherback sea turtles found in the US Atlantic and Gulf of Mexico waters are widely distributed within the entire EEZ (Wallace et al. 2010), overlapping with the current project's extent (Figure 1). However, depending on the species, sex, life stage, and migratory cycle phase, sea turtles utilize different nearshore habitats (Bolten 2003). All sea turtle species in the US begin as hatchlings on the beach, during the summer to fall months, shortly before swimming through nearshore waters on their way to pelagic foraging areas farther offshore in oceanic waters more than 200 m deep (Carr 1986; 1987; Bjorndal et al. 2000; Bolten 2003), defined here as the US EEZ beyond 3 nm (5.6 km) from shore for all areas except off of Texas, Puerto Rico, and the west coast of Florida where it is beyond 9 nm (16.7 km) from shore. Juvenile loggerhead, green, Kemp's ridley, and hawksbill sea turtles can return back to nearshore neritic waters to forage in benthic habitats (Lutcavage and Musick 1985; Byles 1988; Snover 2002; Bolten 2003) and either remain until adults or, for some loggerheads, greens, and hawksbills, shuttle between pelagic oceanic and benthic neritic areas for years (Luschi et al. 2003; Hawkes et al. 2006; McClellan and Read 2007; McClellan et al. 2010). On the other hand, male leatherbacks can remain in offshore oceanic waters for the rest of their lives, while nesting adult female leatherbacks only go to nearshore internesting (time between nesting) habitats for a few months before laying clutches on beaches and returning to offshore waters (Bolten 2003). Adult females of all sea turtle species nest onshore (generally from March to October), spending at least a portion of their time transiting through nearshore waters to get to and from beach sites.

Loggerheads are the most abundant sea turtle species in the US Atlantic and Gulf of Mexico, nesting between April and September, at nesting sites ranging from North Carolina to Texas (Mast et al. 2007; Halpin et al. 2009; Kot et al. 2016). During the subadult and adult benthic life stage, loggerheads in the US Atlantic forage in the Mid- and South Atlantic Bights (Schmid 1995; NMFS and FWS 2008; Ceriani et al. 2012), predominantly on benthic prey (Plotkin et al. 1993); in the Gulf of Mexico, they prefer foraging sites with gravel and rock as opposed to mud (Foley et al. 2014). Loggerheads usually migrate seasonally between foraging and breeding grounds with weak migratory connectivity in that they are not tied to specific foraging and/or breeding areas (Ceriani et al. 2012). Subadult and female adult loggerhead turtles have not been found to have consistent diel activity patterns for foraging and resting (Byles 1988; Godley et al. 2003), and may be feeding whenever their benthic, mobile prey are active, over 24 hours in a day. However, some have found that female adult loggerheads seem to be resting more at night and actively foraging during the day (Renaud and Carpenter 1994; Godley et al. 2003).

Juvenile, subadult, and adult green sea turtles also forage in nearshore habitats (Epperly et al. 1995; Schmid 1995; Meylan et al. 2011) and some select habitat near deep channels (Shaver 1994; Hart et al. 2013; Lamont et al. 2015), shallow areas outside channels (Dickerson et al. 1995b), or tidal creeks and marshes (McClellan and Read 2009). Green turtles graze on seagrass beds mostly during the day (Renaud et al. 1995) starting at about two hours after dawn and peaking in activity at mid-morning and mid-afternoon (Bjorndal 1980; Ogden et al. 1983). Green sea turtles have been found to rest on bare sand and rock bottoms at night and during the day when not actively feeding (Bjorndal 1980), with juveniles sometimes spending more time resting than feeding (Lamont et al. 2015). However, Hochscheid et al.

(1999) found adult females in the Mediterranean to be traveling and foraging more than resting during internesting periods. Like loggerheads, green sea turtles can migrate to various areas during internesting and foraging periods, sometimes with strong site fidelity exhibited by juveniles (Mendonça 1983; McClellan and Read 2009), though the locations of these habitats still are largely unknown in some regions (Hart et al. 2013). Hays et al. (1999) have found that female adult green turtles near the Ascension Islands during internesting periods were submerged for longer periods of time and were considered as taking more time for resting when compared to activity during post-nesting migrations. Green sea turtles mainly nest in Florida from June through September, but some have been found in Texas and Georgia (Halpin et al. 2009; Mast et al. 2011; Kot et al. 2016).

Kemp's ridley sea turtles are the only species in the US Atlantic that nest in "arribadas" or large groups at the same time during daylight hours around April to August, with major nesting sites near Rancho Nuevo, Tamaulipas, Mexico (Mendonça and Pritchard 1986), Veracruz, Mexico (Dow et al. 2007; Mast et al. 2010) and Padre Island, Texas, US (Shaver 2005; Halpin et al. 2009; Kot et al. 2016). Post-nesting adult Kemp's ridley sea turtles have been found to utilize nearshore migratory corridors from late-May to August, with a mean water depth of 26 m (Shaver et al. 2016), on their way to offshore areas within the Northern Gulf of Mexico and Atlantic during internesting and foraging periods (Mendonça and Pritchard 1986; Renaud et al. 1996; Seney and Landry 2011; Shaver et al. 2013). Immature Kemp's ridleys frequented similar areas as adults, including inshore foraging areas such as bays, coastal lagoons, and river mouths in the Gulf of Mexico and northwestern Atlantic (FWS and NMFS 1992; Seney and Landry 2008; 2011). Kemp's ridley sea turtles may also utilize important habitats in shallow areas outside dredged channels (Dickerson et al. 1995b). Juvenile, subadults, and adults forage opportunistically, mostly on benthic crabs (Ogren 1989; Shaver 1991; Burke et al. 1994; Schmid 1998) and other benthic invertebrates from live bottom, flat sand/mud habitats (Witzell and Schmid 2005; Servis et al. 2015). Within nearshore waters of the southeastern US and Gulf of Mexico waters, Kemp's ridleys spend a significant portion of the day and night submerged (Mendonça and Pritchard 1986; Renaud 1995). Subadult and post-nesting female Kemp's ridley sea turtles have not shown consistent diel patterns of activity (Byles 1988; 1989), though Gitschlag (1996) and Morreale and Standora (1989) found juveniles in the US Atlantic to spend more time submerged at night.

In US waters, hawksbill sea turtles nesting occurs around April to November only include southeastern Florida, Puerto Rico, and the US Virgin Islands (NPS 2006; Bolten 2008; Brost 2008; Mast et al. 2008; Kot et al. 2016). However, hawksbills are still widely distributed within the US Atlantic and Gulf of Mexico waters (Witzell 1983; NMFS and FWS 1993). Hawksbill sea turtle hatchlings can migrate to offshore oceanic foraging grounds that are still unknown and are most likely convergence zones or weedlines in the Atlantic Ocean where pelagic prey are abundant (Witzell 1983; Carr 1986; NMFS and FWS 1993). After juveniles, subadults, and adults return to the US Atlantic and Gulf of Mexico nearshore coastal waters, they often utilize hard bottom habitats or coral reefs (NMFS and FWS 1993); some populations can take up year-round residence near nesting beaches (Witzell 1983) or migrate long distances back to foraging grounds (Meylan 1999). Hawksbills also have been shown to have relatively high foraging site fidelity (van Dam and Diez 1998; Blumenthal et al. 2009). In the Caribbean, hawksbills feed primarily on sponges in coral reefs (Meylan 1988; Vicente 1994), and subadults were found to have consistent diel activity patterns (van Dam and Diez 1998).

Leatherbacks forage on pelagic prey (Witt et al. 2007) and are not as limited by temperature or bathymetry, lending to a wider species range and longer migration distances compared to the other sea turtle species (Luschi et al. 2003; Hays and Scott 2013). Most of the anthropogenic threats leatherbacks encounter throughout their life are in oceanic pelagic waters, like fisheries (Fossette et al. 2014), except for nesting females who need to return to nearshore waters on their way to lay eggs on the beach. Leatherbacks in coastal waters are relatively rare compared to other sea turtle species, and during aerial surveys in southeastern US, they have been observed during the spring and summer primarily on the midshelf (Schroeder and Thompson 1987; Murphy et al. 2006). In the US, leatherback nesting usually occurs from April to July, and nesting sites in the US are located mostly in coastal Florida, though some have been found in Texas, Georgia, South Carolina, North Carolina, and Maryland (Rabon et al. 2003; Mast et al. 2006; 2007; Halpin et al. 2009; Kot et al. 2016). Many leatherbacks migrate to the North Atlantic foraging grounds in the summer (James et al. 2006a; Murphy et al. 2006), though some still utilize the waters off of Virginia (Musick 1988) before returning back to sub-tropical and tropical waters in the winter (Fossette et al. 2010; Saba 2013).

2.3 General Nearshore Behavior

As mentioned previously, all hatchling sea turtles traverse the nearshore waters from land-based nests, but usually it is not until the juvenile to adult stage of a sea turtle's life that they spend more time foraging or resting in bottom nearshore waters of the US Atlantic and Gulf of Mexico. Other than the leatherback, juvenile and adult sea turtles are frequently sighted in waters less than 100 m deep (Fritts et al. 1983). However, calculating abundances and densities are difficult because sea turtles spend much of their time underwater and can go undetected, and information on sea turtle surface times that can help account for this in estimates are lacking. For what is known of their benthic habitat utilization and surfacing times, sea turtles seem to be most vulnerable to activities that are destructive to the benthic habitat when they are resting, foraging, mating, and migrating, in descending order.

Migration, or consistent and directed movements, occurs seasonally when sea turtles move between waters used primarily for foraging and nearby nesting sites used for reproduction. Loggerhead sea turtles, and probably other sea turtle species that forage on benthic prey, spend relatively more time near the surface when migrating than when they are at resident foraging sites (Foley et al. 2013). Although the majority of the time is still spent underwater, observations have been made of more surface activity during the day (Foley et al. 2013). At night, sea turtles are likely to be utilizing the waters below the surface (10 to 35 m deep) and benthic habitats mainly for resting and less for foraging (Foley et al. 2013).

Like migration, mating sea turtles in the nearshore waters are active, though they may spend more time "resting" on the bottom than when migrating. Mating, specifically courtship and copulation, generally occurs at the sea surface and on the seabed a few weeks before females nest onshore (Schofield et al. 2006). Although aggregations of mating sea turtles are known to occur, limited information can be found on their behaviors and the anthropogenic threats directly impacting them. Nonetheless, the awareness of important areas and times of mating sea turtle can help determine best practices for minimizing interactions with nearshore projects.

When they have been shown to exist, diel patterns can elucidate more details on sea turtle needs during active foraging and resting times. The literature reports that some, but not all species and age classes have consistent diel patterns of foraging and resting times (e.g., Bjorndal 1980; Mendonça 1983; Byles 1988; 1989; van Dam and Diez 1998; Schmid et al. 2002), so general conclusions cannot be made across all sea turtles. General behaviors are also difficult to ascertain given the variation and typically small sample sizes used to investigate sea turtle behavior. Although data on the times when sea turtles consistently rest at the bottom of the water column may appear to be useful for determining TSHD entrainment risk on a diurnal scale, rather than a seasonal scale (e.g., Bjorndal 1980; Mendonça and Pritchard 1986; Standora et al. 1993; Lamont et al. 2015), past observations for the timing of sea turtle entrainment events have not shown significant patterns (D. Dickerson 2017, personal communication).

Leatherback sea turtles have shown variable diel diving patterns, depending on the availability of prey resources in the region and whether or not they are foraging or migrating from foraging areas (James et al. 2006b). For the benthic sea turtles, foraging sites and times also depend greatly on benthic prey, which may be influenced by environmental factors. Eberle (1994) found that juvenile and male adult loggerhead sea turtle diving behavior (i.e., time spent at the surface and the number of surfacings) and position in the water column may be related to abiotic factors, such as water depth, cloud cover, time of day, light intensity, and temperature. These and any other related environmental factors influencing sea turtle fine-scale movements are critical for creating a model that predicts the best time to avoid sea turtle interactions when they are on the bottom and more likely to encounter TSHD dragheads in operation.

On the other hand, resting times for sea turtles may not be as strongly affected by the same abiotic factors influencing foraging (Eberle 1994). Resting dives can be relatively deep and occur most commonly at night, when sea turtles are inactive, passively motionless in the water column, but near the bottom (Foley et al. 2013). Types of benthic habitats may be critical for predicting resting places. For example, at night, juvenile hawksbill and green sea turtles have been observed to rest under and/or between hard structures, such as coral or artificial reefs; resting on the seabed/coral reef structure was more frequent during the day (Blumenthal et al. 2009; Stimmelmayr et al. 2010). Although resting sea turtles can be caught in trawls, they have also been shown to avoid trawlers (Standora et al. 1993; USACE WES 1997), giving rise to the possibility that they may be able to avoid other equipment, such as TSHDs, when approached. Due to the greater possibility of sublethal (stress) and lethal affects from threats during nighttime resting periods, it has been suggested that threatening activities (e.g., hopper dredging) be limited to the day when the sea turtles can more actively avoid dragheads (Richardson 1990). However, more recent research has shown that it is not feasible to use diel behavior as a basis for restrictions on hopper dredging operations (D. Dickerson 2017, personal communication).

Lowered water temperatures in the nearshore can affect sea turtle behavior both within the water column and within a region. When temperatures decrease to around 15 degrees C, sea turtles can migrate to warmer waters or overwinter by burrowing into the sediment, becoming muddied and dormant (Carr and Caldwell 1956; Carr et al. 1980; Ogren and McVea 1982). If sea turtles are unable to migrate to warmer waters, either latitudinally or to greater depths with suitable habitats, cold-stunning and other sublethal effects will occur (Ogren and McVea 1982). In the presence of lowered water temperatures, sea turtles may be at higher risk of being injured or killed by TSHDs and other threats such as trawling and vessel strikes, because they usually utilize the benthic habitat and lack the energy and speed to avoid danger (Carr et al. 1980). Loggerheads, greens, and Kemp's ridleys found at the entrance of Canaveral channel in the eastern coast of Florida were thought to "hibernate" in the channel walls, due to their torpid and muddy condition (Carr et al. 1980; Joyce 1982; Nelson et al. 1989). While hibernation may occur for select sea turtle populations and regions, the more usual wintering strategy is to move and/or migrate to areas with more suitable temperatures (Broderick et al. 2007; Hochscheid et al. 2007). For areas that have year-round sea turtle residents or long seasons of sea turtle presence, like Canaveral channel (Witzell 1987), determining appropriate windows for dredging and other activities affecting sea turtle benthic habitats will be highly dependent on overwintering cycles. Knowledge on where other popular overwintering areas are located and where multiple sea turtles go into winter dormancy during seasonally low temperatures would be essential for determining relative risk across regions. In the Mid-Atlantic and New England waters, it is not yet known if sea turtles hibernate/brumate (NMFS 2012a).

Lethal temperatures for sea turtles can be around 8 degrees C or below (Ogren and McVea 1982), but sublethal effects for low temperatures during overwintering (between 8 and 15 degrees C) can include immobilization, lethargy, lowered feeding rates, and starvation (Schwartz 1978; Spotila et al. 1997; Milton and Lutz 2003). Turtles become "cold-stunned," or torpid and floating at the surface (Schwartz 1978), which may make them at greater risk to any activities at the surface or throughout the water column, such as fishing gear, vessel strikes, or TSHD operations with pumps engaged while dragheads are off the bottom. There have also been rare incidents suggesting that cold-stunned turtles may be taken by cutterhead dredges while they are lethargic or dying and unable to move away from the cutterhead (D. Dickerson and D. Piatkowski, 2017, personal communication). In addition, if the temperature range within a region can be determined for the initiation of overwintering behavior, the effectiveness of certain mitigation measures can be predicted and warrant the use of alternative practices.

On the other hand, warmer temperatures have long been known to positively affect sea turtle distribution (Hawkes et al. 2007). Because high nearshore abundances can be related to higher temperatures, rates of sea turtle takes by TSHDs and trawl fisheries have been found to increase when waters were warmer than usual for the winter season (NMFS 1997). When water temperatures were up to 15.5 degrees C in Kings Bay, Georgia during early March, higher rates of entrainment from dredging of the same navigation channel prompted Federal agencies to reconsider mitigation measures (NMFS 1997). If possible, seasonal predictions for temperature and other related environmental parameters could be used to guide decisions on the potential for interacting with sea turtles.

General information on residency times and strength of fidelity to certain sites can help determine the relative importance of areas (i.e., critical habitats) and shape management decisions. Residential sea turtle populations in nearshore waters, such as those off of Florida (Hart et al. 2015), can be particularly vulnerable to any long-term activities within their habitat and measures for mitigation can be difficult. For example, since 1992, resident sea turtles in Canaveral Harbor, Florida have prevented maintenance dredging by TSHDs except for emergencies (Dickerson et al. 2004). The use of relocation trawling to move sea turtles can be unsuccessful if there is high site fidelity and a short distance between capture and release because sea turtles can quickly return to the area (Magnuson et al. 1990). Fine-scaled information particularly for resident populations is necessary to investigate marine spatial planning options to help avoid negative interactions with sea turtles during year-round activities.

Hamann et al. (2010) acknowledged that many information gaps on the distribution and behavior of sea turtles in offshore waters remain and stated that the biogeography of sea turtles is a research priority for the future. Although sea turtle behavior while migrating, breeding, foraging, or resting can vary greatly, any information on general behaviors for certain sea turtle species, age classes, and seasons can facilitate decisions for appropriate conservation measures. Given that these nearshore areas can have many competing anthropogenic uses, all available information can be collated to help guide better management decisions. Specifically, sea turtles utilizing the nearshore benthic habitat are especially vulnerable to entrainment by TSHDs. Overlaying areas that have sand/gravel resources to be extracted by TSHDs with sites that sea turtles are known to frequent for specific stages, along with all of the available information gathered about their behavior during those stages, can be useful within the ASTER DST and for other DSTs guiding management decisions.

2.4 Telemetry Datasets

Information on sea turtle presence within an area can be collected in different ways, including the use of stranding events and sea turtle nesting events (for presence on land and nearshore), fishery bycatch observations and records, dedicated and opportunistic surveys, and telemetry. Of the types of data listed, telemetry data are generally higher in quality because of the relatively fine-scale information linked to individual animals. Telemetry data can show animal movements at a high spatiotemporal resolution, which are especially difficult to collect in the marine environment for highly migratory species, such as sea turtles. Sea turtle telemetry data can be received via radio (very high frequency [VHF]), sonar (passively or actively listening to hydrophones from acoustic transmitters), and satellite (Eckert 1999).

The numbers of sea turtle satellite telemetry datasets have been growing over the last few decades (Godley et al. 2008). The relatively high accuracy of the data can help to determine where and when sea turtles are present and where and when they migrate over long distances. Two highly popular satellite telemetry databases within the sea turtle research community are the seaturtle.org STAT (http://www.seaturtle.org/stat; Coyne and Godley 2005) and the Duke University OBIS-SEAMAP (http://seamap.env.duke.edu; Halpin et al. 2006; Halpin et al. 2009). Sea turtle researchers voluntarily contribute their data to these databases, mainly for mapping and visualization, and they also benefit from the ability to use free spatial analyses tools such as associating sea turtle location data with potential environmental correlates and an accessible data archive system that can be shared among colleagues and the public. In addition, data uploaded to STAT can be transferred to OBIS-SEAMAP to maximize user benefits (Figure 3).

Both of these databases and any other research datasets that have satellite telemetry data could be leveraged for marine spatial planning projects concerned with sea turtle interactions, such as the ASTER DST. Both databases include telemetry data collected from over 1,000 tagged sea turtles in over 100 projects within the US Atlantic and Gulf of Mexico (Appendix B). In addition, males and females across different age classes have been tagged for loggerheads, greens, leatherbacks, hawksbills, and Kemp's ridleys (Tables 2 and 3). More sea turtle telemetry data continues to be collected globally and within the US Atlantic and Gulf of Mexico, with subsets that are unpublished, published, and/or uploaded to STAT and OBIS-SEAMAP.

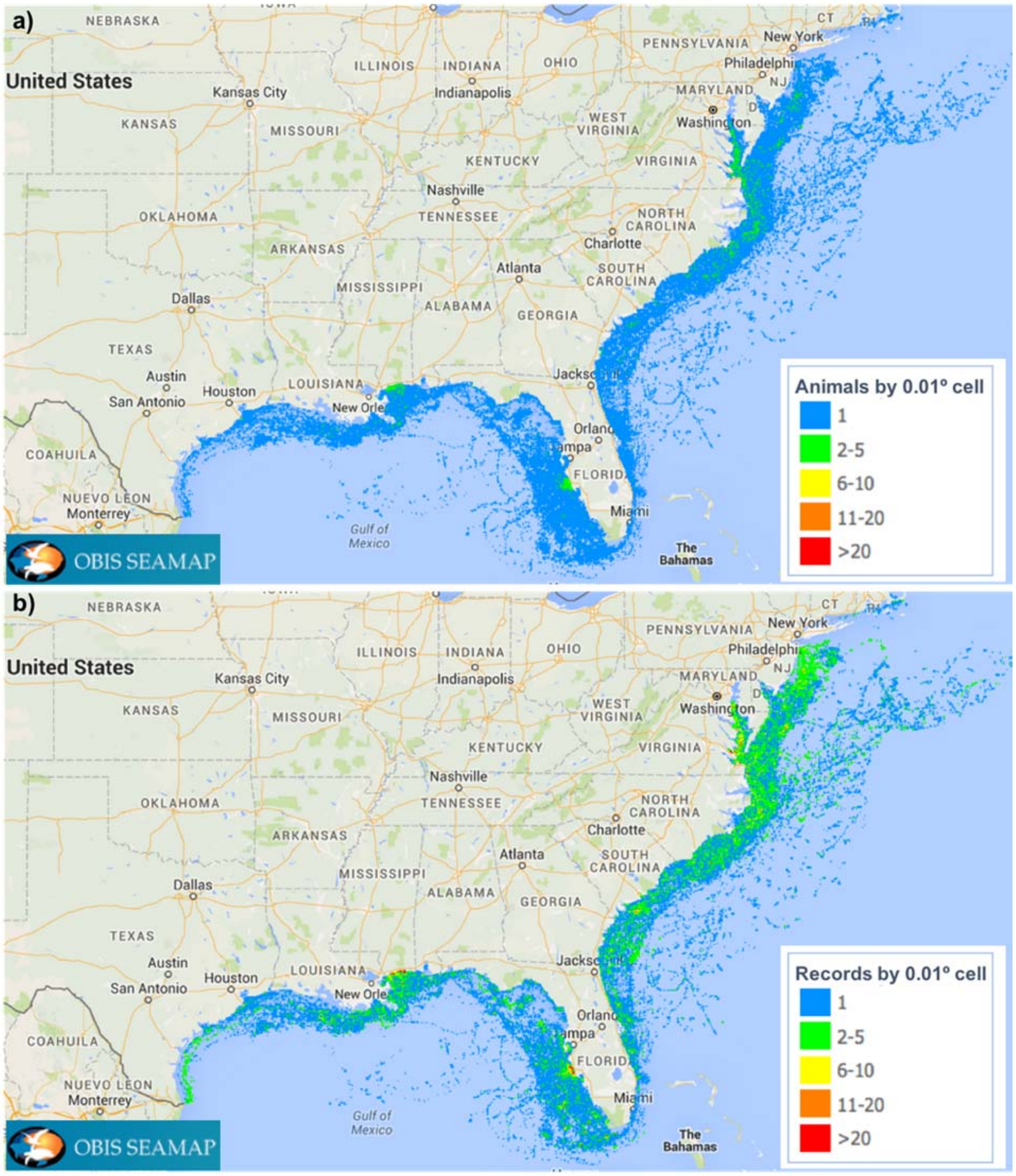

Figure 3. Summarized loggerhead, green, and Kemp's ridley sea turtle telemetry datasets
Data were contributed to the OBIS-SEAMAP and publicly viewable, by a) number of animals, and by b) number of records within a 0.01 degree cell within the US Atlantic and Gulf of Mexico EEZ. A subset of the data has been contributed to the OBIS-SEAMAP, through seaturtle.org/STAT. Map data summary: 44 datasets, 213,262 records, 503 animals, 22 contributors, accessed April 27, 2016 (Coyne and Godley 2005; Halpin et al. 2009).

Table 2. Summary of sea turtle satellite telemetry data within the US Atlantic and Gulf of Mexico waters, by species, sex, and age class

			Male			Female			Unknown			
Species	**Datasets**	**Animals**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
Loggerhead *Caretta caretta*	71	876	53	5	8	416	19	52	2	86	207	28
Green *Chelonia mydas*	28	187	16	2	-	88	3	3	-	7	65	3
Leatherback *Dermochelys coriacea*	2	10	3	-	-	4	-	-	-	3	-	-
Hawksbill *Eretmochelys imbricata*	1	7	1	-	-	6	-	-	-	-	-	-
Kemp's ridley *Lepidochelys kempii*	57	390	6	1	-	182	2	1	2	54	139	3
Total	126	1,470	79	8	8	696	24	56	4	150	411	34

Source: Publicly available online data through two major databases: Duke University's OBIS-SEAMAP (Halpin et al. 2006; Halpin et al. 2009) and seaturtle.org's STAT (Coyne and Godley 2005). Data were accessed between February and March 2016. Blanks = no data. Total number of datasets is less than the sum of all datasets because some datasets included more than one species. Age classes: A = adult, S = subadult, J = juvenile, U = unknown age class. For more information on numbers for individual datasets, see Table 3.

Table 3. List of sea turtle satellite telemetry datasets by species, sex, and age class within the US Atlantic and Gulf of Mexico waters

Source: Publicly available online data through two major databases: Duke University's OBIS-SEAMAP (Halpin et al. 2006; Halpin et al. 2009) and seaturtle.org's STAT (Coyne and Godley 2005). Data were accessed between February and March 2016. Age classes: A = adult, S = subadult, J = juvenile, U = unknown age class. Hyphen (-) = no data. *only one sea turtle out of the whole dataset was found in US waters; **a subset of sea turtles were found in US waters, but all were summarized here; ***originally recorded as "immature turtles." For more information on datasets by ID, see Appendix B.

		Male			Female			Unknown			
Dataset ID	**Total**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
Loggerhead Caretta caretta											
4	27	-	-	-	-	-	-	-	-	22	5
6	1	-	-	-	-	-	-	-	-	1	-
7	1	-	-	-	-	-	-	-	-	1	-
10	3	-	-	-	2	-	-	-	-	1	-
12	5	-	-	-	5	-	-	-	-	-	-
13	1	-	1	-	-	-	-	-	-	-	-
14	12	-	-	-	11	-	-	1	-	-	-
15	12	-	-	-	12			-			-
16	30	-	1	-	2	11	5	-	8	3	-
17	5	-	-	-	-	1	1	-	2	1	-
18	4	-	-	-	-	1	-	-	2	1	-
23	2	-	-	-	-	-	-	-	-	2	-
26	3	-	-	-	-	-	1	-	-	2	-
28	5	1	-	-	2	-	-	-	1	1	-
30	2	-	-	-	-	-	-	-	-	2	-
32	4	-	-	-	4	-	-	-	-	-	-
33	6	-	-	-	6	-	-	-	-	-	-
34	8	-	-	-	8	-	-	-	-	-	-
35	1	-	-	1	-	-	-	-	-	-	-
36	4	-	-	-	4	-	-	-	-	-	-
37	4	-	-	-	4	-	-	-	-	-	-
38	4	-	-	-	4	-	-	-	-	-	-
39	1	-	-	-	-	-	-	-	-	1	-
40	13	-	-	-	13	-	-	-	-	-	-
41	16	-	-	-	16	-	-	-	-	-	-
42	22	-	-	-	22	-	-	-	-	-	-
43	24	-	-	-	24	-	-	-	-	-	-
44	12	-	-	-	12	-	-	-	-	-	-
46	6	5	-	-	1	-	-	-	-	-	-
***48**	1	-	-	-	-	-	-	-	-	1	-
49	24	-	-	-	-	-	-	-	-	24	-
50	38	-	-	-	38	-	-	-	-	-	-

		Male			Female			Unknown			
Dataset ID	**Total**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
51	23	9	-	-	3	2	-	-	9	-	-
53	58	-	-	-	-	-	-	-	28	30	-
54	20	2	-	-	10	-	-	1	7	-	-
***55**	1	-	-	-	-	-	-	-	-	1	-
56	1	-	-	-	-	-	-	-	-	1	-
57	1	-	-	-	-	-	-	-	-	1	-
59	2	-	-	-	-	-	-	-	-	2	-
60	2	-	-	-	-	-	-	-	-	2	-
61	3	-	-	-	-	-	-	-	-	3	-
66	6	-	-	1	-	-	-	-	-	5	-
67	4	-	-	-	1	-	-	-	-	3	-
68	2	-	-	-	-	-	-	-	-	2	-
69	2	-	-	-	-	-	-	-	-	2	-
70	33	-	-	-	-	-	-	-	-	33	-
71	2	-	-	-	-	-	-	-	-	2	-
****92**	2	-	-	-	2	-	-	-	-	-	-
93	2	-	1	-	-	1	-	-	-	-	-
94	8	-	-	-	8	-	-	-	-	-	-
95	4	2	-	-	-	-	1	-	1	-	-
96	29	29	-	-	-	-	-	-	-	-	-
97	19	-	-	-	19	-	-	-	-	-	-
98	36	-	-	6	-	-	27	-	-	3	-
106	4	-	-	-	-	-	-	-	4	-	-
109	1	1	-	-	-	-	-	-	-	-	-
110	1	-	-	-	-	-	-	-	1	-	-
112	17	-	-	-	-	-	17	-	-	-	-
***114**	1	-	-	-	1	-	-	-	-	-	-
115	3	-	-	-	-	-	-	-	1	2	-
116	71	2	-	-	65	3	-	-	-	1	-
117	7	-	-	-	7	-	-	-	-	-	-
109	45	-	-	-	45	-	-	-	-	-	-
119	23	-	-	-	22	-	-	-	1	-	-
120	19	-	-	-	-	-	-	-	-	19	-
121	23	-	-	-	-	-	-	-	-	4	19
122	19	-	-	-	2	-	-	-	13	-	4
123	31	1	2	-	-	-	-	-	2	26	-
124	9	1	-	-	-	-	-	-	6	2	-
Green *Chelonia mydas*											
1	3	-	-	-	3	-	-	-	-	-	-
2	39	-	-	-	39	-	-	-	-	-	-
4	14	-	-	-	-	-	-	-	-	14	-

		Male			Female			Unknown			
Dataset ID	**Total**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
5	3	-	-	-	-	-	2	-	-	1	-
8	4	-	-	-	-	-	-	-	-	4	-
9	3	-	-	-	-	-	-	-	-	3	-
10	4	-	-	-	-	-	-	-	-	4	-
16	3	-	-	-	-	-	1	-	1	1	-
23	2	-	-	-	-	-	-	-	-	2	-
***31**	1	-	-	-		-	-	-	1	-	-
41	1	-	-	-	1	-	-	-	-	-	-
42	1	-	-	-	1	-	-	-	-	-	-
46	2	-	-	-	-	-	-	-	-	2	-
52	4	-	-	-	-	-	-	-	-	4	-
58	1	-	-	-	-	-	-	-	-	1	-
62	1	-	-	-	-	-	-	-	-	1	-
63	2	-	-	-	-	-	-	-	-	2	-
64	2	-	-	-	-	-	-	-	-	2	-
65	6	-	-	-	-	-	-	-	-	6	-
71	3	-	-	-	-	-	-	-	-	3	-
72	3	-	-	-	-	-	-	-	-	-	3
74	1	-	-	-	1	-	-	-	-	-	-
****92**	16	-	-	-	13	-	-	-	1	2	-
100	15	-	-	-	-	-	-	-	4	11	-
111	6	6	-	-	-	-	-	-	-	-	-
115	1	-	-	-	-	-	-	-	-	1	-
116	45	10	2	-	29	3	-	-	-	1	-
123	1	-	-	-	1	-	-	-	-	-	-
Leatherback *Dermochelys coriacea*											
109	7	2	-	-	4	-	-	-	1	-	-
113	3	1	-	-	-	-	-	-	2	-	-
Hawksbill *Eretmochelys imbricata*											
****92**	7	1	-	-	6	-	-	-	-	-	-
Kemp's ridley *Lepidochelys kempii*											
*****3**	7	-	-	-	-	-	-	-	-	7	-
10	1	-	-	-	-	-	-	-	-	1	-
11	10	-	-	-	-	-	-	-	-	10	-
18	1	-	-	-	-	-	-	-	-	1	-
19	6	-	-	-	-	-	-	-	1	5	-
20	5	-	1	-	-	-	-	-	-	4	-
21	7	-	-	-	1	-	-	-	2	4	-
22	5	-	-	-	-	-	-	-	-	5	-
23	14	-	-	-	-	-	-	-	4	10	-
24	15	-	-	-	-	-	-	-	4	11	-

		Male			Female			Unknown			
Dataset ID	**Total**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
25	7	-	-	-	-	-	-	-	2	5	-
29	1	-	-	-	1	-	-	-	-		-
45	21	-	-	-	2	-	-	1	13	5	-
46	3	-	-	-	-	-	-	-	2	1	-
47	1	-	-	-	-	-	-	-	-	1	-
52	1	-	-	-	-	-	-	-	-	1	-
54	26	-	-	-	-	-	-	1	21	4	-
56	1	-	-	-	-	-	-	-	-	1	-
57	4	-	-	-	-	-	-	-	-	4	-
58	1	-	-	-	-	-	-	-	-	1	-
59	2	-	-	-	-	-	-	-	-	2	-
62	1	-	-	-	-	-	-	-	-	1	-
63	4	-	-	-	-	-	1	-	-	3	-
64	1	-	-	-	-	-	-	-	-	1	-
65	1	-	-	-	-	-	-	-	-	1	-
73	1	-	-	-	-	-	-	-	1	-	-
75	4	-	-	-	4	-	-	-	-	-	-
76	4	1	-	-	3	-	-	-	-	-	-
77	5	-	-	-	5	-	-	-	-	-	-
78	4	1	-	-	3	-	-	-	-	-	-
79	6	-	-	-	6	-	-	-	-	-	-
80	10	-	-	-	10	-	-	-	-	-	-
81	10	-	-	-	10	-	-	-	-	-	-
82	10	-	-	-	10	-	-	-	-	-	-
83	10	-	-	-	10	-	-	-	-	-	-
84	11	-	-	-	11	-	-	-	-	-	-
85	3	3	-	-		-	-	-	-	-	-
86	10	-	-	-	10	-	-	-	-	-	-
87	10	-	-	-	10	-	-	-	-	-	-
88	15	-	-	-	14	1	-	-	-	-	-
89	10	-	-	-	10	-	-	-	-	-	-
90	10	-	-	-	10	-	-	-	-	-	-
91	13	-	-	-	13	-	-	-	-	-	-
94	1	-	-	-		-	-	-	-	1	-
99	22	-	-	-	7	-	-	-	-	15	-
101	3	-	-	-	3	-	-	-	-	-	-
102	7	-	-	-	7	-	-	-	-	-	-
103	11	1	-	-	5	-	-	-	-	5	-
104	17	-	-	-	7	-	-	-	1	9	-
105	13	-	-	-	4	-	-	-	1	8	-
107	4	-	-	-	4	-	-	-	-	-	-

		Male			Female			Unknown			
Dataset ID	**Total**	**A**	**S**	**J**	**A**	**S**	**J**	**A**	**S**	**J**	**U**
108	1	-	-	-	1	-	-	-	-	-	-
115	3	-	-	-		-	-	-	-	3	-
116	4	-	-	-	1	1	-	-	2	-	-
121	8	-	-	-	-	-	-	-	-	5	3
123	3	-	-	-	-	-	-	-	-	3	-
124	1	-	-	-	-	-	-	-	-	1	-

2.5 Other Sea Turtle Datasets

Other datasets discussed in the previous section that are generally of lower resolution (e.g., observations from strandings, nesting, bycatch, or surveys) can be useful for understanding sea turtle presence and distribution when gaps remain and these data are determined as the best available source. Many of these datasets can have major caveats, such as being heavily dependent on data collection effort. On the other hand, sea turtle data can also be collected on an even higher resolution and give more fine-scaled information than satellite telemetry data alone, such as data on behaviors within the water column and benthic environment for each species, sex, and age class. These data may be available in relatively small, select regions, but they could inform managers on how sea turtles spatially and temporally utilize habitats. Recent studies have found that telemetry data can be used to identify behavior (e.g., migration vs. foraging vs. overwintering) when incorporating vertical movement metrics (Patel et al. 2015). Much like the horizontal movements, vertical movements and behavior within the water column can vary for sea turtle species, sex, age class, life history cycle, and environmental factors. In addition, studies have shown that the individuals and time spent in the water column at one site compared to migrating to other sites (residents vs. visitors) can vary by population (Hart et al. 2015). Information on how all of the sea turtles (and other endangered species) that are usually present in a specific offshore sand resource borrow area are utilizing the habitats spatially (vertically and horizontally) would be ideal for assessing entrainment risk within the ASTER DST.

Currently, BOEM is collaborating with the US Geological Survey (USGS) to deploy satellite tags with dive and acceleration data loggers on sea turtles caught by relocation trawls during dredging at a current offshore sand resource borrow site in the northern Gulf of Mexico. The project plans to collect data from subadult, juvenile, and adult sea turtles, including information on the location, time/date, temperature, activity and dive periods, as well as other biological information (e.g., sampled skin, blood, and gut content) to analyze habitat hotspots, site fidelity, large- and fine-scale migratory and foraging movements, and assess population abundance, distribution, and structure (K. Hart 2016, personal communication; Piatkowski and Culbertson 2016). BOEM is also collaborating with the US Navy and the Kennedy Space Center to collect sea turtle behavior data at Canaveral Shoals, Florida. Satellite and acoustic transmitters (n = 25) have been attached to adult nesting green (n = 11) and loggerhead sea turtles (n = 14) to track their internesting movements, behaviors, and habitat use characteristics within the vicinity of a frequently dredged OCS sand resource borrow area at Canaveral Shoals (D. Piatkowski 2017, personal communication). These and other related data on discerning behavior patterns, like dive profiles and swimming speeds, especially at current or potential sediment borrow sites, can be integrated into the ASTER DST to further the understanding of how sea turtle interactions with TSHDs can best be mitigated.

A combination of satellite telemetry data and other information from acoustic arrays or genetic samples can provide a more complete picture. For example, additional acoustic and satellite telemetry data on sea turtles in the Chesapeake Bay, collected by the Virginia Aquarium for the US Department of the Navy

(DoN) and BOEM, can help with elucidating habitat use and residency time (A. DiMatteo 2016, personal communication). Stable isotope and genetic analyses can also link foraging areas and nesting habitats, providing information that may supplement the limited data available (e.g., Bass et al. 2004; Bowen et al. 2005; Bass et al. 2006; Ceriani et al. 2012; Pajuelo et al. 2012; Williams et al. 2014; Vander Zanden et al. 2015). Other parallel efforts to determine species presence and characterize OCS habitats, such as data used for informing the siting of areas for wind farms in the Atlantic (BOEM 2013), can also be used to support the ASTER DST. Analyses on the importance of specific dredging areas and how specific sea turtle populations utilize them would also greatly facilitate management decisions for avoiding sea turtles.

In areas where there is an absence of any data through direct observations or telemetry, the availability of data in other areas with similar environmental characteristics could be used to predict the presence of sea turtles, assuming that these environmental characteristics are selected as preferred habitat (Guisan and Zimmermann 2000). Species distribution modeling is commonly used to more reasonably fill knowledge gaps in areas where empirical data are lacking. Typically, oceanographic data such as bathymetry, sea surface temperature, chlorophyll *a* concentration, salinity, and current speed are predictor variables useful to determining the relative distribution, over time and space, of a variety of marine species (Elith and Leathwick 2009; Robinson et al. 2011).

Although research on modeling marine species distributions based on habitat has been recently gaining momentum for many taxa (Robinson et al. 2011), models are still relatively uncommon for sea turtle in-water habitats and, when available, are usually assessed on a small scale relative to the species' range (e.g., Duncan 2012; Mazor et al. 2016). Density models based on a limited amount of dedicated survey data in the US Atlantic and Gulf of Mexico have been developed (DoN 2007a; 2007b; 2007c; Pallin et al. 2015) and these models can be improved with the use of greater amounts of data. Though there are limited data on sea turtle presence (and absence) throughout their range, it has been recognized that satellite telemetry data have been helping to fill in the existing gaps in the US Atlantic and Gulf of Mexico (Hawkes et al. 2007). In the meantime, the great progress being made in predicting species distributions and densities for other related marine taxa within the US Atlantic and Gulf of Mexico (Roberts et al. 2016), could help inform sea turtle researchers as more data become available. The incorporation of any density models and potential environmental or habitat covariates, based on ones identified by other related studies (e.g., Good 2008; Pallin et al. 2015; Mazor et al. 2016; Roberts et al. 2016; Mannocci et al. 2017), should be considered for the ASTER DST (Table 4).

Table 4. Potential environmental/habitat covariate layers available online for sea turtle distribution in the US Atlantic and Gulf of Mexico waters

Environmental Layer	Name	Organization(s)	Reference(s)
Anthropogenic activities	Global map of cumulative human impact	National Center for Ecological Analysis and Synthesis	Halpern et al. (2008); Halpern et al. (2015)
Bathymetry	CleanTOPO2: Cleaned SRTM30_PLUS and ETOPO2 data	US National Park Service (NPS)	Patterson (2005)
Bathymetry	ETOPO1: Earth topographic database	NOAA	Amante and Eakins (2009)
Bathymetry	GEBCO: General Bathymetric Chart of the Oceans	United Nations Educational, Scientific and Cultural Organization, Intergovernmental Oceanographic Commission; International Hydrographic Organization	IOC et al. (2003)
Bathymetry	Sea floor topography	NOAA; Scripps Institution of Oceanography, University of San Diego	Smith and Sandwell (1997)
Bathymetry	SRTM30_PLUS: Shuttle Radar Topography Mission Global Coverage, 30 seconds	Scripps Institution of Oceanography, University of San Diego	Becker et al. (2009)
Benthic habitat	EMUs: Ecological Marine Units	The Nature Conservancy	Greene et al. (2010); Anderson et al. (2015)
Benthic habitat	Seabed forms	The Nature Conservancy	Greene et al. (2010); Anderson et al. (2015)
Benthic habitat	SEAMAP: Southeast Area Monitoring and Assessment Program	Atlantic States Marine Fisheries Commission	Eldridge (1988); SEAMAP-SA (2001)
Benthic habitat	usSEABED: integrated database of seabed characteristics	US Geological Survey	Reid et al. (2005); Buczkowski et al. (2006)
Chlorophyll *a*	CSCV: Coastal Zone Color Scanner by the Nimbus 7 ocean color	National Aeronautics and Space Administration	Hovis et al. (1980)
Chlorophyll *a*	GSM: Garver-Siegel-Maritorena model merged chlorophyll	National Aeronautics and Space Administration; European Space Agency	Maritorena et al. (2002); Maritorena and Siegel (2005); Maritorena et al. (2010)
Chlorophyll *a*	MODIS: Moderate Resolution Imaging Spectroradiometer Aqua ocean color	National Aeronautics and Space Administration	Savtchenko et al. (2004) NASA (2016a)

Environmental Layer	Name	Organization(s)	Reference(s)
Chlorophyll *a*	OCTS: Ocean Color and Temperature Scanner by the ADEOS-1 (Advanced Earth Observing Satellite 1) ocean color	National Space Development Agency of Japan	Kawamura and OCTS Team (1998)
Chlorophyll *a*	SeaWiFS: Sea-Viewing Wide Field of View Sensor ocean color	National Aeronautics and Space Administration	Hooker et al. (1992)
Climate	AMO: Atlantic Multidecadal /index	National Oceanic and Atmospheric Administration	Enfield et al. (2001)
Climate	Bio-ORACLE: Ocean Rasters for Analysis of Climate and Environment	Ghent University	Tyberghein et al. (2012)
Climate	MARSPEC: Marine Spatial Ecology ocean climate	Boston University	Sbrocco and Barber (2013)
Climate	NAO: North Atlantic Oscillation index	NOAA	Hurrell (1995)
Critical habitat	Loggerhead critical habitat in the Northwest Atlantic Ocean: Land	US Fish and Wildlife Service	FWS (2014)
Critical habitat	Loggerhead critical habitat in the Northwest Atlantic Ocean: Water	NOAA	NMFS (2014d)
Currents	Global near-surface currents	NOAA	Lumpkin and Johnson (2013)
Eddies	Nonlinear mesoscale eddies	Oregon State University	Chelton et al. (2011)
Fronts	Chlorophyll and SST fronts	University of Rhode Island	Belkin and O'Reilly (2009)
Geomorphology	GSFM: Global seafloor geomorphic features map	GRID-Arendal; Geoscience Australia; Conservation International	Harris et al. (2014)
Ocean circulation	HYCOM: HYbrid Coordinate Ocean Model	Naval Research Laboratory, Oceanography Division	Chassignet et al. (2007)
Photosynthetically available radiation	PAR	National Aeronautics and Space Administration	NASA (2016b)
Photosynthetic rates	^{14}C-based productivity	Brookhaven National Laboratory	Behrenfeld and Falkowski (1997)
Seafloor salinity	Seafloor salinity	Marine Conservation Institute	Boyer et al. (2005)
Sea surface current	OSCAR: Ocean Surface Current Analysis Real-time	Earth and Space Research	Bonjean and Lagerloef (2002); ESR (2009)

Environmental Layer	Name	Organization(s)	Reference(s)
Sea surface height	AVISO MADT: Archivage, Validation et Interprétation des données des Satellites Océanographiques Maps of Absolute Dynamic Topography	Archiving, Validation, and Interpretation of Satellite Oceanographic Data	AVISO (2015)
Sea surface roughness	NASA Scatterometer Climate Record Pathfinder	Brigham Young University Microwave Earth Remote Sensing Laboratory	Long and Hicks (2010)
SST	AVHRR: Advanced Very High Resolution Radiometer Pathfinder SST	NOAA	Reynolds et al. (2007)
SST	GHRSST-PP: Global Ocean Data Assimilation Experiment (GODAE) high-resolution SST pilot project	National Aeronautics and Space Administration	Donlon et al. (2007); Brasnett (2008)
Sea surface wind speed	Significant wind speed modulus	Archiving, Validation, and Interpretation of Satellite Oceanographic Data	AVISO (2015)
Sea surface wind speed	Sea surface wind speed	NOAA	Zhang et al. (2006)
Sea surface wind speed	CCMP L3.5 wind product	National Aeronautics and Space Administration	NASA and NOAA (2009); Atlas et al. (2010)
Shoreline	GADM: Global Administrative Areas	University of California, Davis	GADM (2015)
Shoreline	GSHHG: Global Self-consistent, Hierarchical, High-resolution Geography Database	NOAA	Wessel and Smith (1996; 2016)
Tides	GOT99.2: Global Ocean Tide Model by TOPEX/POSEIDON satellite altimeter	National Aeronautics and Space Administration	Ray (1999)
Thermal fronts	Thermal fronts	University of Rhode Island	Belkin et al. (2009)
Water masses	Water mass classifications	University of Delaware	Oliver et al. (2004); Oliver and Irwin (2008)

2.6 Stakeholder Feedback from Sea Turtle Research Experts Workshop

BOEM convened an online workshop via webinar to engage representative experts from the US sea turtle research community on October 12, 2016 (Appendix C). The purpose of the workshop was to gather knowledge applicable to the development of the ASTER DST to assess sea turtle entrainment risk in TSHDs. Specific objectives were to:

- Inform the sea turtle research community representatives of the ASTER DST study, their contributing role, and the desired end state
- Engage sea turtle research community representatives as collaborative partners and gather knowledge applicable to the ASTER DST early in the development process
- Identify and leverage existing sea turtle telemetry data and other spatial/temporal data layers to support the tool
- Discuss opportunities to work together to continue gathering data to fill gaps that would help to decrease sea turtle entrainment risk

Prior to the meeting, a list of potential data layers was developed (Table 4) that were considered useful in the ASTER DST for assessing sea turtle entrainment risk, based on other related studies predicting marine animal distribution, density, and behavior. This initial list served as a baseline to solicit other priority variables to include along with their sources. Discussions among sea turtle experts during the online workshop helped to refine the initial list of data variables that were considered for integration into the ASTER DST, based on the most relevant, important, and available variables for sea turtle entrainment risk. Feedback also included recommended sources to access data for integration into the ASTER DST, options within the ASTER DST for the developers to consider, and how results could be applied to management and direct future scientific research priorities.

3 Trailing Suction Hopper Dredge (TSHD)

3.1 Description of the TSHD

In October 1994, Public Law 103-426 amended the US OCS Lands Act Section 8(k) to allow the Secretary of Interior to negotiate agreements for the use of OCS sand, gravel, and shell resources (Figure 1). Since 1995, there have been 54 leases within portions of the US OCS to dredge sand, gravel or shell resources for 42 restoration projects in 8 states (BOEM 2015; 2017). More than 110 million m^3 of sand have been authorized by BOEM to be conveyed from the OCS to restore about 321 miles (517 km) of coastline (BOEM 2017), and these estimated numbers are likely to continue increasing unless sand resources diminish and/or it becomes cost prohibitive (Pilkey and Cooper 2014). BOEM currently averages four to six new leases annually (L. Turner 2016, personal communication) and it has been estimated that 101 offshore beach nourishment projects will need offshore dredging between 2014 and 2023 (NMFS 2014a). With future scenarios of climate change, sea level rise, and increased coastal development and population growth, continuing to dredge for sediment resources to renourish beaches wherever material is still available appears inevitable.

Though a significant volume of sediment has been conveyed from the OCS using TSHDs since 1995, the history of TSHD operations in the US is primarily associated with USACE navigation channel maintenance and beach nourishment dredging activities. Since 1855, TSHDs have been used in the US Atlantic and Gulf of Mexico for maintenance dredging projects, such as the deepening or clearing of channels and waterways to maintain navigability (US Congress Office of Technology Assessment 1987;

Palermo 1990; Taylor 1990). According to the USACE (2016a), dredging in the US is needed for more than 400 ports, more than 200 deep water harbors, and 25,000 miles (40,234 km) of navigation channels. Offshore, TSHDs are mainly used for mining sand to nourish/renourish eroded beaches. There are many different ways unconsolidated offshore sediment can be moved by dredges, but TSHDs are the most popular, being the most economical, better during adverse sea conditions, and able to transport materials over long distances (Taylor 1990; Herbich 1992). As local and state sand resources become more depleted, it becomes necessary to expend higher operational costs (e.g., projects needing more time, equipment, gas, or staff), to utilize sites farther away within the EEZ (US Congress Office of Technology Assessment 1987).

A typical TSHD loading cycle for a project includes dredging within a sand resource borrow area, "loaded" transit to the pumpout site, pumpout of sediment, and unloaded transit back to the borrow area. During dredging operations, hopper dredges travel at a ground speed of 3 to 5 km per hour (1.5 to 3 nm per hour) and can dredge in depths of 10 to over 100 ft (2 to over 30.5 m; US Congress Office of Technology Assessment 1987; Slay and Richardson 1988; Herbich 1992; CSA International et al. 2009). Some dredges outside of the US can operate in depths up to 155 m (Dredgers Today 2015); however, most offshore dredging operations in the US are limited to depths up to 90 ft. One or two dragheads can be used per vessel, and draghead width can range from 1.5 to 4 m, removing 9 to 46 cm of material in each pass (Slay and Richardson 1988; Taylor 1990; CSA International et al. 2009). Material from the sea floor is sucked through a draghead and suction pipe to be stored within a hopper, or large compartment, where heavy material sinks to the bottom and lighter silt and water drain overboard. Material can later be pumped out through pipelines, propelled into the air by heavy duty pumps (rainbowing), or unloaded at a different site through doors that open on the bottom of the hopper (Slay and Richardson 1988; Herbich 1992; Michel et al. 2013). The dredge generally moves forward along a track line while operating, but can be anchored while excavating a pit (US Congress Office of Technology Assessment 1987). In the US, most hopper capacities range from 3,000 to 7,000 m^3, with a maximum of 10,000 m^3 for beach nourishment projects (Michel et al. 2013). A new, large hopper dredge is scheduled to commence its first US beach nourishment project in the next year, with the ability to dredge up to 122 ft and a hopper capacity of about 11,300 m^3 (D. Piatkowski 2017, personal communication). Capacities for hopper dredges outside the US can reach up to 46,000 m^3 (Dredgers Today 2015; Hazekamp et al. 2016) and are mostly limited by the cost of building larger hoppers versus using smaller hoppers that complete more trips (US Congress Office of Technology Assessment 1987).

In general, TSHDs can adversely affect the environment by interfering with traffic, contributing noise pollution, altering and/or damaging important habitats, and directly injuring or killing organisms (Bray et al. 1996). The state of Florida also requires spatial buffers (400 ft or 122 m) around coral reefs and hard grounds to protect them from the impacts of dredging, which can include siltation (Finkl and Makowski 2010). Some studies showed that impacted benthic organisms (invertebrates) and habitat can recover in abundance and diversity within one to three years, if dredging does not create deep pits that limit infilling and recolonization (Jutte et al. 2002; Byrnes et al. 2004). However, recovery rates depend greatly on pre- and post-dredge conditions and the surrounding environment. Recent studies on monitoring long-term effects (i.e., six to eight years after impact), showed that changes to infauna composition and species loss were still significant, and that surficial sediment characteristics had shifted (Crowe et al. 2016).

The use of TSHDs for navigation maintenance dredging and beach nourishment is currently viewed as a long-term need that will likely increase in frequency, given projected population growth and sea level rise. For navigation maintenance projects, the frequency and length of time needed for dredging by TSHD can vary by navigation channel. Previous estimates for maintenance by TSHD of Gulf of Mexico channels ranged from every 3.5 months (Galveston Harbor Channel, Texas) to every 4 years (Matagorda Ship Channel, Texas), with a range of 1 month (Port Mansfield, Texas and Sabine-Neches Waterway, Texas) to 12 months (lower Mississippi River) of dredging (NMFS 1995a; 2003). For beach nourishment projects in the US, more than 370 million cubic yd (283 million m^3) have been used to replenish beaches 469 times since 1970 (Pilkey and Cooper 2014). Dean (2002) estimated that offshore sources have contributed 95% of the sand for beach nourishment, much of which are conveyed using TSHDs. The increased use of offshore OCS sand sources located further offshore is likely (D. Piatkowski 2017, personal communication).

3.2 Sea Turtle Risks from the TSHD

Sea turtles can be affected by TSHD activities in several ways, ranging from mild disruptions in behavior to mortality (Dickerson and Nelson 1990; LaSalle et al. 1991). Other than the use of a TSHD, activities associated with dredging include “support” vessels (e.g., trawlers used to move sea turtles out of the way, boats to ferry crew and supplies, and geophysical survey vessels) that can also disturb marine wildlife (Michel et al. 2013). TSHDs and other support vessels can disrupt sea turtles if they change their behavior and/or actively avoid the operational area because of the physical presence or acoustic disturbances from the activities (LaSalle et al. 1991; Reine et al. 2014). During dredging, transiting, or unloading, TSHDs can indirectly affect sea turtles by degrading habitat, such as altering benthic foraging areas, decreasing the number and abundance of prey species, and reducing the water quality by increasing turbidity and releasing potential contaminants into the water column (Richardson 1990; LaSalle et al. 1991; van Raalte 2006). TSHDs and other support vessels can have significant direct impacts, with the possibility of vessels striking slow-moving sea turtles (Richardson 1990; Reine et al. 1998) or sea turtles entraining in the TSHD draghead, where they are taken directly by the force of the suction or entrapped beneath the draghead as it moves across the seabed (Magnuson et al. 1990; Richardson 1990; Reine and Clarke 1998). Direct impacts, especially for entrainment, most often results in severe injury and/or mortality (Dickerson et al. 1990; Dickerson et al. 1991).

Sea turtle experts often list coastal development activities, including dredging, as a hazard affecting sea turtle populations (Magnuson et al. 1990; Donlan et al. 2010; Wallace et al. 2011). NMFS and US Fish and Wildlife (FWS) have several sea turtle species recovery plans mentioning the need to mitigate the threat of dredging on sea turtle populations, particularly from incidental hopper dredge entrainment and habitat destruction (Hopkins and Richardson 1984; NMFS and FWS 1991a; 1991b; FWS and NMFS 1992; NMFS and FWS 1993; 2008). Protected sea turtle species most directly affected by TSHDs in the US Atlantic and Gulf of Mexico in decreasing order are loggerhead, green, and Kemp’s ridley (Table 5). Leatherbacks and hawksbills can be impacted by other activities associated with dredging operations (e.g., relocation trawling, noise, and vessel traffic) in the US Atlantic and Gulf of Mexico.

Within the US, the history of documented sea turtle entrainment dates back to the 1980’s and has largely been associated with USACE navigation dredging activities in state waters, specifically for coastal channels from New York to the Texas-Mexico border (Dickerson et al. 2008b). It is important to note the difference between USACE navigation dredging projects, which occur primarily in channels close to shore, and dredging of OCS sand resources which occurs at least 4.8 km (3 miles) offshore in areas with less dense turtle abundances (Michel et al. 2013). Navigational dredging generally poses greater risks of entrainment of sea turtles because of their tendency to concentrate in channels in the southeastern U.S. and the constrained operating environment for TSHDs. The number of sea turtles entrained by TSHDs in offshore borrow areas, including both state waters and the OCS, has historically been relatively low when compared to navigation channel dredging (GEC 2012). Offshore borrow areas are generally more expansive and allow for more operational flexibility of dredging equipment to implement current mitigation requirements designed to minimize sea turtle entrainment risk (i.e., dredge pumps are dis-engaged until dragheads are firmly on the bottom) (see section 3.3 and Appendix D).

Sea turtle entrainment specifically associated with dredging of OCS sand resources was first reported in 1995 (Michel et al. 2013). Between 1995 and 2017 a total of 25 sea turtles have been entrained while dredging OCS sand sources. BOEM anticipates this number will likely increase as the number of OCS dredging projects and total cubic yardage dredged per project continues to increase along with dredging of new sand source locations (D. Piatkowski 2017, personal communication). Considering the relatively low number of sea turtles historically entrained by TSHDs in the OCS, the history of USACE TSHD activities operating within navigation channels and offshore borrow areas in state waters can be used to elucidate patterns of entrainment. Therefore, the history of sea turtle entrainment by TSHDs described in this report is largely based on USACE navigation and borrow area dredging activities.

Almost 800 incidental sea turtle takes by TSHDs were reported by USACE from 1980 to 2015 within the US southeastern coastal state waters, with more takes occurring in the South Atlantic region when compared to the North Atlantic and the Gulf of Mexico (Figure 4; USACE 2016b). Across the Atlantic and Gulf of Mexico regions, there were 401 reported sea turtle takes (about 28 individuals per year) between 1995 to 2008, with 70% being loggerheads, about 16% Kemp's ridleys, 13% greens, and the rest unidentified (Dickerson 2009; 2015). For 2008 to 2012, there are 89 documented takes from TSHDs (about 18 individuals per year), with 53% being loggerheads, about 25% Kemp's ridley, 21% greens, and the rest unidentified (Table 5; Dickerson et al. 2008a; Dickerson et al. 2008c; Dickerson and Theriot 2009a; 2009b; 2010a; 2010b; 2011a; 2011b; 2012a; 2012b). Between 1995 and 2008, more sea turtles were taken in the Atlantic than the Gulf of Mexico but there were more takes per project occurred in the Gulf of Mexico (Dickerson 2009; 2015). From 2008 to 2012, there were more sea turtle takes and takes per project in the South Atlantic when compared with the Gulf of Mexico, though more turtles were relocated by trawling during dredging operations in the Gulf of Mexico than in the South Atlantic (Table 6). The overall trend of sea turtle takes has not changed significantly since it was discovered that measures were needed to reduce takes after 1980 (Figure 4). Protection measures implemented in 1992, however, have decreased annual sea turtle takes per project (Dickerson 2009; 2015). The recent increase in demands on offshore resources, resulting in greater TSHD activity and possibly more projects, could pose a larger risk to sea turtle populations in the future.

It should be noted that documented takes are most likely underestimates, because evidence of sea turtle interactions can be missed for a variety of reasons, including sea turtle parts sinking to the bottom and being buried, unscreened overflow in parts of the hopper dredge, or turtles being impinged underwater and not brought aboard (Slay and Richardson 1988; Dickerson et al. 1990; Richardson 1990). It also may be difficult to determine if injured or killed sea turtles observed near dredging operations were impacted by other nearby threats, such as fishing (Richardson 1990). Some sea turtles can be taken through the hydraulic system and remain alive in the hopper, if they are small enough to pass through the impeller pumps without injury, but most sea turtles do not survive entrainment by TSHDs (Taylor 1990).

Sea turtle takes by TSHDs have been reported to affect both females and males of all ages (except for neonates). Because hopper dredges can kill sea turtles at different life stages (Goldberg et al. 2015), assessing the impacts of TSHD entrainment rate on sea turtles, based on reproductive value, could help facilitate prioritization of any necessary mitigation measures. The reproductive value of an individual, or the value based on the capacity to reproduce and contribute to population recovery, with small juveniles being lower than adults and large juveniles (Caswell 1989), have been used to assess relative adverse population-level impacts (NMFS and FWS 2008; Wallace et al. 2008; Haas 2010). Depending on particular cases, negative impacts on more individuals with a lower reproductive value may have greater effects than negative impacts on fewer individuals with a higher reproductive value (Wallace et al. 2008). Because behavior has been shown to vary among different sexes and life stages of sea turtles, it would be extremely useful to know the frequency of potential interactions (based on presence) and historic takes among sexes and age classes to determine differential risk of entrainment in TSHDs, if any. Although it may be difficult for on-board observers to determine and record sea turtle sex, size, and age classes taken, details on the presence and historic takes of sea turtles could help guide prioritization within the ASTER DST.

Compared to takes within the current project's study extent (Federal waters), more information surrounding incidental sea turtle takes and TSHD operations is currently available from nearshore state waters. Furthermore, within the US Atlantic and Gulf of Mexico, more incidental sea turtle takes were reported for nearshore state waters than in the OCS. The data collected for the USACE Endangered Species Observer Program showed that between 2008 and 2012, over 100 projects were reported with over 150 sea turtle takes in the US Atlantic and Gulf of Mexico (Table 6). With the exception of three trawling relocation takes documented in the Gulf of Mexico in 2010, all other takes were dredging related. These numbers should be considered as conservative estimates since many takes can be undetected.

According to Michel et al. (2013), 19 loggerhead sea turtles have been taken by TSHDs for 21 projects at OCS sand borrow areas in the South Atlantic region during 1995 to 2012. All 19 sea turtle takes occurred while dredging OCS borrow areas associated with three different USACE projects (Myrtle Beach, SC (n=11); Duval County, FL (n=3); and Brevard County, FL (n=5)). During that same time period, no reported takes were found in the Gulf of Mexico or Mid-Atlantic OCS region (Michel et al. 2013). Between March 2013 and January 2018, at total of six additional loggerhead sea turtles were taken in association with one project in the Gulf of Mexico (Caminada Headlands, LA (n=1)), one project in the Mid-Atlantic (Dare County, NC (n=2)), and one project in Florida (Brevard County, FL (n=3)) (D. Piatkowski 2017, personal communication). Currently, improved ways of utilizing data collected from dredging operations in the OCS is needed to better understand the conditions for the sea turtle entrainment events in the OCS, such as the mitigation measures in place, observer monitoring methods, and any other available data describing the dredging project and environmental variables. These data would allow managers to assess the differences among dredging operations that may affect the number of reported sea turtle entrainment events. In the meantime, building on any available information and lessons learned from sea turtle entrainment risk and takes by TSHDs outside of the OCS could be an initial approach.

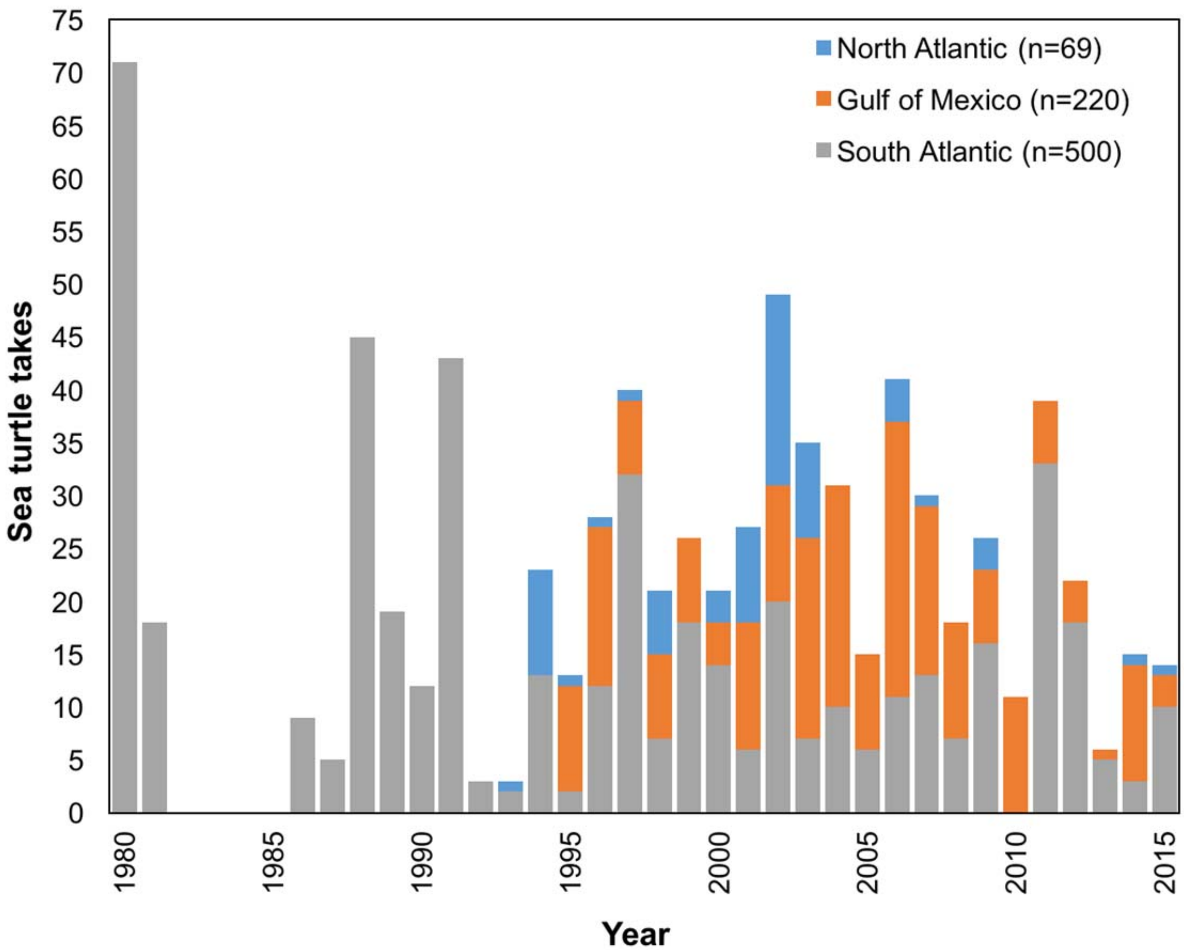

Figure 4. Sea turtle takes reported by project start year in the North Atlantic, South Atlantic, and Gulf of Mexico state water

Source: Data were summarized from the USACE ODESS (USACE 2016b)
Observers were not required on most projects until 1989 and many mitigation measures were implemented in 1992 (NMFS 1997). Prior to 1993, monitoring was only conducted in the South Atlantic (D. Dickerson 2017, personal communication). Records without a project start date were not included.

Table 5. Total numbers of sea turtles reported as TSHD incidental take, by species and by age classes, in the US Atlantic and Gulf of Mexico regions

Species	Adult	Juvenile	Subadult	Unknown	Total
Loggerhead *Caretta caretta*	58	75	96	289	518
Green *Chelonia mydas*	3	61	7	41	112
Kemp's ridley *Lepidochelys kempii*	5	39	21	34	99
Unknown *sp*.	-	-	1	59	60
Total	66	175	125	423	789

Source: Data were summarized from the USACE ODESS (USACE 2016b). Straight carapace length age class definitions: Adult > 87 cm; subadult = 80.1 to 87 cm; juvenile = 10.1 to 80 cm.

Table 6. Sea turtle incidental takes by TSHD and relocation trawling in the South Atlantic and Gulf of Mexico reported by fiscal year

		Dredging related							Relocation trawling (all species)		
	Projects	Total takes	Takes per project	Cc	Cm	Lk	Ei	Un	Total relocated	Relocations per project	Total injured or killed
South Atlantic											
2008	13	11	0.85	6	3	2	0	0	17	1.31	0
2009	11	11	1.00	11	0	0	0	0	0	0	0
2010	9	6	0.67	1	4	1	0	0	18	2.00	0
2011	7	5	0.71	4	0	0	0	1	0	0	0
2012	13	18	1.38	9	3	6	0	0	8	0.62	0
Gulf of Mexico											
2008	11	6	0.55	2	2	2	0	0	17	1.55	0
2009	14	13	0.93	6	4	3	0	0	39	2.79	0
2010	10	8	0.80	4	1	3	0	0	276	27.6	3
2011	10	4	0.40	2	0	2	0	0	113	11.3	0
2012	11	7	0.64	2	2	3	0	0	8	0.73	0
All South Atlantic	53	51	0.96	31	10	9	0	1	43	0.81	0
All Gulf of Mexico	56	38	0.68	16	9	13	0	0	453	8.09	3
All	109	89	0.82	47	19	22	0	1	496	4.55	3

Source: Data were summarized using USACE annual summary reports (Dickerson et al. 2008a; Dickerson et al. 2008c; Dickerson and Theriot 2009a; 2009b; 2010a; 2010b; 2011a; 2011b; 2012a; 2012b). Species: Cc = loggerhead *Caretta caretta*; Cm = green *Chelonia mydas*; Lk = Kemp's ridley *Lepidochelys kempii*; Ei = hawksbill *Eretmochelys imbricata*; Un = Unknown *sp*.

3.3 Historic and Current Mitigation Measures

In compliance with the US ESA of 1973, which requires activities that may negatively impact protected threatened or endangered species to take appropriate precautions, Section 7 (a)(2) consultations with NMFS are necessary for TSHD activities because of their potential interactions with sea turtles. The acting agency (usually the USACE or BOEM) submits a biological assessment describing the proposed activity with a review of potential and likely impacts to any listed species, and NMFS formulates a Biological Opinion on if and how listed species are potentially affected (Dickerson et al. 2008b). RPMs or reasonable and prudent alternatives (RPAs; 50 CFR 402.02) and associated T&Cs (50 CFR 402.14) for how RPMs/RPAs would be implemented are proposed by NMFS, based on the best available data, when there is a possibility of the proposed activity negatively impacting listed species (FWS and NMFS 1998). Adherence to the RPMs and the T&Cs allows for the exemption in the US ESA Section 7(o)(2). NMFS incidental take statements (ITSs) are provided with the Biological Opinion to determine the limits for the listed species that may be affected, for which actions would be exempt while all possible measures have been implemented to reduce and minimize impacts (FWS and NMFS 1998). Based on available data, these incidental take limits are determined to not place listed species in jeopardy (Dickerson et al. 2004). Consultations with NMFS may be reinitiated if one or more of the following triggers are met:

- The amount or extent of incidental take is exceeded.
- New information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered.
- The action is modified in a manner causing effects to listed species or critical habitat not previously considered.
- A new species is listed under the US ESA or critical habitat is designated that may be affected by the action.

3.3.1 US South Atlantic

In 1978, after sea turtles were intentionally caught in high numbers by shrimp trawlers to assess relative abundance in the Canaveral ship channel, Florida, the USACE initiated ESA Section 7(a)(2) consultations with NMFS to determine the effects of dredging in that area. Although sea turtles were known to be present in high abundances in the channel, the risk of dredging was unknown for the corresponding NMFS Biological Opinion (March 30, 1979). After more trawl surveys assessed the abundance and distribution of sea turtles within the Canaveral ship channel, the NMFS Biological Opinion (January 22, 1980) was that “dredging may result in the loss of large numbers of loggerhead sea turtles but is not likely to result in jeopardizing either the loggerhead or Atlantic ridley sea turtle stocks” (NMFS 1995b). Therefore, initial mitigation measures within the 1980 Biological Opinion were to restrict TSHD use to August 1 through November 1 and to recommend NMFS-approved observers monitor turtle takes on hopper dredges (NMFS 1995b).

The USACE Endangered Species Observer Program began in 1980 and is currently ongoing, using consistent methods starting in 1995 and monitored the interactions of endangered species (i.e., sea turtles, shortnose and Gulf sturgeon, and marine mammals) for TSHD projects at over 90 coastal sites (Dickerson 2009). Observers search for evidence of wildlife interactions (e.g., sea turtles, marine mammals, sharks, fish, and other bycatch) by monitoring inflow and overflow screenings (Slay 1991; 1995; Dickerson et al. 2004). From 1980 to 2003, screening requirements and configurations varied greatly among hopper dredges (Richardson 1990; Dickerson et al. 2004). After 2003, screening of the dredging material became more standardized so that incidental take numbers could be compared among dredging projects (Dickerson et al. 2004).

The issue of sea turtle entrainment within TSHDs was brought to light in 1980, with record numbers of loggerheads taken in Canaveral channel, Florida from July to November (Moulding 1981; Rudloe 1981; Joyce 1982). Because it was acknowledged that the numbers reported were likely an underestimate, significant investments were made to research alternatives and protective measures to reduce the threat of TSHDs to sea turtles (NMFS 1991; Dickerson et al. 2004). Many of the efforts involved partnerships across multiple agencies and organizations, such as Federal, state, and local governments, universities, and industry.

In 1981, a Sea Turtle/Dredging Task Force was established with technical experts from the USACE, NMFS, FWS, DoN, and Florida Department of Natural Resources to gather more information on the sea turtle population, movement, and behavior modification in Canaveral Harbor, Florida and research modifications on dredging methods and equipment to reduce sea turtle takes (Berry 1990). Unfortunately, the seasonal restrictions on TSHD use, along with other trial efforts by the USACE, NMFS, and DoN (e.g., scaring sea turtles away from dredging areas using acoustics, detecting and capturing turtles, removing and relocating turtles, and deflecting turtles away from the draghead), were ineffective for eliminating sea turtle takes reported in Canaveral between 1980 through 1986 (NMFS 1991; 1995b). Beginning in 1981, the earliest, most effective alteration was the use of a California-style draghead that operated flatter in the sediment as opposed to previous operations where dragheads were upright and more like a scoop (Studt 1987; Dickerson et al. 1990; Dickerson et al. 2004). Estimated seasonal sea turtle abundances showed that Canaveral had the highest abundances, when compared to four other eastern Florida navigational channels (Butler et al. 1987), which could partially explain why many of the trial efforts were not successful in Canaveral and that dredging in other channels may not have as large of an impact.

Subsequently, another channel dredging project at Kings Bay, Georgia in 1988 also reported a large number of sea turtle takes, including takes of species other than loggerheads (Slay and Richardson 1988; Richardson 1990; Dickerson et al. 1991; NMFS 1995b). Conservation measures in place at Kings Bay were the use of endangered species observers, screening of dredged material, and the use of relocation trawlers (NMFS 1995b). NMFS requested formal consultations for all areas with proposals for hopper dredging and 25 to 100% of all TSHDs required observers for projects in Brunswick and Savannah, Georgia, and Wilmington, North Carolina (NMFS 1995b; Slay 1995). Another mitigation technique available to the US projects was to reduce the time that pumps are engaged while they are either going through the water column or are above the sand, as opposed to in the sediment, which was implemented in 1985 (Dickerson et al. 1990). Beginning in 1988, the use of screens or covers on water intake openings at the top of the draghead were also found to reduce the risk of entrainment for smaller turtles (Dickerson et al. 2004). After 1989, trained observers were required on most hopper dredges (NMFS 1997).

A sea turtle workshop was held in 1988 to discuss and propose ways forward for preventing sea turtle mortalities during dredging operations, especially for the Canaveral and Kings Bay ship channels (Dickerson and Nelson 1990). Conclusions and recommendations from the workshop were:

- More sea turtle biological and behavioral research was needed, such as compiling the best available data, gathering information on seasonal/daily behavior and activities, along with any cycles/patterns if they exist, exploring physical and chemical covariates, examining the effectiveness of relocation and scare tactics, and understanding sublethal impacts of dredging activities (Dickerson et al. 1993)
- Evaluations for alternative dredging actions were needed, such as the alterations to dragheads and equipment, changes to the environmental window, improvements to turtle deflectors, establishment of methods for determining accurate take estimates, better screening techniques for sea turtle evidence, more efficient methods for sea turtle relocation, and the effective use of scaring devices (Dickerson and Nelson 1990; Dickerson et al. 1991)

Around 1991 in coastal Georgia, strandings near dredging projects, observed takes of sea turtles by TSHDs operating in channels (Brunswick and Savannah), and high abundances of sighted sea turtles resulting from aerial surveys (Nelson et al. 1991; Slay 1991; Maley 1995; Slay 1995; Braun and Epperly 1996) prompted the first NMFS regional Biological Opinion for the Southeast Atlantic (SARBO; NMFS 1991). RPMs and associated T&Cs for hopper dredging activities occurring in southeastern US channels from Oregon Inlet, North Carolina to Canaveral, Florida included (NMFS 1991):

- Environmental windows for all channels from December 1 to March 30 (which may be adjusted with any new sea turtle information), except Canaveral, Florida ship channel where hopper dredging was prohibited year-round
- Requirements for trawling to estimate sea turtle abundances before dredging operations start and dredging would not occur if high numbers of sea turtles were found. If many sea turtles were present, delays or other precautionary measures may be necessary
- Recommendations for unrestricted use of alternative dredges when feasible in all southeastern US channels
- Requirements for observers on dredges during operations within the window to document any take with outflow and/or inflow screening (NMFS 1991)

The ITS in the NMFS SARBO set levels for 2 Kemp's ridleys, or 5 green, hawksbill or leatherback turtle mortalities, or 50 loggerhead mortalities for all channel dredging projects in the southeastern US combined.

Conservation recommendations were also included within the NMFS SARBO, including additional protection methods that were implemented in 1992 to effectively minimize sea turtle takes (Clausner et al. 2004). Alternative dredges that were shown to be less risky to sea turtles (e.g., cutter-suction pipeline, bucket, or clamshell) were considered for projects and utilized outside of the environmental windows, minimizing the use of TSHDs (Dickerson 2009). Early termination of projects with high rates of sea turtle takes was also recommended, to decrease the likelihood of sea turtle interactions (NMFS 1997; Dickerson et al. 2007). Since 1993, the use of a rigid deflector on California-style dragheads was included as an RPM for NMFS Biological Opinions on hopper dredging in the southeast (Dickerson et al. 2004), after testing multiple types of turtle deflectors between 1981 and 1993 using steel plates, anchor chains, flexible chain webbing, and pipes (Dickerson et al. 1990; Banks and Alexander 1994). Finally, capturing sea turtles using a modified shrimp trawler and associated techniques to minimize negative impacts in the dredging project's vicinity and relocating them to another site was also implemented in 1992 (Dickerson et al. 2007). Standora et al. (1994) and Joyce (1982) have found that relocated sea turtles can return back to the dredging project area where they were captured, but other studies have found that relocation can be effective based on the low occurrence of recaptures and entrainment rate (Bolten and Bjorndal 1991; Reine and Dickerson 1994; Fitzpatrick et al. 2006; Dickerson et al. 2007; Bargo et al. 2008).

The first revision of the NMFS SARBO was prepared in 1995 and included refined restrictions after research showed that they would effectively decrease sea turtle takes in six channels in North Carolina, South Carolina, Georgia, and Florida (Dickerson et al. 1990; Dickerson et al. 1995b; NMFS 1995b). This was the first NMFS Biological Opinion to include activities for beach nourishment and borrow area dredging, in addition to navigation channel dredging, and the RPMs and T&Cs listed within the Biological Opinion applied to all activities. NMFS included new RPMs and T&Cs that:

- Required observers in some channels in the winter (outside the former environmental windows), and disallowed beach observers over shipboard observers with exceptions

- Required 100% inflow screening and recommended 100% overflow screening for areas and seasons in which sea turtles may be present
- Required the use of a rigid sea turtle deflecting draghead
- Recommended that, to the greatest extent possible, dredge pumps should not be engaged until dragheads are firmly on the bottom
- Required reports of sea turtle takes from dredging to be submitted to the USACE and NMFS within 30 days of the project end date
- Expanded the former environmental window to allow year-round dredging north of Pawleys Island, South Carolina, and between November and May 31 from Tybee Island, Georgia through Pawleys Island, South Carolina. Canaveral channel, Florida dredging by TSHDs was still prohibited

RPMs regarding ESA-listed marine mammals (cetaceans) and shortnose sturgeon (*Acipenser brevirostrum*) were also added (NMFS 1995b). The ITS in the NMFS Biological Opinion set levels for 7 Kemp's ridleys, 7 greens, 2 hawksbills, and 20 loggerhead sea turtle injuries or mortalities for all channel and beach nourishment dredging projects in the southeastern US combined (NMFS 1995b).

The NMFS SARBO was revised a second time in 1997 due to high loggerhead sea turtle take rates that were approaching the incidental take limits in Georgia and South Carolina harbors, even with the use of draghead modifications and relocation trawling (NMFS 1997). Although unseasonably high temperatures were present during dredging, which may have contributed to higher abundances of sea turtles within the harbors, it was determined that proper usage of draghead deflectors was critical to avoiding or minimizing sea turtle takes (NMFS 1997). Additional RPMs and associated T&Cs in the NMFS SARBO included:

- Requirements for USACE annual inspections on the rigid draghead deflector and assessments on dredge operator familiarity on how to operate the deflector, with training provided if necessary
- Recommendations for the rigid draghead deflector to be removed for Wilmington Harbor, if it has been shown to be ineffective and if the project time was increased in Wilmington Harbor
- Requirements for the development of an educational/training program to inform dredge operators on how draghead deflectors work and its necessity

The ITS was modified from the NMFS SARBO with an additional 15 loggerheads. Therefore, the annual documented sea turtle incidental take (injury or mortality) was set at 7 Kemp's ridleys, 7 greens, 2 hawksbills, and 35 loggerheads for all channel dredging in the southeastern US combined (Table 7; NMFS 1997).

Table 7. NMFS Biological Opinion annual incidental take limits by sea turtle species and region

	Dredging take limits				Relocation limits (any species)	
	Cc	**Cm**	**Lk**	**Ei**	**Relocations**	**Relocation takes**
South Atlantic	35	7	7	2	-	-
Gulf of Mexico	40	14	20	4	300	2
Civil works	32	11	16	3	-	-
Regulatory	8	3	4	1	-	-

Source: Data were from the most current NMFS ESA Section 7 consultation Biological Opinions (NMFS 1997; 2007). Limits in the Gulf of Mexico are also broken down by civil works or regulatory projects. Species: Cc = loggerhead *Caretta caretta*, Cm = green *Chelonia mydas*, Lk = Kemp's ridley *Lepidochelys kempii*, Ei = hawksbill *Eretmochelys imbricata*; Hyphens (-) = none set.

In response to the second SARBO revision in 1997, the USACE issued an internal SARBO management protocol (USMP) that provided similar guidance for the USACE Districts to further reduce sea turtle entrainment in TSHDs (USACE 1997), including:

- Requirements for the use of sea turtle deflecting dragheads at all times, with confirmation that sea turtle deflecting draghead systems are fully operational through inspections and that draghead operators can use the system properly
- Establishment of an environmental window for Savannah, Brunswick and Kings Bay Harbors, Georgia for December 15 to the end of March. The environmental window for Wilmington, North Carolina and Charleston, South Carolina Harbor channels was established for December 1 to the end of March without a sea turtle deflecting draghead system and mid-November to the end of March with a sea turtle deflecting draghead system
- Requirements for the use of sea turtle observers, inflow screens, and overflow screens at all times, except with January and February being optional
- Requirements for prompt reporting and posting online of sea turtle takes to the USACE
- If two sea turtle takes occur within 24 hours or during a project, notification to the USACE was needed to reinitiate consultation with NMFS. If a third sea turtle take occurs within a project, operations will only continue after a risk assessment and management plan was developed, typically involving trawling to estimate relative abundance and relocate sea turtles
- Requirements for the dredging operation to be suspended if two sea turtles are taken during the project until the USACE guidance was issued
- Requirements for all work on a project to stop if a total take of five sea turtles is reached

Further guidance on marine mammal observations and sturgeon takes were also included in the protocol (USACE 1997).

The combination of using alternative dredging equipment, altering the design of the draghead after multiple trials (California-style and deflector), changing draghead operations (disengaging pumps while in the water column), and implementing broad environmental windows based on the information gathered on seasonal sea turtle occurrence and distribution within specific channels were all shown to be effective in reducing reported takes (Dickerson et al. 1995b; NMFS 1997). The testing of draghead deflector designs and their effectiveness of the final model showed that sea turtles were pushed out of the pathway for entrainment (Banks and Alexander 1994; NMFS 1997) and more ongoing research continues for alternative methods to move turtles away from the draghead (D. Dickerson 2016, personal communication).

The NMFS SARBO is currently being revised (BOEM is serving as a joint consulting agency with the USACE acting as the lead agency), but in the meantime, emergency or individual long-term projects may warrant a separate NMFS Biological Opinion with RPMs and T&Cs in addition to the ones already in place. One project-specific example is the NMFS Biological Opinion issued for the Savannah Harbor Expansion Project, which will operate under extra RPMs and T&Cs addressing potential effects to essential fish habitat and endangered and threatened species (NMFS 2011). NMFS RPMs and associated T&Cs in regards to sea turtles included:

- NMFS-approved protected species observers required for 100% monitoring of the hopper bin, inflow and overflow screening (of specific size and flexibility), and dragheads for sea turtles,
- Engaged dredging pumps only when firmly on the bottom
- Rigid draghead deflector required
- Report TSHD sea turtle takes, strandings, and relocation trawl results to NMFS

- Relocation trawling required during all TSHD activity, non-capture relocation trawling used only after NMFS approval, with relocations three miles or more away from the center of the capture site's navigation channel
- Required trawling protocols detailed for safe handling/holding, scientific measurements and data/biological sample collection, responding to injuries, flipper tagging and PIT tag scanning,
- Trained TSHD personnel for minimizing sea turtle takes
- Limited dredge lighting within 3 nm of sea turtle nesting beaches
- Compliance with NMFS BMPs

Details for the implementation T&Cs for RPMs for mitigating negative impacts to shortnose sturgeon and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) were also listed (NMFS 2011). The ITS set by NMFS listed the limits for sea turtle takes over the three years of the project, injury or mortality, to be 27 sea turtles (11 Kemp's ridley and 16 loggerhead) during dredging and up to 51 non-injurious takes of any species of sea turtles from all activities over the entire three years. Conservation recommendations to further protect sea turtles were to conduct studies and evaluations on draghead modifications and bed-leveling, improve methods for monitoring and detection of takes and overflow screening, encourage outside permits to take advantage of research opportunities during relocation trawling, improve dragheads, consider economic incentives for no turtle takes to hopper dredge operators, and encourage sodium vapor light usage when lights were necessary (NMFS 2011).

3.3.2 US Gulf of Mexico

For US Gulf of Mexico channels, there were relatively low amounts of information on sea turtles and their interactions with TSHDs when the South Atlantic first reported issues (Weber 1990) and since 1991, consultations between the USACE and NMFS were conducted for individual channels in the Gulf of Mexico or were more informal, mostly concluding that TSHDs were not a threat to any listed species or critical habitat (NMFS 1995a). During the period of individual and informal consultations, NMFS asked the USACE to advise and instruct TSHD operators to avoid sea turtle interactions and to notify NMFS of any sea turtles observed within TSHD project areas (NMFS 1995a). One early formal consultation resulting in a NMFS Biological Opinion with RPMs and T&Cs was for Port Mansfield Channel, Texas where the environmental window for hopper dredging was set for December through March, alternative dredges suggested to be used if possible year-round, and the USACE inspectors and dredge personnel observers were required (NMFS 2003). NMFS also recommended the USACE to follow recommendations for dredging and disposal by the NPS, and address the need for sea turtle abundance research in the channel (NMFS 2003).

In the early 1990s, more research that sea turtles may be negatively impacted by TSHDs became available, such as studies that showed sea turtles were using and aggregating in Texas and other Gulf of Mexico channels (Renaud et al. 1992; Landry et al. 1993; Renaud 1994; Renaud et al. 1994), observations of lethal and non-lethal takes from dredging in a Brazos Pass, Texas project, and the occurrence of high levels of sea turtle strandings near dredging projects in Louisiana (NMFS 1995a). In response to the USACE's request for consultation in early 1995, NMFS stated that NMFS-approved observers were necessary to investigate what impact dredging was having on sea turtles starting in 1995, and suggested the use of a rigid sea turtle deflector on dragheads and formal consultation with NMFS (NMFS 1995a). Formal consultation with NMFS was initiated by the USACE in late 1995 and the NMFS Biological Opinion included RPMs and T&Cs for hopper dredging in Texas and Louisiana stating:

- The environmental window for hopper dredging was determined as December 1 to March 31, and pipeline or hydraulic dredges must be used for maintenance dredging (up to one mile into rivers) outside of the window

- NMFS-approved observers were required year-round from Corpus Christi, southwest from Aransas Pass to Brazos Pass at the Mexican border except in January and February if there were no observed sea turtle takes in December, or if water temperatures were below 12 degrees
- When aboard, observers were required to screen 100% of the inflow and outflow materials
- When observers were not aboard during TSHD operations, the USACE must advise and instruct dredging operators on avoiding interactions with sea turtles and to notify NMFS of any sea turtle takes or observations in the dredging project area
- Dredging pumps must be disengaged while in the water column, whenever possible,
- Rigid deflector draghead was required
- Within 30 days of completion of any project, summary reports on dredging results and documented sea turtle takes must be submitted to NMFS. An annual report of all projects and takes was also required
- Reinitiation consultation with NMFS within five years was needed (NMFS 1995a)

The ITS for the annual documented sea turtle incidental take (injury or mortality) was set at 7 Kemp's ridleys, 5 greens, 1 hawksbills, and 15 loggerheads for all channels in the Galveston District combined. For all channels in the New Orleans District combined, the ITS set levels 7 Kemp's ridleys, 3 greens, 1 hawksbill, and 15 loggerheads. The set difference in the number of greens allowable was based on research showing south Texas waters having a greater abundance of green sea turtles (NMFS 1995a). In addition, research on seasonal relative sea turtle abundance and habitat characterization, considerations for relocation trawling for projects with early documentation of takes, and the evaluation of modified dragheads was recommended (NMFS 1995a). Dredging windows were encouraged, but not required T&Cs for the NMFS 1995 Biological Opinion (NMFS 1995a) and subsequent Biological Opinions for hopper dredging state waters of the Gulf of Mexico (NMFS 2003; 2005b; 2007).

Following the actions in the South Atlantic, the first NMFS Biological Opinion covering a larger region within the Gulf of Mexico was formulated in 2003 for the maintenance of all navigational channels and intracoastal waterways in the Galveston, New Orleans, Mobile, and Jacksonville USACE Districts, Houston-Galveston, Texas navigation channel, and Corpus Christi Ship Channel Improvement Project, Texas (GRBO; NMFS 2003). The listed RPMs and associated T&Cs included (NMFS 2003):

- Recommendations for December 1 to March 31 for TSHD activities from the Mexico-Texas border to Key West, Florida up to one mile into rivers, and the use of pipeline or hydraulic dredges outside of those dates
- Requirements for NMFS-approved observers to monitor for sea turtles, with 100% monitoring using two observers year-round from Brazos Santiago Pass, Texas to (not including) Key West, Florida and 50% monitoring in other areas, and takes must be reported to NMFS, with the exception of Mississippi River-Southwest Pass, Louisiana
- Recommendations for observers to screen 100% inflow and overflow with specific screen size and flexible designs, except for the Mississippi River-Southwest Pass, Louisiana
- When NMFS-approved observers were not required, the USACE must instruct and advise dredging and vessel operators to avoid sea turtles and to report any sightings of sea turtles to the USACE
- Dredging pumps should be engaged only when firmly at the bottom
- Rigid sea turtle deflecting draghead was required at all times, except for the Mississippi River-Southwest Pass, Louisiana
- Temperature threshold of 11 degrees C set for hopper dredging operations, which has been changed from 12 degrees C in the previous NMFS Biological Opinion (NMFS 1995a)
- Summary and annual reports with documented takes, sea turtle strandings, and relocation trawling details must be submitted to NMFS

- Relocation trawling must be used with NMFS-approved observers when a) two or more turtles were taken in a 24-hour period, b) four or more turtles were taken in the project, or c) 75% of a USACE District's sea turtle species quota for a particular species has previously been met, unless NMFS approves a waiver to not use relocation trawling
- Requirements set for following the details listed for trawl time, handling of sea turtles, captured turtle holding conditions, weight and size measurements, take and release time specifications, injuries and incidental take quotas, flipper tagging, passive integrated transponder (PIT) tag scanning, tag and tissue sampling data collection, genetic analysis costs, and handling of fibropapillomatose turtles during relocation trawling
- Dredging cannot occur within a minimum of 400 ft from significant hardground areas or bottom structures
- Training of TSHD personnel on methods to minimize sea turtle takes was required
- Lighting from TSHDs and other vessels within 3 nm of sea turtle nesting beaches should be minimized from May 1 through October 31

Additional RPMs existed in regards to marine mammals and Gulf sturgeon (*Acipenser oxyrinchus desotoi*). Other than expanding the dredging window to other channels in the Gulf of Mexico and lowering the threshold temperature, the newer NMFS Biological Opinion (NMFS 2003) revised the previous NMFS Biological Opinion (NMFS 1995a) by including details for requirements for relocation trawling as a T&C, with requests for waivers when relocation trawling cannot be used, and tissue sampling and genetic analyses must be funded by the USACE. The ITS set annual limits for takes by TSHD, injury or mortality, within the entire Gulf of Mexico (USACE Galveston, New Orleans, Mobile, and Jacksonville Districts) at 20 Kemp's ridleys, 14 greens, 4 hawksbills, and 40 loggerheads (NMFS 2003). Relocation trawling take limits were set at 300 captures (non-injurious) and 0 to 2 sea turtles of any species injured or killed. Take limits for TSHDs were broken down by the USACE District and by responsibility (civil works or regulatory project) while relocation trawling takes were not allocated further (Table 7; NMFS 2003). Conservation recommendations included the continued study of channel conditions and seasonal abundance of sea turtles, study of draghead modifications/evaluations and bed-leveling, improvement in monitoring and detecting takes, apply for ESA Section 10 research permits for relocation trawling, consider economic incentives for no turtle takes, recommend sedimentation limits to hard bottoms/reefs and other resources, develop relocation trawling guidelines, and use sodium vapor lights on offshore equipment when lights were needed (NMFS 2003).

After multiple discussions between the USACE and NMFS, the first revision of the GRBO in 2005 included more clear language and addressed some of the concerns raised by the USACE, replacing three sections within the original 2003 GRBO (NMFS 2005b). Amended RPMs and associated T&Cs included changes for:

- Relocation trawling details, such as how to handle fibropapillomatose turtles, and for designing a sampling and analysis plan with NMFS to modify requirements for required funding for collecting tissue samples and genetic analysis
- Reallocation of initial take allotments, based on the overall ITS set for the entire Gulf of Mexico

Total ITS limits for sea turtles did not change from the 2003 GRBO (NMFS 2003), but clarification to the ITS for separating the annual limits for sea turtle takes, based on injuries/mortalities by TSHD, captures by relocation trawling, and injuries/mortalities by relocation trawling was provided in the 2005 revision (Table 7; NMFS 2005b). Reported sea turtle strandings were stated to not be counted against the ITS limit (NMFS 2005b). Also, allocations defined in the 2003 GRBO (NMFS 2003), by USACE District, were initial estimates and the USACE and NMFS could work together to determine the best way for allowing Districts to allocate takes among Districts (NMFS 2005b). If the total Gulf of Mexico-wide ITS set numbers were anticipated to be exceeded or more information was available on listed species or critical habitat, consultation must be reinitiated early, without requiring projects to be suspended (NMFS 2005b).

In 2006, NMFS issued construction conditions for any projects that may overlap with sea turtles in the southeast Atlantic and Gulf of Mexico that can reduce delays due to encountering them and reduce their risk of injury and mortality (NMFS 2006). Conditions included:

- Instructing and advising project personnel of how to avoid sea turtles and the consequences of interactions with them
- Using siltation barriers to prevent entanglement, entrapment, entry or exit from designated critical habitat
- Operating at no wake/idle speeds for certain depths
- Ceasing operations if sea turtles were seen within 50 ft of equipment and only resuming after the species has departed on its own
- Immediate reporting of any interactions to NMFS (NMFS 2006)

Further discussions among the USACE Gulf of Mexico divisions and NMFS on the first revision led to a second revision in 2007 that resulted in a Biological Opinion superseding both earlier GRBOs in 2003 and 2005 (NMFS 2007). Changes to the RPMs and associated T&Cs of the revised GRBO (NMFS 2007) were to replace the original GRBO so that the first revision would be made null, but many of the changes in the first revision were included in the second. Amendments included:

- No requirement to consult with or notify NMFS when dredging outside recommended hopper dredging windows
- Notification of protected species takes sent to NMFS electronically (email)
- Takes from strandings or relocation trawling were not included in the numbers for the GRBO ITS take limits, but bed-leveling was included
- PIT tagging of endangered species was permitted through GRBO and does not require a NMFS ESA Section 10 permit
- Submission of data on PIT tags, external tags, and genetic samples were to be within 60 days after project completion
- Hardgrounds do not include navigation channels and jetties
- Sampling protected species (e.g., weighing and measuring) required only when feasible
- No requirement for funding of tissue sample collection for genetic testing, or take tissue samples when encountering sea turtle viral fibropapillomas
- Authorized take can be 25% over set limits in one calendar year, given that the total anticipated take will not be exceeded in a five-year period
- Leverage the USACE interactions with protected species during TSHD operations (dredging and relocation trawling) for other permitted research projects

Revisions also included changes regarding smalltooth sawfish (*Pristis pectinata*) relocation trawling takes (NMFS 2007). Conservation recommendations listed within the second revised GRBO (NMFS 2007) were similar to the original (NMFS 2003).

The internal USACE (2006) GRBO Management Protocol (UGMP) was issued and approved in 2007, shortly after the NMFS Biological Opinion (NMFS 2007) was issued, to provide further guidance for the USACE dredging projects permitted and conducted within the Gulf of Mexico to implement the requirements and recommendations within the GRBO (NMFS 2003; 2005b; 2007). Conditions listed within the UGMP included:

- Details on the roles of point of contacts and an executive advisory group (EAG) with implementing the GRBO RPMs and addressing other issues
- Coordination of data collected on sea turtle takes and catches from relocation trawls
- Annual reporting and reviews
- The USACE District trigger points for sea turtle takes by species (signals the need for engaging the EAG before allocated limit was reached)
- Hopper dredge inspections
- Determining the need for pre-trawling condition and abundance surveys, risk assessments, and the reinitiation of the NMFS consultation (USACE 2006)

Like the USMP, the UGMP TSHD projects in the Gulf of Mexico with permits issued by the USACE must comply with the GRBO and the UGMP.

3.3.3 US North Atlantic

Currently, a regional NMFS Biological Opinion for TSHD activities within all channels of the US northeast Atlantic region (north of North Carolina) does not exist. However, "batched" or "multi-action" consultations, where one Biological Opinion was produced by NMFS in response to more than one individual action/project (FWS and NMFS 1998), have been conducted for the USACE northeast projects in the past (e.g., NMFS 2012e; 2013c; 2014b). Individual NMFS Biological Opinions continue to be issued, with varying regional scopes, RPMs, associated T&Cs, and ITSs (Dickerson et al. 2004). The NMFS annual incidental take levels that were anticipated under the existing NMFS Biological Opinions on the northeast Atlantic USACE monitored dredging projects were 27 loggerheads, 11 leatherbacks, 6 greens, and 5 Kemp's ridleys (NMFS 2003). These limits were set based on relative abundances from regional surveys. Much like projects in the other regions, temporarily stopping individual northeast Atlantic dredging projects that were close to reaching or have exceeded their set allowable limits have occurred voluntarily (Mansfield 2006).

In the northeast Atlantic state waters, sea turtle incidents with TSHDs have been monitored since 1994 (Dickerson et al. 2004), and there were 69 total takes up to 2015, the majority being loggerheads and including one recorded in 1993 (Figure 4). About 69 projects recorded sea turtle takes within channels in New Jersey, Delaware, and Virginia (USACE 2016b), though there probably have been many more projects where sea turtle takes were not officially recorded. Additionally, methods for monitoring and mitigating for sea turtle takes can vary, depending on what was issued within individual NMFS Biological Opinions. One requirement most frequently used for TSHDs operating in northeast Atlantic channels was the installation of intake screens to prevent unexploded ordnance (UXO) or munitions of explosive concern (MEC) from entering the hopper and/or from being conveyed (NMFS 2012d). Although NMFS has determined that the risk of protected species entrainment was unchanged, these required UXO/MEC screens to lower the rate of detecting any interactions, because evidence was less likely to be observed (NMFS 2012d). Based on earlier trials using draghead screens, their use was not recommended because sea turtles can still be trapped and killed beneath them (Richardson 1990). Varying measures taken to reduce the risk of sea turtle entrainment and avoid UXO/MEC, which could differentially affect rates of takes and the observations of takes, can make comparisons across projects within and beyond the northeast Atlantic difficult (D. Dickerson 2016, personal communication).

3.3.4 Dredging in the OCS

It is important to note that not all USACE permitted and conducted activities, such as those covered by the SARBO and GRBO, pertain to hopper dredging in Federal waters or permitted by other Federal agencies (such as BOEM or DoN). BOEM is the US Federal agency that is manages the extraction of sand, gravel, and other offshore minerals from the ocean floor of the OCS (BOEM 2017). Therefore, in the OCS waters of the US Atlantic and Gulf of Mexico, dredging projects may need separate ESA Section

7 consultations with NMFS when BOEM is serving as lead agency (NMFS 2003). For greater efficiency and effectiveness, USACE and BOEM work together to identify lead agency responsibilities when borrow areas are located within state and Federal waters. Therefore, RPMs, T&Cs, and ITSs issued by NMFS for individual projects can vary and differ from projects consulted with the USACE alone (e.g., NMFS 2005a; 2012b; 2012c; 2012d; 2012e; 2013a; 2013b; 2014c; 2015a; 2015b; 2016). These can include RPMs and T&Cs similar to previous Biological Opinions issued to the USACE (e.g., the SARBO and GRBO), such as requiring NMFS-approved observers to monitor inflow and overflow screens, reporting all interactions with protected species to NMFS, using relocation trawling 24 hours in advance and simultaneously throughout hopper dredging, and inspecting and using sea turtle deflector dragheads (NMFS 2012b). Currently, BOEM and USACE are jointly consulting with NMFS on revised SARBO that will include both state and Federal waters (D. Piatkowski 2016, personal communication). Because incidental take is currently set for individual projects, the anticipated amount or extent can be separated into dredge-related mortalities, dredge-related non-injurious, and relocation trawl mortalities, usually lower than the total set for the associated regional Biological Opinion ITS (e.g., the GRBO if the project is in the Gulf of Mexico as in the NMFS [2012b] Biological Opinion).

For all TSHD projects in the US Atlantic and Gulf of Mexico state and Federal waters, the current mitigation measures were established with limited information on sea turtles and the effect on TSHD entrainment risk (with or without mitigation measures in place) and have not been revised or updated for decades. More information on sea turtles and TSHD operations are now available to be analyzed in a standardized way to better inform resource managers on how to mitigate TSHD entrainment risk. The use of the ASTER DST could set the framework for analyzing sea turtle entrainment risk while utilizing knowledge gathered more recently, especially for sea turtle takes by TSHDs in the OCS where data are more limited.

3.3.5 Costs for Mitigation Implementation

Several mitigation measures now required in the US Atlantic and Gulf of Mexico have been shown to effectively decrease the number of sea turtle takes (Studt 1987; Dickerson et al. 2008b). Although the benefits for conserving sea turtles, other species, and important habitats may be obvious, there can be significant costs to the dredging industry and public (taxpayers), several of which have not been quantified or well-studied for “buying down” sea turtle takes with required mitigation measures. In terms of monetary costs, estimated project costs can further increase due to complications with adhering to environmental windows, such as scheduling conflicts, risks to safety, and delays due to weather (LaSalle et al. 1991; Dickerson et al. 1998; Reine et al. 1998). NMFS-approved observers were estimated at $150 to $200 per day, with possibilities of delays due to clogged screens and sea turtle takes (NMFS 2003; 2005b). Dickerson et al. (2007) estimated relocation trawling costs at $500 per day for personnel per person per day, $5,000 per day per vessel with at least $9,000 worth of nets per project. Individual nets specialized for relocation can range from $1,000 to $1,400 with a minimum of six nets per project (Fitzpatrick et al. 2006). Other costs can involve damage to vessels, gear, habitat, and other organisms caught as bycatch in trawls, injuries of personnel during operations that can occur in unsafe conditions, and unintentional injuries or mortality of sea turtles, all of which can cause delays and contribute to higher project costs (Fitzpatrick et al. 2006; Dickerson et al. 2007). NMFS also estimated the cost of sea turtle genetic data collection and analysis used to support research on sea turtle populations within dredged areas was between $3,200 and $4,800 (NMFS 2005a). With the trends in rising operation costs, these are presumed to be underestimates of present conditions. However, NMFS has stated that the estimated costs associated with the use of observers, relocation trawling, and deflector dragheads were small in comparison to overall project costs and have not been shown to cause significant delays.

3.4 Other Potential Mitigation Measures

Because sea turtle entrainment has not been eliminated for TSHDs, research continues on improving the efficiency of dredging projects while keeping sea turtle takes low. One method that has been used for many years, but not consistently and has not been examined or documented much in regards to the effects on sea turtles, was the use of a bed-leveler during TSHD projects. Bed-levelers are primarily used in association with dredging of navigation channels and are towed on the bottom of the dredged area to smooth out ridges and pits and minimize the amount of "clean up" dredging to achieve required navigation depths. Smoothed bottom surfaces may help with dredging efficiency and may inadvertently remove sea turtles from trenches where they are at risk of being entrained when TSHDs return to the same dredging area (Hales 2003; Paul 2010). Bed-levelers also travel slower, so sea turtles have a greater chance of being deflected or avoiding equipment (Paul 2010). One study of a project in Brunswick Harbor, GA successfully demonstrated that sea turtles were not captured and strandings of crushed turtles did not result from the use of bed-levelers (ANAMAR Environmental Consulting and CH2M Hill 2006). Similarly, positive results from methods outside of relocation trawling, like non-capture seabed sweeping (Dickerson 2009) may minimize sea turtle takes. Non-capture seabed sweeping uses open-ended trawl nets that can encourage sea turtles to move outside of the planned dredging area while reducing their risk of injury or mortality (Dickerson and Bargo 2011).

Planning and designing borrow areas that consider TSHD operational efficiencies to minimize sea turtle entrainment risk may also have promise. A BMP design has been recommended for siting and designing sand resource borrow sites dredged for beach nourishment projects, including specifications that could minimize sea turtle takes in TSHDs (PBS&J 2008). Sites that have large and wide borrow sites can minimize trenches, the number of times the draghead needs to be raised in the water column, and potential for sea turtles to become entrained by the forceful suction (PBS&J 2008). Additional Florida state requirements in place to protect biological resources from dredging, such as the state of Florida's dredging buffer zone around coral reefs and hard grounds, can also affect the design and quality of feasible dredging sites (Finkl and Makowski 2010). Designs that can benefit sea turtles still need more research in terms of costs to TSHD operations and other environmental resources.

International cases for implementing methods to protect sea turtles from TSHD risks have built upon the related research, RPMs, and T&Cs listed in the various NMFS Biological Opinions. Australia, Brazil, Gabon, India, Qatar, and the United Arab Emirates are just some countries that have considered measures to mitigate and better understand sea turtle entrainment at ports and dredging sites (Dickerson 2015). For example, sea turtle deflector dragheads, 100% inflow and outflow screening by trained observers, relocation trawling, and slower vessel speeds were implemented during dredging of Dhamra Port, India in addition to water injection to scare sea turtles away from dragheads (Pilcher 2008, D. Dickerson 2016, personal communication; Dickerson 2009). There were other cases where different mitigation measures may have been in place (e.g., chain deflectors instead of rigid deflectors in Gorgon Gas Project and Wheatstone, Australia, and flexible chain deflectors in Brazil), but gathering details on the implementation, effectiveness, and sea turtle take rates for these alternatives has been challenging (D. Dickerson 2016, personal communication). Information on the continued use of flexible chains used to deter sea turtles in Brazil (Goldberg et al. 2015) may help further research designs. Best practices and lessons learned from other global projects may be beneficial to reducing sea turtle takes within US TSHD operations as more information is released.

3.5 US Atlantic and Gulf of Mexico TSHD Data

There are multiple efforts in the US Atlantic and Gulf of Mexico to collect and analyze data on dredging operations that could inform the risk of sea turtle entrainment by TSHDs in offshore areas, ranging from simply organizing key information collected before, during, and after dredging to the development of tools to analyze the relative use of resources within an area. Because the USACE has a longer history with managing dredging projects in the US Atlantic and Gulf of Mexico, building upon their established programs, data collection mechanisms, and valuable lessons learned would be beneficial. It is recognized that effective and ineffective mitigation measures and environmental parameters surrounding documented sea turtle takes within coastal and inshore waters can still be applicable to OCS borrow sites used mostly for beach nourishment projects. Analyzing factors that have the potential to affect entrainment risk in both nearshore and offshore regions would be an initial step for increasing knowledge and understanding.

For most TSHD projects, the USACE requires information to be collected during operations, such as dredging location, depth, tonnage, vessel speed, and vessel status (e.g., loading, sailing dumping, or idle), to be stored within a National Dredging Quality Management (DQM) Program (CSA International et al. 2009). Information from the DQM can help managers monitor projects more efficiently, especially if linked with other information collected during projects, such as endangered species takes, observed species at the project site, and any mitigation measures (e.g., data on relocation). Data within the DQM have been used to examine intensity (time spent) and exposure (cumulative time) of dredging within specific areas to improve leasing, monitoring, and environmental impact assessments (Gwin 2016; Decker and Whitmont [date unknown]). Improvements to the USACE DQM are ongoing, including better integration of data within other related dredging databases and designating dredging projects affiliated with other agencies such as BOEM (M. Sessions 2016, personal communication).

The NMFS-approved endangered species observers are required for most TSHD projects to document impacts to protected species. The USACE has developed standardized endangered species observer forms to document critical information associated with incidental takes during dredging. These forms have been approved by NMFS and are also required by BOEM to be used for OCS dredging projects. Data collected include time, date, species, location, number of dragheads, mitigation details (e.g., draghead deflector in use, condition of deflector and screening), environmental conditions (e.g., beaufort sea state, air and water temperature), and sea turtle details (e.g., condition, measurements, sex, and age class of the sea turtle). The USACE made early efforts to archive these data in a Microsoft Access database for the Sea Turtle Data Warehouse (USACE 2013), and the data were adapted for studying sea turtle mortalities related to dredging using a geographic information system (GIS; Shellito and Lockwood 2006). Currently, these data are in the process of being transferred to the USACE ODESS, which uses an Oracle database to route information to data web services to make the information viewable and downloadable for the public (USACE 2016b).

In addition to the observed sea turtle takes by TSHDs, data collected on sea turtle relocation by contracted companies during dredging projects are being organized by the USACE. Project name, location, contractor, date, time, environmental conditions (e.g., weather, water and air temperature, tide, and wind speed and direction), begin and end latitude and longitude, sea turtle species, behavior, and condition are just some of the information archived (K. Lockwood 2016, personal communication). Along with similar information on dredge takes, these trawl-associated data can be examined visually within a GIS to assess mortality rates and habitat (Shellito and Lockwood 2006). Requirements for integrating a sea turtle trawling data component in the USACE ODESS are currently being gathered so that the information would be more accessible (M. Sessions 2016, personal communication).

Efforts are currently underway by BOEM to spatially delineate lease and dredging areas for all historic and active sand and gravel borrow areas (BOEM 2015). BOEM is also collating information collected from study areas related to lease projects, such as environmental source data (e.g., sediment and water samples), bottom characteristics (e.g., seabed features and faults), bathymetry and backscatter data (e.g., data from multibeam, LiDAR [light detection and ranging], and sidescan sonar surveys), construction survey data (e.g., tracklines, dredge pipelines and pumpouts), and any other related data from partners (e.g., significant sand resource areas, planning areas/boundaries, essential fish habitat, submerged paleocultural landscapes, and cetacean biologically important areas; Reidenauer and Turner 2016). These georeferenced datasets are being gathered for the BOEM Marine Minerals Information System (MMIS) to help characterize OCS lease and dredging areas for better resource management in the future (Reidenauer and Turner 2016) and would be fundamental for the ASTER DST. Past recommendations for the design of offshore borrow sites have been to have large and wide borrow sites to minimize trenches, while minimizing the number of times the draghead needs to be raised in the water column (PBS&J 2008). Following this specific recommendation can also decrease sea turtle take rates and costs while increasing dredging productivity (PBS&J 2008). Borrow site design that is feasible for minimizing costs and sea turtle interactions (Bates and Jordan-Sellers 2011) can be analyzed within the ASTER DST by using data available from the MMIS to characterize sites spatially and environmentally.

3.6 Stakeholder Feedback from Dredging Industry Experts Workshop

BOEM convened a workshop to engage representative experts from the US dredging industry on September 13, 2016 (Appendix D). The purpose of the workshop was to gather knowledge applicable to the development of the ASTER DST to assess sea turtle entrainment risk in TSHDs. Specific objectives were to:

1. Inform the dredging industry representatives of the ASTER DST study, their contributing role, and the desired end state,
2. Engage dredging industry representatives as collaborative partners early in the development of the ASTER DST,
3. Solicit dredging industry knowledge on project-specific risk factors (physical, biological, geological, etc.) that reduce the efficacy of current mitigation practices and rank the significance, and
4. Solicit recommendations from the dredging industry regarding new mitigations and/or modifications of existing mitigations to reduce entrainment risk.

Participants were asked to identify dredging project-specific risk factors (physical, biological, geological, etc.) that could reduce the efficacy of current mitigation practices and rank their significance, based on their experience. The top three priority risk factors identified included sea turtle behavior, borrow area footprint and design, and the bottom environment of the dredging area. Participants were also asked to suggest any new mitigation measures or improvements to the current mitigations that could potentially be used to minimize the risk of sea turtle entrainment. Discussions among dredging industry experts during the workshop helped to build a comprehensive list of risk factors and mitigation measures that were considered for integration into the ASTER DST, based on the most relevant and important variables for sea turtle entrainment risk. Feedback also included recommendations for sharing insights and expertise from dredging industry representatives with BOEM and NMFS, essential data to integrate into the ASTER DST, options within the ASTER DST for the developers to consider, and how results could be applied to management and direct future scientific research priorities.

4 Development of the ASTER DST

4.1 Background to the Development Process

One of the primary goals of this project was to develop a standardized geographically and temporally based DST for use by multiple practitioners in the Atlantic and Gulf region to assess project-specific dredging entrainment risk within a common framework. The resulting ASTER DST allows a user with some amount of sea turtle behavior, dredging, and/or borrow area planning experience to utilize existing data when analyzing entrainment risk and allows them to share their logic in a consistent manner. Having the information from the selected datasets available to review will provide more power and transparency in the decision-making process.

A total of 21 variables were compiled for use in the ASTER DST. These variables were initially defined based on the results of the literature review describing factors influencing entrainment risk of sea turtles associated with TSHD operations, as discussed in section 2.5. The previously mentioned workshops with dredging and sea turtle technical experts were used to validate and prioritize those data assumptions.

When available, datasets for those variables identified during the two expert meetings were located, downloaded, and compiled into a file geodatabase (fGDB). A full list of data can be seen in Table 12. Data sources included MarineCadastre.gov, BOEM's Marine Minerals Information System, OBIS-SEAMAP, and personal communications with BOEM, US Navy, and USACE stakeholders. Remotely sensed data (SST, chlorophyll *a*, current velocity, etc.) was compiled as ten year monthly averages using the Marine Geospatial Ecology Tools (MGET) developed by the Marine Geospatial Ecology Lab at Duke University (Roberts et al. 2010).

Table 8. List of available data layers within the ASTER tool, the data owners, and links to the data when available

Variable	Source(s)	Link
Marine Minerals Lease Areas	BOEM Marine Minerals Information System (MMIS) Federal OCS Sand and Gravel Borrow Areas (Lease Areas)	https://gis.boem.gov/arcgis/rest/services/BOEM_BSEE/MMC_Layers/MapServer/14
Marine Minerals Resource Areas	BOEM MMIS Sand Resource Areas Feature Class	Unavailable
Number of Trawl Encounters	BOEM MMPGIS Direct Species Impacts Feature Class	Unavailable
Number of Dredge Entrainments	BOEM MMPGIS Direct Species Impacts Feature Class	Unavailable
Number of Turtle Records	OBIS-SEAMAP All turtle Telemetry and Visual Records at 0.01 degree resolution	http://seamap.env.duke.edu/serdp
Loggerhead Critical Habitat	NOAA Critical Habitat Designations in the US as of January 2016	ftp://ftp.coast.noaa.gov/pub/MSP/CriticalHabitatDesignations.zip
Loggerhead Distribution Density	SERDP NODES Habitat Density Models	http://seamap.env.duke.edu/serdp
USGS East Coast Sediment Texture Database	USGS National Seafloor Sediment (usSEABED)	https://woodshole.er.usgs.gov/project-pages/sediment/gis-data-catalog.html
Seagrass	NOAA Seagrasses in the continental US as of March 2015	ftp://ftp.coast.noaa.gov/pub/MSP/Seagrasses.zip
NAMERA Benthic Habitat	The Nature Conservancy Benthic Habitat Feature Classes	https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/namera/namera/Pages/Spatial-Data.aspx
NOAA Benthic Habitat	NOAA OCM Benthic Cover	https://coast.noaa.gov/arcgis/rest/services/MarineCadastre/BenthicCover/MapServer

Variable	Source(s)	Link
US Navy Bottom Type	US Navy NAVFAC	Unavailable
SEAMAP South Atlantic Bottom Type	South Atlantic Fisheries Management Council - SEAMAP Bottom Mapping Workgroup	http://www.seamap.org/SouthAtlantic.html
Bathymetry	NOAA Coastal Relief Model	https://www.ngdc.noaa.gov/mgg/coastal/crm.html
Slope	Derived from Bathymetry	
Roughness	Derived from Slope	
SST	Canada Meteorological Center. 2012. GHRSST Level 4 CMC0.2deg Global Foundation SST Analysis (GDS version 2). Ver. 2.0. PO.DAAC, CA, USA –monthly climatological average for previous 10 years	http://dx.doi.org/10.5067/GHCMC-4FM02
Current Velocity	NASA OSCAR – monthly climatological average for previous 10 years	http://podaac.jpl.nasa.gov/dataset/OSCAR_L4_OC_third-deg
Wind Velocity	AVISO group – monthly climatological average for previous 10 years	http://www.aviso.altimetry.fr/
Significant Wave Height	AVISO group – monthly climatological average for previous 10 years	http://www.aviso.altimetry.fr/
Chlorophyll A	NASA GSFC OceanColor Group - MODIS-Aqua L3 SMI	http://oceancolor.gsfc.nasa.gov/

Once all available datasets were combined into an fGDB, the data was loaded into a mapping application and published as a web service for use in the application.

4.2 Application Development

BOEM was interested in creating a simple, standardized application for users with fair to poor GIS skills and experience. This removed the potential for developing an add-in package to be used in conjunction with desktop mapping software as access to this software would be limiting. The solution was determined to be a web-based mapping application that could be operated on a standard internet browser. The chosen technologies are illustrated in Figure 5 and were selected to be consistent with other applications developed for BOEM. A more detailed description of the technical architecture can be found in Appendix E.

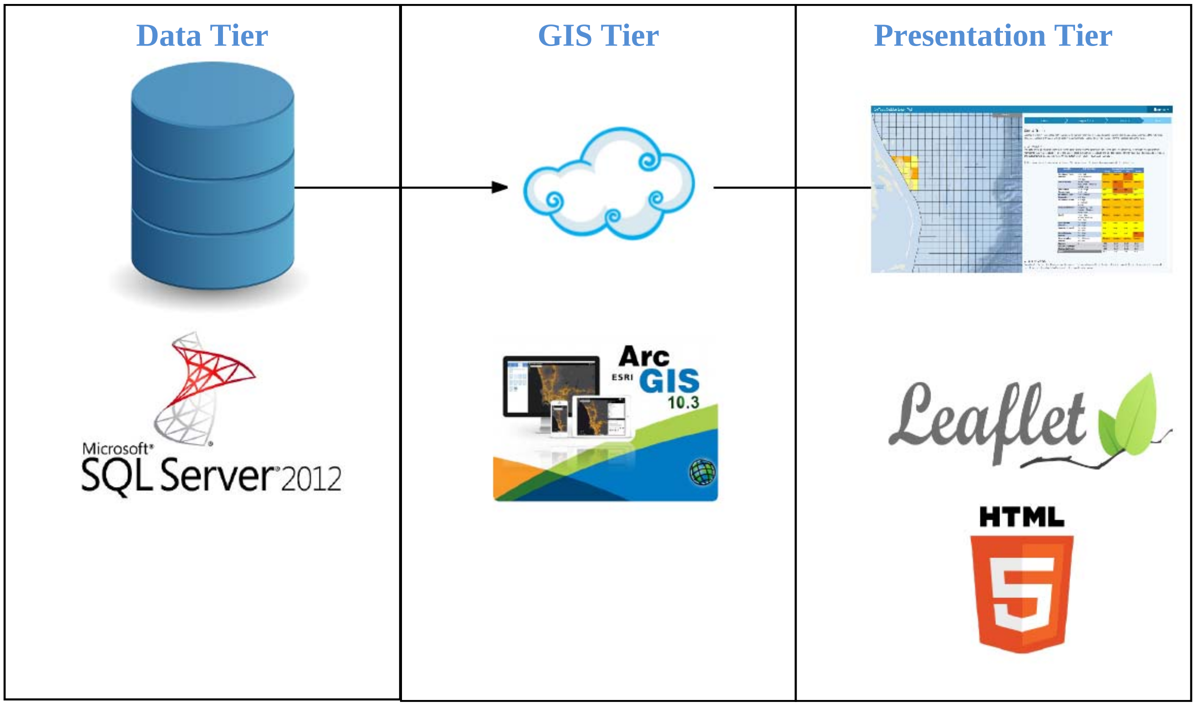

Figure 5. High-level architecture for the ASTER application

The high-level workflow for ASTER involves four main steps described in Figure 6.

Step 1: Select Variables – The user chooses an area of interest (AOI) and selects variables and associated risks relevant to that area. From that selection, a qualitative risk score is calculated.

Step 2: Define Risk Ranges – The user defines absolute risk ranges from the resulting collection of risk scores, which are used to symbolize the data as low, medium, and high risk classification for reviewing the spatial distribution of risk.

Step 3: Review Mitigations – The user can review mitigation options and "buy down" risk by applying one or more mitigation measures to a dredge project.

Step 4: Generate Report – The DST compiles all the user inputs and results into a printable report.

A detailed user manual is provided in Appendix F, but a summary of the tool workflow is provided below.

To optimize the application's processing time, a geoprocessing service was developed to compile data layer values into a gridded polygon feature class which became the scale of analysis for the tool. The grid is a combination of a subset of BOEM OCS Leasing Blocks and blocks of the same size extended into state waters to cover the nearshore environment. The analysis area available for ASTER can be seen in Figure 7 and was driven by the depth limitations of a hopper dredge, however the decision to extend the grid into both deeper and shallower waters was based on the need to perform the analysis not just in lease areas, but also proximal to them due to the transient nature of turtles. Because of the large area covered, this "canning" of the data allows for significant performance improvements over conducting the analyses on the fly with each run of the tool.

Two primary categories of data exist within ASTER, polygon data that reflects presence or absence of a seabed or political feature (e.g., seagrass or MMP leases) and continuous data (point and raster) that indicate a value (e.g., number of turtle records and SST).

For each block, the geoprocessing service performs one of two analyses on each data layer. For presence/absence data, a spatial intersect is run and a yes/no flag is added as an attribute to the grid dataset. For continuous data, an average or a sum is calculated for the extent of the block and the value is added as an attribute in the grid dataset. This process is iterated for temporally discreet data layers so that an attribute exists for SST in January, SST in February, etc.

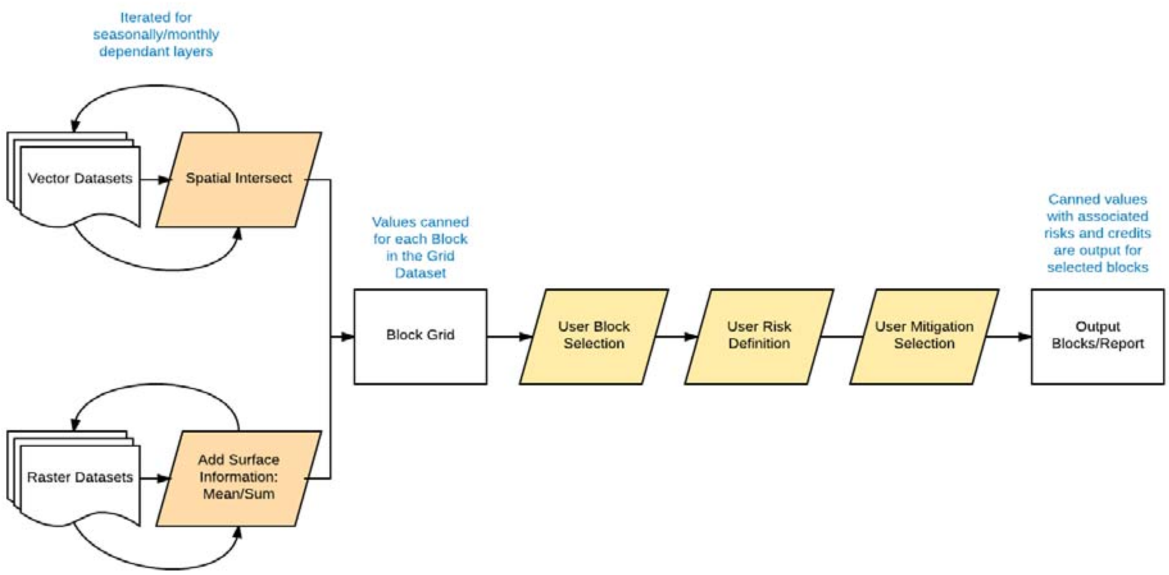

Figure 6. High-level workflow for the ASTER application

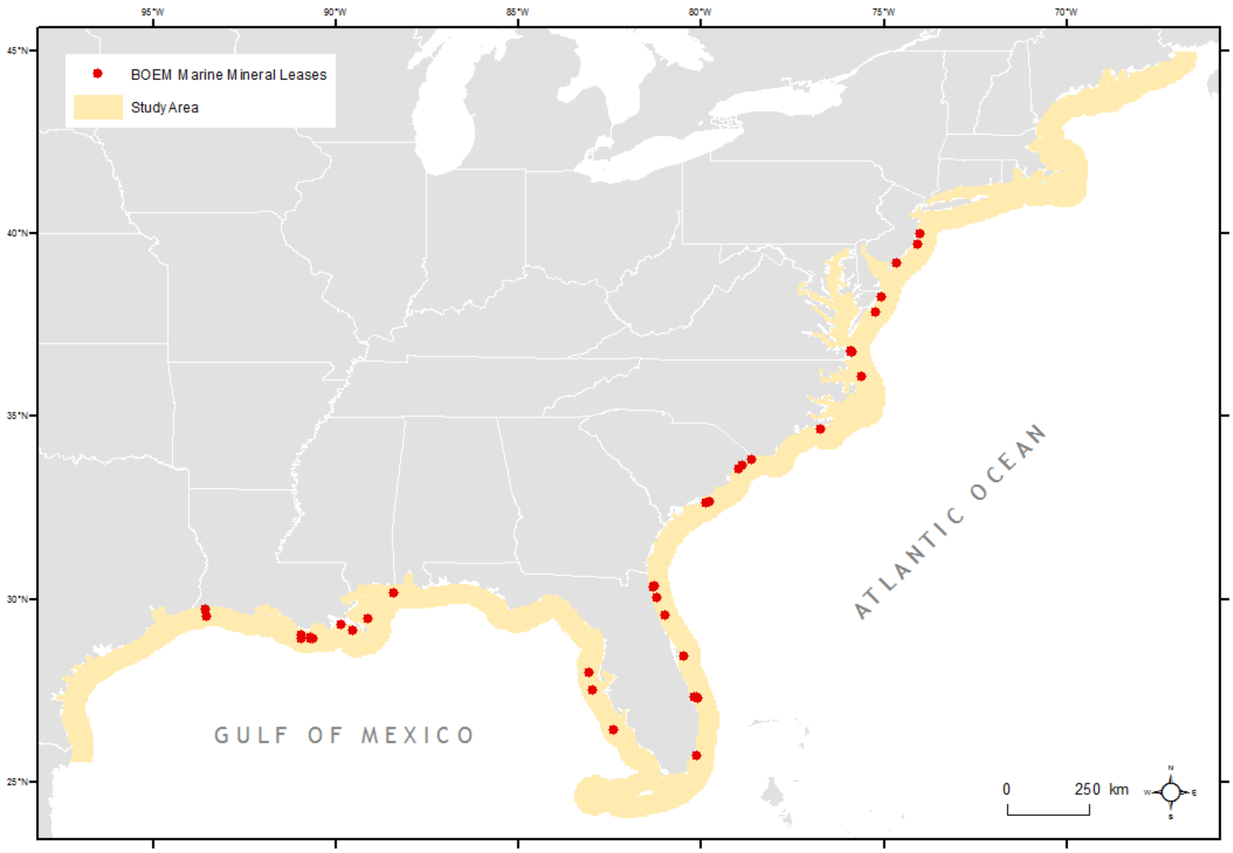

Figure 7. Extent of the ASTER analysis grid
The beige area represents the available areas for analysis covered by the canned data grid within the ASTER tool.

4.2.1 Step 1 – Select Variables

After selecting a temporal division over which to summarize data (months or seasons), a selection of blocks is made in the map panel. The user will then choose variables from a defined list and assign risk intervals for low, medium, and high using a slider or drop-down selector (Figure 8). This subset of blocks, the name of the variable to analyze (field name), and the from and to values are passed into the geoprocess. Conditional logic is applied to each field (representing each variable selected for analysis in the application) to assign a numerical value of 1, 2 or 3 i.e. low, medium and high. All the new risk attributes are tallied based on their respective temporal division and new total risk fields are added to the attribute table. Upon completion of the process the selected blocks with newly added variable and total risk fields are passed back to the application.

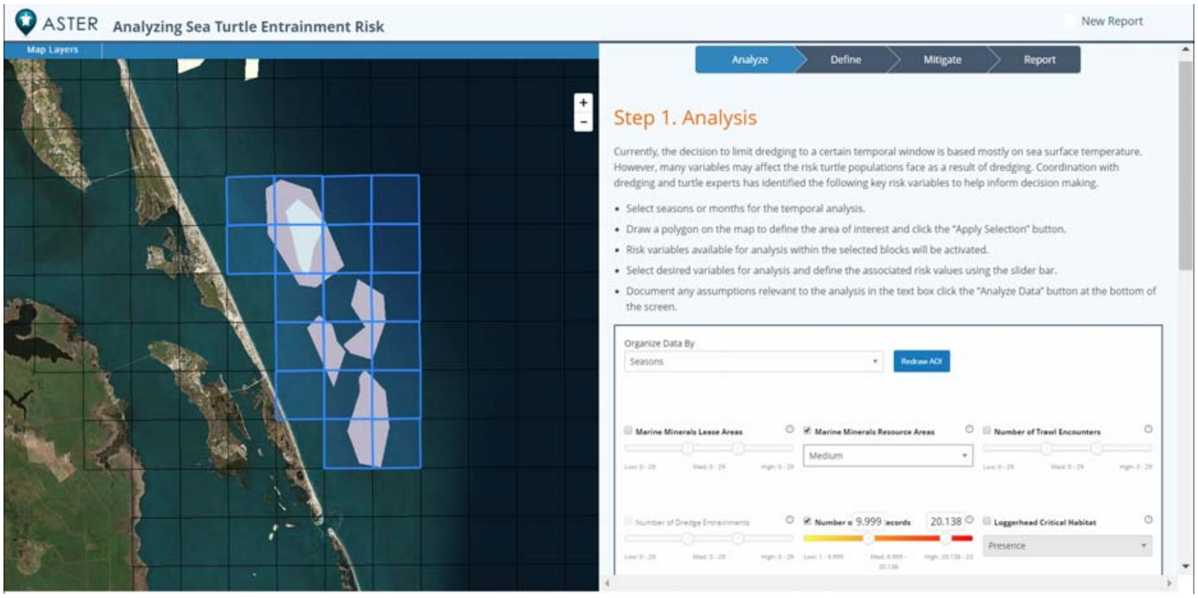

Figure 8. Available and selected variables for the selected blocks

4.2.2 Step 2 – Define Risk Ranges

The assignment of Low, Medium, and High risk classifications at the block level allows the distribution of total risk scores to be viewed in a map. In this way, the user can review the results of Step 1. A histogram graphically displays the distribution of total risk scores over all blocks and for all time periods (Figure 9). Statistics (minimum, maximum, mean, standard deviation) associated with the graph are calculated and displayed. A slider bar captures the risk score interval representing medium risk. Low risk symbology is applied to any score less than the lower limit of the medium risk interval and high risk symbology is applied to any score greater than the upper limit of the medium risk interval.

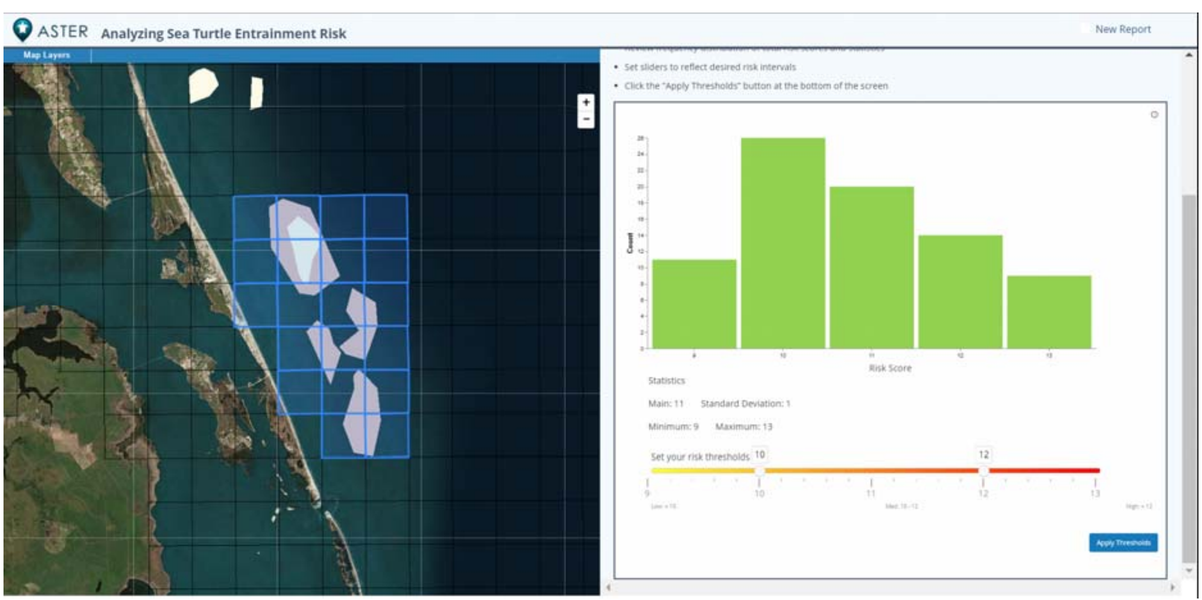

Figure 9. Histogram showing distribution of total risk scores and slider to define block level risk

4.2.3 Step 3 – Review Mitigations

The third step in the workflow allows users to review the results based on the analysis in step 1 and the symbology assigned in step 2. A drop-down menu is provided to review the spatial and temporal distribution of risk across seasons/months. Then, the option of enacting mitigations allows the values assigned during Step 2 to be reduced by applying various mitigations, in the form of credits, to better reflect the overall impact of the proposed dredge project. The user is provided a list of mitigation options (Figure 10), each with a corresponding credit value. As mitigations are selected, the symbology and distribution of risk is updated dynamically in the map view. Currently, because of insufficient research and documentation, all mitigations have the same credit value. As more studies are conducted and information is gathered from experts, the goal for the ASTER DST would be to apply a more significant weighting to each mitigation. The sum of selected credits is deducted from the total risk calculated during Step 1, creating the final mitigated value.

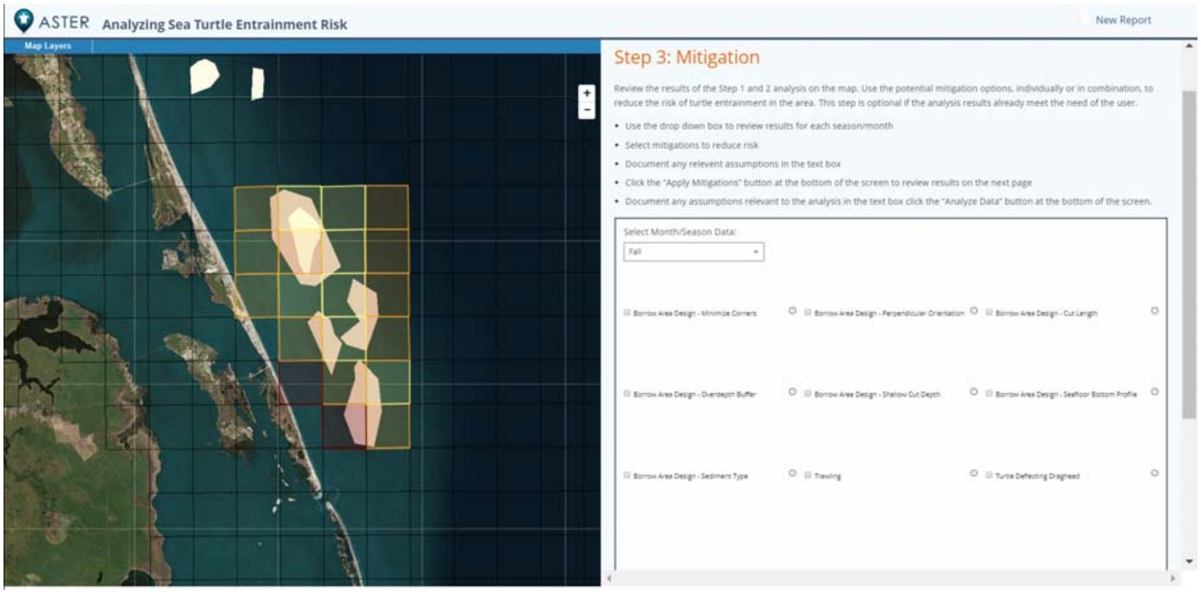

Figure 10. Results from Steps 1 and 2 displayed on the map along with a list of mitigations to select

4.2.4 Step 4 – Generate Report

User inputs are stored throughout the run of the tool so that a report containing an easy to read summation of results can be generated at the completion of the tool. The report can be previewed in the application (Figure 11) and then exported as a PDF to be stored locally. Along with the PDF version of the report a feature class of the selected blocks is also output. This feature class contains the original data from the canning process, variable risk values as assigned by the user, total risk score, credit value, and final mitigated score. Having this information available for inspection gives the user power to provide that information to planning partners, to view individual dataset values within a mapping application, and to agree or disagree with the ultimate results of the tool.

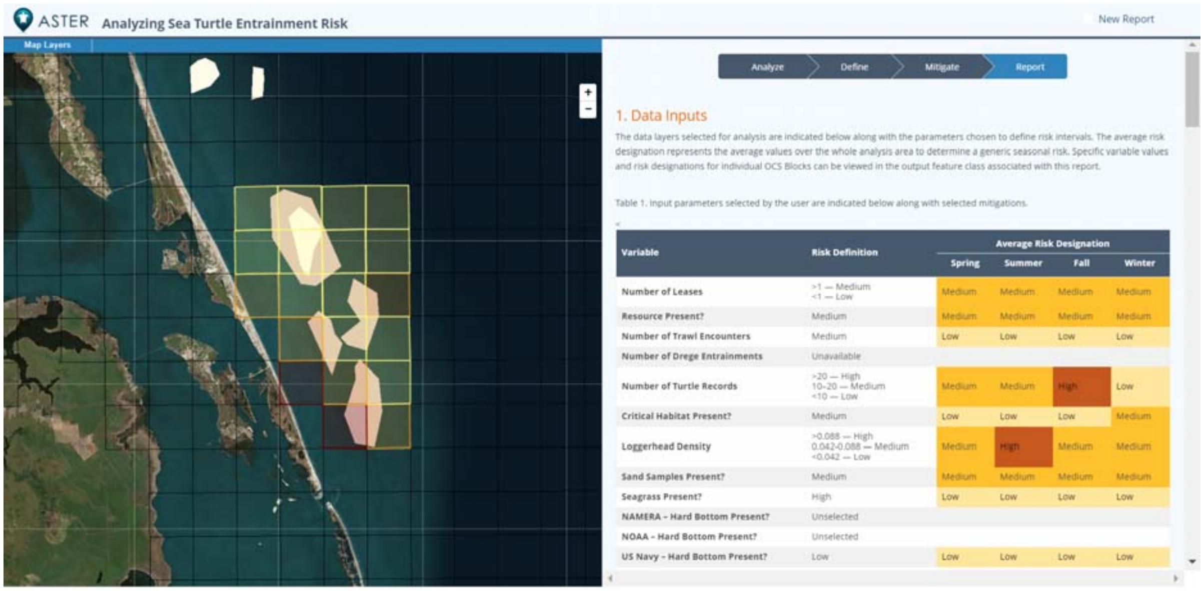

Figure 11. Preview of the report generated by the ASTER tool
The map shows changes in risk distribution from Figure 9 as a result of selected mitigations.

4.3 Potential Improvements and Future Work

Through the course of development new functional requirements were generated that exceeded the scope and/or timeline of this project. The implementation of these would result in a more accurate and/or more robust tool in the future and should be considered. A list of key suggestions is provided in Table 9.

Table 9. Suggested improvements to the ASTER tool for future development

ID	Improvements	Logic	Effort
1	Add suggested risk ranges to variable slider bars	Potential ranges for slider bars would give a user more information on how to define risk. For turtle experts, this would open up the dredge-related variables to potential use and vice versa for dredge experts.	M
2	Implement functionality to move back and forth through the tool using the breadcrumbs in the application	Being able to move freely through the app allows a user to refine variable or risk choices based on information reviewed in a following step without starting the process over from scratch.	M
3	Create a user-friendly interface for the canned data process	To update the block feature class on regular intervals with new data the canned data process needs to be re-run to ensure matching with the back-end database. Currently the process is run through a python script with no user interface. Novice users may not be able to execute this script.	L
4	Add multiple base map options	Having the ability to switch basemaps between imagery, the ESRI Ocean, or nautical charts would allow a user to better define their AOI.	L
5	Expand data sets to state waters	Currently the analysis block grid extends into state waters, though several of the datasets do not. Leases, Sand Resources, relocation trawling, and entrainment data is only available in the OCS under BOEMs jurisdiction. To be fully confident in the analysis within state waters these datasets should be expanded.	M
6	Incorporate post-construction feedback	The creation of a new data set that incorporates the results of a dredge operation with the initial analysis of the tool would provide an opportunity for the tool to learn and improve on future runs of the tool.	H
7	Add custom user layer	In order to accommodate the large extent of the project area, many of the datasets are consumed at the global scale, which results in coarse data resolution. A user may have a more detailed bathymetry or wave height model at a local scale for their AOI that would improve the analysis results. Being able to add a custom data set to the analysis would allow them to use this project-specific data.	H
8	Deployment	Deploying this system was not a requirement of this project. A final location for where this application will live should be determined and the work put in to deploy so that stakeholders can begin to use the tool early in the lease planning process, review the results, and provide feedback for additional improvements.	M/H *depending on deployment location

5 Research Recommendations and Conclusions

5.1 US Atlantic and Gulf of Mexico Sea Turtles

Stakeholders from both the sea turtle research and dredging industry communities identified the number one limitation to analyzing sea turtle entrainment risk was the lack of comprehensive sea turtle distribution and behavior data, especially in regards to certain species, life stages, seasons, and sites (Appendices C and D). Sea turtles are most accessible for research when nesting on land (females), but nearshore habitats can be areas where sea turtles are the most vulnerable due to their life history and the amount of anthropogenic threats (e.g., fishing, boat traffic, pollution, dredging; Weber 1990). The availability of data on sea turtles are geographically and temporally biased, with generally more information on nesting females in the western Atlantic (Godley et al. 2008; Kot et al. 2010). It has also been recognized that nearshore marine habitats can be important for parts or even all of a sea turtle's life cycle, yet much work still needs to be done in understanding sea turtle distribution and habitat use of all sexes and species, especially in the Gulf of Mexico where there are relatively few nesting beaches (Weber 1990). Many gaps remain on the basic biogeography of sea turtles, where and when sea turtles spend their time nearshore, resources they depend on, migratory routes and population boundaries (Hamann et al. 2010). Filling in these gaps can give more insight on the level of impact specific anthropogenic threats have, such as risks from TSHDs.

Engaging with key data owners and researchers for information across species, sex, and age classes was fundamental for analyzing entrainment risk within the ASTER DST. Data collected using satellite telemetry can provide great insights on sea turtle habitats (e.g., migratory routes, foraging and nesting sites, internesting areas, and overwintering habitats), so increasing the amount of available data would be beneficial. As the number of tagged sea turtles continues to grow worldwide, it is important to note that there are still biases in terms of species, sex, and age classes. Just within the US Atlantic and Gulf of Mexico EEZ, adult female loggerheads make up at least 25% of all tagged animals, corresponding to what Godley et al. (2008) found in global trends of published tracking studies. According to the data available on seaturtle.org/STAT and OBIS-SEAMAP, tagging data from subadults and juveniles of all species were relatively rare, especially for males. More satellite tag data may also be available outside of seaturtle.org/STAT and OBIS-SEAMAP (see Appendix A, Sea turtle telemetry datasets section for references), but the need for information on sea turtles other than nesting loggerhead females still exists (Godley et al. 2008). In addition, any potential niche separation among the different species, sex, and age classes could be examined with greater amounts of data from a variety of animals (Block et al. 2011). According to participants of the sea turtle research expert workshop, several sources of data on sea turtle movement and ecology applicable to analyzing sea turtle entrainment risk in TSHDs are forthcoming, such as telemetry data collected by the USGS on tagged sea turtles relocated from dredging sites (Appendix C). The increased use of telemetry data collected by satellite and other devices (e.g., radio, acoustic, global positioning systems [GPS]) has been advancing research on the life histories of marine animals, which in turn, can be used for more effective management (Hussey et al. 2015).

The ASTER DST will utilize any sea turtle habitat and density models to cover areas that lack information, and will rely on the most up to date results when possible. Proceedings from a workshop on sea turtles and marine mammals in 1989 had described the needs for a model to predict impacts on sea turtles based on their distribution, movements, ecology, behavior, and physiology (Bjorndal and Bolten 1990; Tucker and Associates 1990). Sea turtle research experts at the stakeholder workshops in 2016 placed a high priority on developing habitat models for assessing potential anthropogenic impacts by predicting the location of sea turtle habitats, distribution, and relative abundance (Appendix C). Unfortunately, habitat models are still needed for the US Atlantic and Gulf of Mexico because much of the basic information for these sea turtle species is still unknown. Great strides have been made to develop habitat and density models for marine mammals in the US Atlantic and Gulf of Mexico using NMFS dedicated survey data (DoN 2007a; 2007b; 2007c; Best et al. 2012) along with improved models that have incorporated data collected more recently and outside of NMFS surveys and are better controlled for animal detection, among others (Roberts et al. 2016). Sea turtle density models have also been developed (DoN 2007a; 2007b; 2007c), and newer models are in progress by Duke University to build upon lessons learned and methods developed for the improved marine mammal models developed by Roberts et al. (2016). In addition, recent work by University of St. Andrews determined better detection functions for loggerhead sea turtles that could enhance the accuracy of sea turtle density estimates in the US Atlantic (Burt 2014; Scott-Hayward et al. 2014).

Leveraging multiple types of data to determine the spatial and temporal distributions, behavioral patterns, and any related life history characteristics would be necessary for a more comprehensive assessment (Dickerson et al. 1995a; Fujioka et al. 2014). While many efforts are ongoing for collecting more biological information, the use of existing data (e.g., strandings, nesting sites, dedicated and opportunistic surveys, and telemetry) should be utilized in the meantime. Recent improvements on the tools and methods used to combine different types of data for marine habitat modeling within a standard, common framework have been made (Fujioka et al. 2014), many of which could be incorporated into the ASTER DST. Another priority would be to overcome the challenge of "losing" data and knowledge because of the unwillingness or failure to disseminate research for broader applications. The ability to share and give access to readily available data from past and new research contributing to these knowledge gaps should be a high priority.

Efforts that would facilitate the discovery of fine-scale data within specific regions would support the objectives of the ASTER DST in using the best available data to make more informed decisions. Fine-scale movements of sea turtles in shallow waters, such as dive profile data are especially rare, but progress is being made to slowly fill the knowledge gaps with the use of telemetry and other technologies. Information on the way sea turtles behave during different times in their life history, is critical to understanding relative risk of TSHD entrainment. Currently, there is no centralized repository or information database for sea turtle behavior data (M. Coyne and K. Vigness-Raposa 2016, personal communication), though it has been recognized to be extremely useful for marine mammals and other taxa in order to identify research gaps (Shaffer and Costa 2006; Raposa et al. 2007). Many of the technologies collecting fine-scale behavior data are customized and unique, which makes it difficult to standardize and collate into one system. Raposa et al. (2007) put together georeferenced footprints for select marine mammal and leatherback behavior projects, which can be viewed online (http://seamap.env.duke.edu/mwbd), but it is not currently being updated. Participants from the sea turtle research and dredging industry expert workshops stressed the need for collecting more information on sea turtle behavior in relation to dredging operations and a strong interest in collaborating with others (Appendices C and D). The trends of increasing access to computers and other electronic devices and improved technologies for processing and storing data (Shaffer and Costa 2006) will continue to drive interest in using robust datasets to answer broader questions, but many analyses can only be achieved with a variety of data sources.

Environmental windows have previously been established based on temperature thresholds below which sea turtles were less likely to be present. SSTs have been shown to correlate with sea turtle locations along the Outer Banks in North Carolina, with aggregated distributions in waters 8 — 28 degrees C and relatively infrequent sightings in waters less than 11 degrees C (Coles et al. 1994; Epperly et al. 1995). The chances of abundances and overwintering may also be discerned by temperature if the minimum bottom temperatures of a site are known to be below the lethal limits (Lutcavage and Musick 1985). Information on sea turtle takes by TSHDs and temperature are currently being collected (Slay 1995; USACE 2016b), and any other environmental factors associated with takes at borrow sites (e.g., in situ [collected by observers or operators], or remote [collected by buoy or satellite]) should be made available to the ASTER DST. Environmental windows can be refined based on available fine-scale data on how sea turtle distribution and takes are affected by temperature or any other environmental covariates. Stakeholders at the dredging industry expert workshop agreed that environmental windows should be improved with the use of sound science and operational logic (Appendix D). Past sea turtle density models for the US Atlantic and Gulf of Mexico examined bottom depth, latitude, longitude, SST, and chlorophyll *a* concentrations as covariates (DoN 2007a; 2007b; 2007c). Mazor et al. (2016) found that sea turtle distribution in the Mediterranean were related to chlorophyll, salinity, SST minimum, phosphorous concentration, calcite concentration, silicate concentration, bathymetry, and distance to shore. Environmental parameters found to be related to marine mammal distribution in the US Atlantic and Gulf of Mexico can also help guide dataset inclusion for the ASTER DST (Good 2008; Roberts et al. 2016; Mannocci et al. 2017). Although many of these environmental parameters are dynamic within a relatively small temporal and spatial scale, there have been successful cases of implementing marine spatial planning based on dynamic covariates (Howell et al. 2008; Hobday et al. 2010; Hobday et al. 2011; Bethoney et al. 2013; Howell et al. 2015; Lewison et al. 2015). Furthermore, adaptive management using real-time availability of dredging data can be applied to optimize dredging operations during the course of the project (Savioli et al. 2013). Based on these success stories, determining environmental scenarios for managing sea turtle entrainment risk may be possible within the ASTER DST.

5.2 US Atlantic and Gulf of Mexico TSHD

One of the mitigation measures that have had the greatest impact on reducing sea turtle entrainment risk, while affecting project costs, are the regional environmental windows where TSHD operations are restricted to certain months based on the location of the project (Dickerson et al. 1990). Environmental windows have mainly been defined by using water temperature as a proxy for low sea turtle presence along with low probability of entrainment risk. However, when dredging operations are restricted to operate only within environmental windows, the current demand on the limited hopper dredging fleet can significantly impact project costs (Suedel et al. 2008). Furthermore, there have been multiple projects (including offshore borrow area projects) where dredging by TSHDs within environmental windows occurred while sea turtles were present in high numbers with little to no observed takes (D. Piatkowski 2017, personal communication). After gathering information from dredging industry and sea turtle research community experts, many other factors should be considered for analyzing risk that could be used to refine how environmental windows are currently defined (Appendices C and D). Therefore, it is important for managers to have tools, such as the ASTER DST, to be able to reconsider how environmental windows can take into account a large suite of factors (e.g., TSHD operational conditions, sea turtle behavior, etc.) to better estimate entrainment risk and reduce dredging project costs.

Alterations in dredging equipment and operational practices have also shown to reduce sea turtle entrainment and research is still ongoing for improvements. Operational measures include using California-style dragheads (for USACE fleet TSHDs, as they are no longer used by the US private dredging industries), which operate flatter and closer to the sediment than other designs, restricting draghead opening size to 120 square in (120 square cm), screening for evidence of sea turtles within drag arm and draghead water intakes and hopper bins (with openings less than 3 in), constant use of observers, and turning on suction pumps only when dragheads are in the bottoms sediment (Studt 1987; Montante 1990; Dickerson et al. 1991). Although the USACE has gathered much of the biological and engineering data to inform management approaches that would minimize impacts to sea turtles, mortality and most likely sublethal effects still exist with TSHD operations (Dickerson et al. 1995a). In certain cases, the current NMFS Biological Opinion's RPMs and T&Cs in place to minimize the risk of sea turtle entrainment in TSHDs have been effective when the requirements were properly implemented. Pursuing conservation recommendations listed within the NMFS Biological Opinions have also furthered the protection of sea turtles from TSHDs. However, cases still exist for entrained sea turtles when mitigation measures were properly in place. As discussed during the dredging industry and sea turtle research community expert meetings, more research is needed to determine parameters (e.g., sea turtle behavior, environmental factors, site-specific characteristics, time period, etc.) that can better explain differences in entrainment rates (Appendices C and D).

Currently, the USACE is testing the use of a curtain of chain ("tickler chain") hung ahead of the draghead to provoke sea turtles to move away while dredging channels in Hawaii, following earlier usage in Brazil (D. Dickerson 2016, personal communication). It is important to note that the earlier, unsuccessful tests of "flexible chain deflectors" by Nelson and Shafer (1996) were experimented as an alternative to more rigid deflectors; these tickler chains used a different technology to encourage sea turtles to move away from the draghead. Preliminary results showed that tickler chains have great mitigation potential, but more research is needed to assess efficacy and the effects of tickler chain use in lieu of the deflector (D. Dickerson 2016, personal communication). Other mitigation measures currently not required in the US, but have been explored or used outside of the US, are the use of hydroacoustics to detect turtles so they can be removed, techniques to disperse turtles from the project area (e.g., physical or acoustic disturbances and water jets), and bed-levelers during operations to smooth pits so that sea turtles cannot be caught in them (Dickerson et al. 1995a; Dickerson 2015). Methods for acoustic dispersal and detection have not yet been successful (Kasul and Dickerson 1993; Moein 1994; Moein et al. 1994; USACE WES 1997; Dickerson et al. 2004), but recent technological advancements and research with the use of sidescan sonar to detect sea turtles may be applicable in the future (Avens et al. 2013, D. Piatkowski 2016, personal communication). Similar alternative approaches have been used to mitigate entrainment of other organisms (e.g., fish). In addition, the USACE has conducted some studies in 2015 using acoustic cameras during a dredging project in Hawaii to survey the presence of sea turtles and other organisms during dredging operations (D. Dickerson 2017, personal communication). Improvements to the TSHD operating measures already in place and expanding upon other past efforts, while reducing their cost, is an ongoing need (Dickerson et al. 2004). Participants of the dredging industry expert workshop were willing to explore and test other mitigation measures if given the ability (flexibility within current mandates) and support/incentives (Appendix D).

Current technologies and costs of mitigation measures to the TSHD industry need to be taken into account when determining alternatives, such as changing environmental windows, adjusting operational procedures, or redesigning equipment. However, considerations should also be taken for the use of other dredge types (e.g., clamshell and pipeline dredges) to reduce entrainment (NMFS 1991) where operationally feasible. Given that clamshell and pipeline dredges are stationary and/or impact relatively small areas at a given time, these methods are not subjected to the same hopper dredging requirements, including environmental windows (NMFS 2005b). Cost-benefit analyses of a project would need to guide decisions for the use of TSHD alternatives, given the advantage that TSHDs can carry larger loads long distances from offshores sites and the disadvantage of incurring more costs for complying with the various mitigation measures. Improving the efficiency of alternative dredge types may be beneficial if overall costs can be minimized.

Another way to reduce sea turtle risk is to optimize sites (inshore, offshore, and on land) and the design of sites for obtaining sand and gravel resources. The assessment of multiple scenarios can be used to determine the most efficient alternative to maximize dredging operations while minimizing interactions to protected marine organisms and damage to essential marine habitats. Any improvements or supplemental information to the past recommendations for BMPs in designing and siting areas to avoid and minimize impacts and associated costs to TSHD operations should be taken into account for future scenarios (PBS&J 2008). Participants at the dredging industry expert workshop suggested several practices that could be applied to mitigate and possibly reduce entrainment risk, including more training for borrow area design engineers to be more involved in properly designing borrow areas to minimize entrainment (Appendix D). These and other suggestions for monitoring sea turtle behavior and environmental parameters discussed by sea turtle research experts (Appendix C) should be investigated further for various borrow designs and operation methods.

Past research has focused on assessing the environmental risks of TSHDs, particularly on the destruction of benthic habitat, release of contaminants, and mortality to benthic invertebrates. However, sea turtle interactions with TSHDs are less understood, and this information is critical for decision making. One reason for the lack of information is the difficulty of detecting interactions when they occur, whether it is a sublethal but negative response (i.e., physiological stress), injury, or mortality (Slay and Richardson 1988; Richardson 1990; Slay 1995).

The effects TSHD operations and associated activities have on sea turtles are still largely unknown, especially since many are undetected because of the inherent limitations to observing evidence of entrainment or injury, inability to assess sea turtle conditions post-interactions (injurious or not), and unknown behavior modifications during TSHD projects (Richardson 1990). For example, sounds associated with TSHD operations have recently been characterized (Reine et al. 2014), but there are still major gaps in knowing the effects of anthropogenic sound exposure to sea turtles (Hawkins et al. 2015). In addition, Dickerson et al. (2007) found that more aggressive relocation trawling effort initiated early in the dredging project was better at reducing TSHD takes than less aggressive trawling late in the project. Sea turtles have been shown to have significant physiological stress, sometimes resulting in mortality, from being captured and released by other trawling methods (Lutcavage and Lutz 1991; Harms et al. 2003). Juveniles are at higher risk to stress when compared to adults because their size can make them more vulnerable to trawl captures (Lutcavage and Lutz 1991). To date, efficacy of relocation trawling for reducing sea turtle entrainment and the effects on sea turtle condition have not been fully investigated and remains uncertain. Furthermore, some projects require observers to monitor the dredging area to avoid collisions with protected species (e.g., NMFS 2012a). However, more information on how the presence of vessels negatively impact sea turtles is needed. In general, it has been recognized that anthropogenic threats to sea turtle habitats and the impacts of pollution are research priorities for future sea turtle conservation efforts (Hamann et al. 2010). Given that sea turtles can experience a variety of impacts from TSHD operations, it would be useful if mitigating for certain aspects could decrease the rate of entrainment, the impact known to cause mortality.

In order to fully assess sea turtle entrainment risk by TSHDs, several pieces of information are key, including details on the dredging project, sea turtle biological data, past entrainment data, and the current protection methods used (Dickerson 2009). Precautions for hopper dredging operations within the US Atlantic and Gulf of Mexico need to be taken during all seasons because many age classes and species of sea turtles in the nearshore waters spend much of their time in the benthic zone foraging and resting, mainly during the spring to fall (Addison et al. 2002; Hart et al. 2010; 2013), and taking up residence in overwintering areas, mainly in the winter (Hochscheid et al. 2005; Hawkes et al. 2007). Analyses on the patterns of documented takes, in regards to location, date, time, age classes, and species, relative to the sea turtles' known abundance and dredging effort, can be useful for determining if there are different levels of risk. Annual incidental take limits determined by NMFS Biological Opinions pertaining to TSHD projects vary by North Atlantic, South Atlantic, and Gulf of Mexico regions and USACE Districts within the Gulf of Mexico (Table 7; NMFS 1997; NMFS 2007). Incidental take limits for the North Atlantic vary by channel and volume of sediment dredged. Knowledge on the varying levels of risk can inform managers on a project's potential for contributing to annual take limits set by NMFS and hopefully the appropriate measures needed for reducing takes based on spatial and temporal patterns.

The USACE ODESS has greatly improved the communication of endangered species interactions with TSHDs in the US Atlantic and Gulf of Mexico. Currently, the publicly available data include dredging project, general region, volume of sediment dredged, start and end project dates, and some incidental take details (e.g., species, age class, and condition). Critical pieces of information that would be useful to the

ASTER DST that are recorded on ODESS but not yet available for public download, are details on the time, date, and location of the take. The resolution of information on a take is limited for time and location; the time of take can be attributed to the range between the start and stop time of the load and the location of the take can be attributed to the path of the load or the straight-line path between observer recorded GPS coordinates (D. Dickerson 2017, personal communication). Future releases may include more data integrated from the USACE DQM system, which houses data on dredging operations and conditions, maps and spatial overlays of dredging project, endangered species activity data, and a component of relocation trawling data (M. Sessions 2016, personal communication), all of which would inform any decisions on how to mitigate sea turtle entrainment risk. Another feature not yet available within the ODESS is the ability to determine the lead acting agency (e.g., BOEM or USACE) for a given project, which would be useful for assessing OCS specific entrainment events.

Currently, there is also not a consolidated source for information on borrow sites, the final destination of materials, and impacts on the environment for both. A project conducted by Western Carolina University and the USGS is mapping borrow areas and associated nourishment sites within parts of the US Atlantic coast for the USACE projects that have occurred since 1990 (A. Coburn 2016, personal communication). This project will build upon a database that houses estimated point locations of beach nourishment episodes, with improvements of delineating sediment placement boundaries and sediment sources to enable overall sediment budget (PSDS 2016). Beach nourishment has been used primarily to mitigate erosion and protect infrastructure, but there is also the potential to increase sea turtle nesting habitat assuming subsequent beach characteristics are amenable to nesting females (Witham 1990; Lebuff and Haverfield 1992; Crain et al. 1995; Montague 2006; 2008). Results from collating beach nourishment episodes and any other related sources of data can be the first step to spatially assess borrow and placement areas and examine positive and negative impacts to the environment over time.

The availability of multiple mitigation measures or alternative areas can easily compound the difficulty of prioritizing the best conservation action or project site. DSTs or systems can be used to provide guidance on the most appropriate mitigation measures, given parameters selected by practitioners (Appendix G). Optimization can involve multiple criteria, complex models, constraints, weights, and penalties. The use of weights and/or penalties can account for conflicting factors, such as risks to sea turtles, costs of different mitigation strategies on TSHD operations, effects to critical habitat, and effects on other nearby activities such as fishing, vessel traffic, or surrounding communities. A DST that is flexible in incorporating multiple costs and benefits, including risks to sensitive species, can give more realistic scenarios and potential results after decisions and measures have been implemented (Best 2016). Moreover, the use of any DST should be an iterative process to allow for adaptive management as additional information becomes available (Savioli et al. 2013). While the initial development of the ASTER DST was not intended to incorporate ways to address optimizing dredging sites with the use of parameters outside of information related to sea turtles and specific dredging operation characteristics, the frame work on which it was built does allow for additional information to be added in the future.

In 1981, a Sea Turtle/Dredging Task Force (herein as the Task Force) was created in response to high rates of sea turtle takes in TSHDs and composed of sea turtle experts from the Florida Department of Natural Resources, DoN, FWS, NMFS Southeast Fisheries Science Center and Southeast Regional Office, and the USACE, Jacksonville (Witzell 1987). The main goals for the Task Force was to evaluate ways to reduce sea turtle mortalities during maintenance dredging operations, resulting in mitigation recommendations from the Task Force that are still in place and effective (Witzell 1987). Currently, the Task Force is not active but the need for such a group for evaluating the effects of TSHDs on sea turtles in the nearshore and OCS projects is recommended, especially given the increasing demands of OCS resources and the addition of over 30 years of sea turtle research in the US Atlantic and Gulf of Mexico. The advantage of in-place Federal agency partnerships and collaborations with state, local, and research entities can be leveraged for organizing efforts to improve the knowledge base. With the availability of more information since TSHD mitigation measures were first put in place in the US, it would be prudent to revisit current dredging operations and insights into sea turtle ecology to determine if more refined mitigation measures (e.g., specifically for offshore lease areas, or smaller windows throughout the year) could be more effective. Since sea turtle takes by TSHDs within the US OCS has been relatively low, when compared to channel dredging within nearshore waters (GEC 2012), patterns for entrainment may be more difficult to elucidate in the OCS. Therefore, lessons learned or existing patterns for any takes in nearshore waters may be the first step to facilitate analyses of entrainment risk in other regions. It is not yet known what the relationship is for sea turtle entrainment risk in the nearshore and OCS waters, but along with gathering the necessary data to start to analyze this, long-term involvement of experts from the sea turtle research and dredging industry community stakeholders would be fundamental. Participants of the workshops held in 2016 for the current project (Appendices C and D) have provided significant and valuable information on data layers needed to analyze sea turtle entrainment risk, priority sea turtle entrainment risk factors, practical dredging mitigation measures and innovations to reduce sea turtle entrainment, and advice on the development, design, outputs of the ASTER DST. Continued interactions among expert stakeholders, managers, and practitioners should enhance understanding and increase the possibility for implementing more efficient ways to reduce sea turtle entrainment risk in both the nearshore and OCS waters.

5.3 General Conclusions

The potential for entrainment and mortality of Federally protected sea turtles is one of the significant factors impacting how and when projects can be conducted using TSHDs to extract these resources. As a responsible steward of OCS resources, BOEM seeks to minimize adverse environmental effects related to project-specific dredging operations through deliberate planning efforts and the implementation of relevant and effective mitigation measures. Developing the ASTER DST as a standardized geographically and temporally based decision support tool for use by practitioners in the US Atlantic and Gulf regions can help to assess project-specific dredging entrainment risk within a common framework. Ideally, future work on the tool would expand its spatial application as well as its user base. ASTER DST users can define biological and environmental parameters for candidate dredging areas, including suitable benthic habitat, bottom type, bathymetry, and sea turtle presence/density. The final output of the ASTER DST includes a report informing the user of the relative risk of sites within the selected AOI, providing resource managers a documented process of the mitigation factors considered for site-specific projects. In addition, the ArcGIS feature class provided as an output by the tool can help the user compare the results of the tool with other data and adjust decisions as necessary.

Historically, the USACE, dredging industry, academia, and other partners have made significant investments in improving protective measures and BMPs, by principally focusing on dredging windows, the use of sea turtle deflecting dragheads, dredging operational parameters, and relocation trawling. However, less emphasis has been placed on analyzing existing data and subsequently tailoring these mitigation strategies on a project and/or geographic-specific level.

Based on the available literature and feedback recently gathered directly from experts in the sea turtle research and dredging industry community, the priority factors needing more data to improve analysis of be entrainment risk are:

- Temporal and spatial relationship of sea turtle behavior within the water column (e.g., foraging, migrating, etc.) relative to draghead operating parameters
- Borrow area design relative to turtle deflecting draghead efficacy

Considering the full array of all potential risk factors within the project-specific context, targeted mitigation strategies may be more effective than the conservative presence/absence-based dredging windows currently used. The literature review and technical insight from expert stakeholders were used to inform the development of the ASTER DST and would continue to be good resources for any new information that may be incorporated in the future.

The ASTER DST is intended to be a tool to guide future planning decisions within marine mineral resource areas so that more informed decisions may minimize impacts to sea turtle species. The main objectives for the ASTER DST did not include providing users a final decision on whether or not to dredge in a particular area. In addition, the ASTER DST could help resource managers understand the best way to decrease dredging costs through reduced downtime associated with entrainment incidents and potentially allow more flexibility of environmental windows in areas perceived to have less risk.

6 References

Addison DS, Gore JA, Ryder J, Worley K. 2002. Tracking post-nesting movements of loggerhead turtles (*Caretta caretta*) with sonic and radio telemetry on the southwest coast of Florida, USA. Mar Biol. 141(1):201-205.

Amante C, Eakins BW. 2009. ETOPO1 1 arc-minute global relief model: Procedures, data sources and analysis. NOAA Technical Memorandum NESDIS NGDC-24. Boulder (CO): National Oceanic and Atmospheric Administration, National Geophysical Data Center, Marine Geology and Geophysics Division.

Anderson MG, Prince J, Barnett A, Weaver KJ, Conley M, Goodin KL. 2015. Seafloor habitats. Draft report. Boston (MA): The Nature Conservancy.

Atlas R, Hoffman RN, Ardizzone J, Leidner SM, Jusem JC, Smith DK, Gombos D. 2010. A cross-calibrated, multiplatform ocean surface wind velocity product for meteorological and oceanographic applications. Bull Amer Meteor. 92(2):157-174.

Avens L, Eguchi T, Epperly S, Haas H, Richards P, Seney E, Thompson N, Houtan KSV. 2013. Sea turtle assessment status and research needs. NOAA Technical Memorandum NMFS-F/SPO-131. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

[AVISO] Archiving, Validation, and Interpretation of Satellite Oceanographic. 2015. SSALTO/DUACS user handbook: (M)SLA and (M)ADT near-real time and delayed time products. CLS-DOS-NT-06-034. Toulouse, France: Archiving, Validation, and Interpretation of Satellite Oceanographic Data.

Ball IR, Possingham HP, Watts M. 2009. Marxan and relatives: Software for spatial conservation prioritisation. In: Moilanen A, Wilson KA, Possingham HP, editors. Spatial conservation prioritisation: Quantitative methods and computational tools. Oxford, United Kingdom: Oxford University Press. p. 185-195.

Bamford D, Ye Y, McGuinn R, Stroh C, Beard S, Burkhalter S, Hadley B, Love R. 2009. Habitat priority planner, version 2: Help document. Charleston (SC): National Oceanic and Atmospheric Administration, Coastal Services Center.

Banks G, Alexander MP. 1994. Development and evaluation of a sea turtle-deflecting hopper dredge draghead. Miscellaneous Paper HL-94-5. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

Bargo T, Glass J, Fitzpatrick T, Ouellette D. 2008. Sea turtle relocation trawling: Is it effective? In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 116.

Bass AL, Epperly SP, Braun-McNeill J. 2004. Multi-year analysis of stock composition of a loggerhead turtle (*Caretta caretta*) foraging habitat using maximum likelihood and Bayesian methods. Conserv Genet. 5(6):783-796.

Bass AL, Epperly SP, Braun-McNeill J. 2006. Green turtle (*Chelonia mydas*) foraging and nesting aggregations in the Caribbean and Atlantic: Impact of currents and behavior on dispersal. J Hered. 97(4):346-354.

Bates PC, Jordan-Sellers T. 2011. Best management practice design criteria for hopper dredge/sea turtle friendly borrow sites. In: Jones TT, Wallace BP, editors. Proceedings of thirty-first annual symposium on sea turtle biology and conservation, 10 to 16 April 2011, San Diego, California, USA NOAA Technical Memorandum NMFS-SEFSC-631. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 258.

Becker JJ, Sandwell DT, Smith WHF, Braud J, Binder B, Depner J, Fabre D, Factor J, Ingalls S, Kim SH. 2009. Global bathymetry and elevation data at 30 arc seconds resolution: SRTM30_PLUS. Mar Geod. 32(4):355-371.

Behrenfeld MJ, Falkowski PG. 1997. Photosynthetic rates derived from satellite‐based chlorophyll concentration. Limnol Oceanogr. 42(1):1-20.

Belkin IM, Cornillon PC, Sherman K. 2009. Fronts in large marine ecosystems. Prog Oceanogr. 81(1-4):223-236.

Belkin IM, O'Reilly JE. 2009. An algorithm for oceanic front detection in chlorophyll and SST satellite imagery. J Mar Syst. 78(3):319-326.

Berry SA. 1990. Canaveral Harbor entrance channel operational measures to protect sea turtles. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

Best BD. 2016. Data to decision in a dynamic ocean: Robust species distribution models and spatial decision frameworks. [PhD dissertation]. Durham (NC): Duke University.

Best BD, Halpin PN, Read AJ, Fujioka E, Good CP, LaBrecque EA, Schick RS, Roberts JJ, Hazen LJ, Qian SS. 2012. Online cetacean habitat modeling system for the US east coast and Gulf of Mexico. Endangered Species Res. 18(1):1-15.

Bethoney ND, Schondelmeier BP, Stokesbury KDE, Hoffman WS. 2013. Developing a fine scale system to address river herring (*Alosa pseudoharengus*, *A. aestivalis*) and American shad (*A. sapidissima*) bycatch in the US Northwest Atlantic mid-water trawl fishery. Fish Res. 141:79-87.

Bjorndal KA. 1980. Nutrition and grazing behavior of the green turtle *Chelonia mydas*. Mar Biol. 56:147-154.

Bjorndal KA, Bolten AB. 1990. Goals for sea turtle research in the Gulf of Mexico with respect to the oil and gas industries. In: Tucker and Associates, Inc., editor. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1-3, 1989 OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region. p. 47-58.

Bjorndal KA, Bolten AB, Martins HR. 2000. Somatic growth model of juvenile loggerhead sea turtles *Caretta caretta*: Duration of pelagic stage. Mar Ecol Prog Ser. 202:265-272.

Block BA, Jonsen ID, Jorgensen SJ, Winship AJ, Shaffer SA. 2011. Tracking apex marine predators in a dynamic ocean. Nature. 475:86-90.

Blumenthal JM, Austin TJ, Bell CDL, Bothwell JB, Broderick AC, Ebanks-Petrie G, Gibb JA, Luke KE, Olynik JR, Orr MF. 2009. Ecology of hawksbill turtles, *Eretmochelys imbricata*, on a western Caribbean foraging ground. Chelonian Conserv Biol. 8(1):1-10.

[BOEM] Bureau of Ocean Energy Management. 2013. Guidelines for providing information on marine mammals and sea turtles for renewable energy development on the Atlantic outer continental shelf. Pursuant to 30 CFR Part 585 Subpart F. Sterling (VA): Bureau of Ocean Energy Management Office of Renewable Energy Programs; [accessed 2016 May 13]. http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Regulatory_Information/BOEM_Renewable_MMandST_Guidelines.pdf.

BOEM. 2015. Federal sand and gravel borrow areas (lease areas). Sterling (VA): Bureau of Ocean Energy Management, Marine Minerals Program; [accessed 2016 Feb 19]. http://marinecadastre.gov/data.

BOEM. 2017. Marine Minerals Program current statistics website. Washington (DC): Bureau of Ocean Energy Management; [accessed 2017 Dec 5]. https://www.boem.gov/MMP-Current-Statistics/.

BOEM. [date unknown]. Federal sand and gravel borrow areas (lease areas). Sterling (VA): Bureau of Ocean Energy Management, Marine Minerals Program; [accessed 2016 Apr 27]. https://gis.boem.gov/arcgis/rest/services/BOEM_BSEE/MMC_Layers/MapServer/14.

Bolten AB. 2003. Variation in sea turtle life history patterns: Neritic vs. oceanic developmental stages. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 243-257.

Bolten AB. 2008. Hawksbill nesting in Bahamas: Personal communication. In: Mast RB, Bailey LM, Hutchinson BJ, editors. Where the hawksbills are State of the World's Sea Turtles report volume III. Arlington (VA): State of the World's Sea Turtles. p. 11.

Bolten AB, Bjorndal KA. 1991. Relocation of sea turtles during dredging at Cape Canaveral, FL, 30 December 1990-15 January 1991. Archie Carr Center for Sea Turtle Research - University of Florida, USACE Cooperative Agreement DACW17-90-H-0015. US Army Corps of Engineers.

Bonjean F, Lagerloef GSE. 2002. Diagnostic model and analysis of the surface currents in the tropical Pacific Ocean. J Phys Oceanogr. 32:2938-2954.

Boumans R, Roman J, Altman I, Kaufman L. 2015. The multiscale integrated model of ecosystem services (MIMES): Simulating the interactions of coupled human and natural systems. Ecosyst Serv. 12:30-41.

Bowen BW, Bass AL, Soares L, Toonen RJ. 2005. Conservation implications of complex population structure: Lessons from the loggerhead turtle (*Caretta caretta*). Mol Ecol. 14(8):2389-2402.

Boyer TP, Levitus S, Garcia HE, Locamini RA, Stephens C, Antonov J. 2005. Objective analyses of annual, seasonal, and monthly temperature and salinity for the World Ocean on a 0.25° grid. Int J Climatol. 25:931-945.

Brasnett B. 2008. The impact of satellite retrievals in a global sea‐surface‐temperature analysis. Q J R Meteorol Soc. 134(636):1745-1760.

Braun J, Epperly SP. 1996. Aerial surveys for sea turtles in Southern Georgia waters, June, 1991. Gulf Mex Sci. 14(1):39-44.

Bray RN, Bates AD, Land JM. 1996. Dredging and the environment. In: Bray RN, Bates AD, Land JM, editors. Dredging (second edition): A handbook for engineers. Oxford, United Kingdom: Butterworth-Heinemann. p. 371-387.

Bridges TS, Walker J. 2011. Engineering with nature. Engineering with nature: Designing navigation infrastructure for greater environmental sustainability, 7 - 8 September 2011, Charleston, South Carolina. US Army Corps of Engineers; [accessed 2016 Apr 29]. http://el.erdc.usace.army.mil/training.cfm?Topic=Workshop&List=11Sept-EWN.

Broderick AC, Coyne MS, Fuller WJ, Glen F, Godley BJ. 2007. Fidelity and over-wintering of sea turtles. Proc R Soc Lond B Biol Sci. 274(1617):1533-1539.

Brost B. 2008. Hawksbill nesting in Florida, USA: Personal communication. In: Mast RB, Bailey LM, Hutchinson BJ, editors. Where the hawksbills are State of the World’s Sea Turtles report volume III. Arlington (VA): State of the World’s Sea Turtles.

Buczkowski BJ, Reid JA, Jenkins CJ, Reid JM, Williams SJ, Flocks JG. 2006. usSEABED: Gulf of Mexico and Caribbean (Puerto Rico and US Virgin Islands) offshore surficial sediment data release. USGS Data Series 146 (DS-146). Woods Hole (MA): United States Geological Survey Coastal and Marine Geology Program; [accessed 2016 Apr 27]. http://pubs.usgs.gov/ds/2006/146/htmldocs/data_cata.htm.

Burke VJ, Morreale SJ, Standora EA. 1994. Diet of the Kemp's ridley sea turtle, *Lepidochelys kempii*, in New York waters. Fish Bull. 92(1):26-32.

Burt ML. 2014. Analysis of aerial surveys conducted in coastal waters of Maryland and Virginia, including Chesapeake Bay, 2011 - 2013: Loggerhead turtles. Unpublished technical report Prepared for: Department of the Navy Naval Facilities Engineering Command, Atlantic. Contract: N624070-10-30, CTO 0040. Prepared by University of St. Andrews, St. Andrews, Scotland. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Butler RW, Nelson WA, Henwood TA. 1987. A trawl survey method for estimating loggerhead turtle, *Caretta caretta*, abundance in five eastern Florida channels and inlets. Fish Bull. 85(3):447-453.

Byles RA. 1988. The behavior and ecology of sea turtles in Virginia. [PhD dissertation]. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Byles RA. 1989. Satellite telemetry of Kemp's ridley sea turtle, *Lepidochelys kempi*, in the Gulf of Mexico. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 25-26.

Byrnes MR, Hammer RM, Thibaut TD, Snyder DB. 2004. Physical and biological effects of sand mining offshore Alabama, USA. J Coast Res. 20(1):6-24.

Carr A. 1986. New perspectives on the pelagic stage of sea turtle development. NOAA Technical Memorandum NMFS-SEFSC-190. Miami (FL): National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

Carr A. 1987. New perspectives on the pelagic stage of sea turtle development. Conserv Biol. 1(2):103-121.

Carr A, Caldwell DK. 1956. The ecology and migrations of sea turtles, 1. Results of field work in Florida. Am Mus Novit. 1793:1-23.

Carr A, Ogren L, McVea C. 1980. Apparent hibernation by the Atlantic loggerhead turtle *Caretta caretta* off Cape Canaveral, Florida. Biol Conserv. 19(1):7-14.

Casale P, Tucker AD. 2015. *Caretta caretta*. The IUCN red list of threatened species 2015: e.T3897A83157651. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T3897A83157651.en.

Caswell H. 1989. Matrix population models. Sunderland (MA): Sinauer.

Ceriani SA, Meylan AB. 2015. *Caretta caretta* (North West Atlantic subpopulation). The IUCN red list of threatened species 2015: e.T84131194A84131608. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T84131194A119339029.en.

Ceriani SA, Roth JD, Evans DR, Weishampel JF, Ehrhart LM. 2012. Inferring foraging areas of nesting loggerhead turtles using satellite telemetry and stable isotopes. PLOS ONE. 7(9):e45335.

Chassignet EP, Hurlburt HE, Smedstad OM, Halliwell GR, Hogan PJ, Wallcraft AJ, Baraille R, Bleck R. 2007. The HYCOM (hybrid coordinate ocean model) data assimilative system. J Mar Syst. 65(1):60-83.

Chelton DB, Schlax MG, Samelson RM. 2011. Global observations of nonlinear mesoscale eddies. Prog Oceanogr. 91(2):167-216.

Clausner JE, Dickerson D, Dasilva A, Banks G. 2004. Equipment and operational modifications for hopper dredges to reduce impacts on sea turtles in the southeastern USA. WODCON XVII: Dredging in a sensitive environment, September 27 - October 1, 2004, Hamburg, Germany. Central Dredging Association.

Coles W, Keinath J, Keinath D, Musick J. 1994. Sea surface temperatures and sea turtle position correlations. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 211-212.

Coyne MS, Godley BJ. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing and mapping animal tracking data. Mar Ecol Prog Ser. 301:1-7.

Crain DA, Bolten AB, Bjorndal KA. 1995. Effects of beach nourishment on sea turtles: Review and research initiatives. Restor Ecol. 3(2):95-104.

Crowe SE, Bergquist DC, Sanger DM, Van Dolah RF. 2016. Physical and biological alterations following dredging in two beach nourishment borrow areas in South Carolina’s coastal zone. J Coast Res. 32(4):875-889.

CSA International, Applied Coastal Research and Engineering, Inc., Barry A. Vittor and Associates, Inc., C. F. Bean, Florida Institute of Technology. 2009. Analysis of potential biological and physical impacts of dredging on offshore ridge and shoal features. OCS Study MMS 2010-010. Herndon (VA): Minerals Management Service, Leasing Division, Marine Minerals Branch.

Dean RG. 2002. Beach nourishment: Theory and practice. River Edge (NJ): World Scientific.

Decker L, Whitmont M. [date unknown]. Using dredge plant operational data to measure dredging intensity and cumulative exposure. OCS Study BOEM 2015. Sterling (VA): Bureau of Ocean Energy Management.

Dickerson D. 2009. Dredging and sea turtles: Potential impacts, assessing risk, and protection methods. Navigating the environment - Management risks and sustaining benefits seminar, October 28, 2009, New Orleans, Louisiana. Alexandria (VA): World Association for Waterborne Transport Infrastructure (PIANC) USA and PIANC International Environmental Commission.

Dickerson D. 2015. Sea turtles and dredging: A historical perspective of research. Dredging Operations Technical Support Program Dredging Workshop, August 26, 2015, Vicksburg, MS. Vicksburg (MS): US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory.

Dickerson D, Richardson JJ, Ferris JS, Bass AL, Wolf M. 1991. Entrainment of sea turtles by hopper dredges in Cape Canaveral and King's Bay Ship Channels. Environmental Effects of Dredging. 91:1-9.

Dickerson D, Theriot C, Wolters M, Slay C, Bargo T, Parks W. 2007. Effectiveness of relocation trawling during hopper dredging for reducing incidental take of sea turtles. In: Randall RE, editor. Proceedings of the eighteenth world dredging congress (WODCON XVIII), May 27 - June 1, 2007, Lake Buena Vista, Florida USA. Bryan (TX): Newman Printing Company.

Dickerson DD, Bargo T. 2011. Occurrence of a sea turtle congregation near Louisiana Chandeleur Islands following the Deepwater Horizon oil spill. In: Jones TT, Wallace BP, editors. Proceedings of thirty-first annual symposium on sea turtle biology and conservation, 10 to 16 April 2011, San Diego, California, USA NOAA Technical Memorandum NMFS-SEFSC-631. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 11-12.

Dickerson DD, Nelson DA. 1990. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

Dickerson DD, Nelson DA, Banks G. 1990. Alternative dredging equipment and operational methods to minimize sea turtle mortalities. Environmental Effects of Dredging Technical Notes EEDP-09-6. Vicksburg (MS): US Army Engineer Waterways Experiment Station.

Dickerson DD, Nelson DA, Dickerson CE, Reine KJ. 1993. Dredging related sea turtle studies along the southeastern US. In: Laska S, Puffer A, editors. Coastlines of the Gulf of Mexico. New York (NY): American Society of Civil Engineers. p. 6-17.

Dickerson DD, Nelson DA, Nye R. 1995a. US Army Corps of Engineers sea turtle studies associated with hopper dredging projects. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 175.

Dickerson DD, Reine KJ, Clarke DG. 1998. Economic impacts of environmental windows associated with dredging operations. DOER Technical Notes Collection (TN DOER-E3). Vicksburg (MS): US Army Engineer Research and Development Center.

Dickerson DD, Reine KJ, Nelson DA, Dickerson CE. 1995b. Assessment of sea turtle abundance in six South Atlantic US channels. Miscellaneous Paper EL-95-5. Vicksburg (MS): US Army Engineer Waterways Experiment Station.

Dickerson DD, Theriot CT. 2009a. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 09 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2009b. USACE hopper dredging interactions with sea turtles: Fiscal year 2009 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2010a. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 10 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2010b. USACE hopper dredging interactions with sea turtles: Fiscal year 2010 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2011a. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 11 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2011b. USACE hopper dredging interactions with sea turtles: Fiscal year 2011 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2012a. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 12 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Draft final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2012b. USACE hopper dredging interactions with sea turtles: Fiscal year 2012 annual summary report for the northern Gulf of Mexico region. Draft final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT, Wolters MS. 2008a. USACE hopper dredging interactions with sea turtles: Fiscal year 2008 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT. 2008b. Dredging impacts on sea turtles in the southeastern USA: A historical review of protection. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 26.

Dickerson DD, Wolters MS, Theriot CT. 2008c. USACE hopper dredging interactions with sea turtles: Fiscal year 08 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT. 2008d. USACE hopper dredging interactions with sea turtles: FY07 annual summary report for the northern Gulf of Mexico region. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT, Slay C. 2004. Dredging impacts on sea turtles in the southeastern USA: A historical review of protection. Proceedings of the world dredging congress XVII, Dredging in a sensitive environment, 27 September - 1 October 2004. Central Dredging Association.

[DoN] Department of the Navy. 2007a. Navy OPAREA density estimate (NODE) for the GOMEX OPAREA. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007b. Navy OPAREA density estimate (NODE) for the Northeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007c. Navy OPAREA density estimate (NODE) for the Southeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Donlan CJ, Wingfield DK, Crowder LB, Wilcox C. 2010. Using expert opinion surveys to rank threats to endangered species: A case study with sea turtles. Conserv Biol. 24(6):1586-1595.

Donlon C, Robinson I, Casey KS, Vazquez-Cuervo J. 2007. The global ocean data assimilation experiment high-resolution sea surface temperature pilot project. Bull Amer Meteor. 88(8):1197-1213.

Dow W, Eckert K, Palmer M, Kramer P. 2007. An atlas of sea turtle nesting habitat for the wider Caribbean region. WIDECAST Technical Report Number 6. Beaufort (NC): The Wider Caribbean Sea Turtle Conservation Network and The Nature Conservancy.

Dredgers Today. 2015. Database of dredgers: The largest dredgers in the world. Dredgers Today; [accessed 2016 Apr 21]. http://www.dredgers-today.com/index.php?/category/47.

Duncan RG. 2012. Development of a species distribution model for the east Pacific green sea turtle using ecological geoprocessing tools. [Master's thesis]. College Station (TX): Texas A&M University.

Eberle MD. 1994. The effect of abiotic factors on the position of loggerhead turtles (*Caretta caretta*) in the water column at Cape Canaveral, Florida. [PhD dissertation]. Buffalo (NY): State University of New York College at Buffalo.

Eckert SA. 1999. Data acquisition systems for monitoring sea turtle behavior and physiology. In: Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M, editors. Research and management techniques for the conservation of sea turtles. Washington (DC): IUCN/SSC Marine Turtle Specialist Group Publication. p. 88-93.

Eldridge PJ. 1988. The Southeast Area Monitoring and Assessment Program (SEAMAP): A state-federal-university program for collection, management, and dissemination of fishery-independent data and information in the southeastern United States. Mar Fish Rev. 50(2):29-39.

Elith J, Leathwick JR. 2009. Species distribution models: Ecological explanation and prediction across space and time. Annu Rev Ecol Evol Syst. 40(1):677-697.

Enfield DB, Mestas ‐ Nuñez AM, Trimble PJ. 2001. The Atlantic multidecadal oscillation and its relation to rainfall and river flows in the continental US. Geophys Res Lett. 28(10):2077-2080.

Epperly SP, Braun J, Chester AJ, Cross FA, Merriner JV, Tester PA. 1995. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull Mar Sci. 56(2):547-568.

ESR. 2009. OSCAR third degree resolution ocean surface currents. Version 1. National Aeronautics and Space Administration Physical Oceanography Distributed Active Archive Center; [accessed 2016 Sep 28]. http://dx.doi.org/10.5067/OSCAR-03D01.

Finkl CW, Makowski C. 2010. Increasing sustainability of coastal management by merging monitored marine environments with inventoried shelf resources. Int J Environ Stud. 67(6):861-870.

Fitzpatrick TG, Glass JD, Bargo TD, Parks W. 2006. The effects of sea turtle relocation trawling during selected coastal dredging projects. In: Pilcher NJ, editor. Proceedings of the twenty-third annual symposium on sea turtle biology and conservation, 17 to 21 March 2003, Kuala Lumpur, Malaysia NOAA Technical Memorandum NMFS-SEFSC 536. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service. p. 46-50.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M. 2014. Long-term behavior at foraging sites of adult female loggerhead sea turtles (*Caretta caretta*) from three Florida rookeries. Mar Biol. 161(6):1251-1262.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M, Coyne MS. 2013. Postnesting migratory behavior of loggerhead sea turtles *Caretta caretta* from three Florida rookeries. Endangered Species Res. 21(2):129-142.

Fossette S, Hobson VJ, Girard C, Calmettes B, Gaspar P, Georges J-Y, Hays GC. 2010. Spatio-temporal foraging patterns of a giant zooplanktivore, the leatherback turtle. J Mar Syst. 81(3):225-234.

Fossette S, Witt MJ, Miller P, Nalovic MA, Albareda D, Almeida AP, Broderick AC, Chacón-Chaverri D, Coyne MS, Domingo A. 2014. Pan-Atlantic analysis of the overlap of a highly migratory species, the leatherback turtle, with pelagic longline fisheries. Proc R Soc Lond B Biol Sci. 281(1780):20133065.

Fredette TJ, Suedel BC, Davis AV, Banks CJ. 2015. Engineering with nature geographic project mapping tool (EWN ProMap). ERDC TN-EWN-15-1. Vicksburg (MS): US Army Corps of Engineers, Engineer Research and Development Center.

Fritts TH, Hoffman W, McGehee MA. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. J Herpetol. 17(4):327-344.

Fujioka E, Kot CY, Wallace BP, Best BD, Moxley J, Cleary J, Donnelly B, Halpin PN. 2014. Data integration for conservation: Leveraging multiple data types to advance ecological assessments and habitat modeling for marine megavertebrates using OBIS-SEAMAP. Ecol Inform. 20:13-26.

[FWS] US Fish and Wildlife Service. 2014. Endangered and threatened wildlife and plants; Designation of critical habitat for the Northwest Atlantic Ocean distinct population segment of the loggerhead sea turtle. US Fish and Wildlife Service final rule. Federal Register. 79(132):39756-39854.

FWS. 2016. Critical habitat GIS files. Washington (DC): US Fish and Wildlife Service Environmental Conservation Online System; [accessed 2016 Apr 22]. http://ecos.fws.gov/ecp/report/table/critical-habitat.html?xmlfile=../docs/crithab/metadata/FCH_Caretta_caretta_20140710.shp.xml#Distributor1.

[FWS, NMFS] US Fish and Wildlife Service, National Marine Fisheries Service. 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife.

FWS, NMFS. 1998. Consultation handbook: Procedures for consultation and conference activities under Section 7 of the Endangered Species Act. Washington (DC): US Fish and Wildlife Service and National Marine Fisheries Service.

FWS, Warren Pinnacle Consulting Inc., Image Matters LLC, The Nature Conservancy, Federation NW. 2012. Sea level affecting marshes visualization (SLAMM View). [accessed 2016 Aug 17]. http://www.slammview.org.

[GADM] Global Administrative Areas. 2015. GADM database of global administrative areas. Version 2.5. Davis (CA): Global Administrative Areas, University of California, Davis; [accessed 2015 Sep 4]. http://gadm.org.

GEC, Inc. 2012. Final environmental assessment for issuance of a non-competitive negotiated agreement for the use of outer continental shelf sands for Caminada Headland beach and dune restoration (BA-45), Lafourche Parish, Lousiana. Baton Rouge (LA): Coastal Protection and Restorationa Authority of Louisiana.

Gitschlag GR. 1996. Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the US southeastern Atlantic coast. J Exp Mar Biol Ecol. 205(1-2):115-135.

Godley BJ, Blumenthal JM, Broderick AC, Coyne MS, Godfrey MH, Hawkes LA, Witt MJ. 2008. Satellite tracking of sea turtles: Where have we been and where do we go next. Endangered Species Res. 4(1-2):3-22.

Godley BJ, Broderick AC, Glen F, Hays GC. 2003. Post-nesting movements and submergence patterns of loggerhead marine turtles in the Mediterranean assessed by satellite tracking. J Exp Mar Biol Ecol. 287(1):119-134.

Goldberg DW, de Almeida DT, Tognin F, Lopez GG, Pizetta GT, Leite NO, Jr., Sforza R. 2015. Hopper dredging impacts on sea turtles on the northern coast of Rio de Janeiro State, Brazil. Mar Turtle Newsl. 147:16-20.

Good CP. 2008. Spatial ecology of the North Atlantic right whale (*Eubalaena glacialis*). PhD dissertation. Durham (NC): Duke University.

Greene JK, Anderson MG, Odell J, Steinberg N. 2010. The Northwest Atlantic marine ecoregional assessment: Species, habitats and ecosystems. Phase one. Boston (MA): The Nature Conservancy, Eastern US Division.

Guisan A, Zimmermann NE. 2000. Predictive habitat distribution models in ecology. Ecol Model. 135(2–3):147-186.

Gwin V. 2016. National Dredging Quality Management (DQM) Program. Paper presented at the Gulf WEDA Chapter Meeting, November 16, 2016, Galveston, TX. Bonsall (CA): Western Dredging Association; [accessed 2017 Oct 24]. https://www.westerndredging.org/phocadownload/GulfCoast/2016Meeting/027_Gwin-Vern_National_Dredging_Quality_Management_Program.pdf.

Haas HL. 2010. Using observed interactions between sea turtles and commercial bottom-trawling vessels to evaluate the conservation value of trawl gear modifications. Mar Coast Fish. 2(1):263-276.

Hales LZ. 2003. Bed-leveling following dredging operations. Report submitted to Dredging Operations Technical Support (DOTS) Program. Vicksburg (MS): US Army Corps of Engineers, South Atlantic Division.

Halpern BS, Frazier M, Potapenko J, Casey KS, Koenig K, Longo C, Lowndes JS, Rockwood RC, Selig ER, Selkoe KA. 2015. Spatial and temporal changes in cumulative human impacts on the world's ocean. Nat Commun. 6:7615.

Halpern BS, Walbridge S, Selkoe KA, Kappel CV, Micheli F, D'Agrosa C, Bruno JF, Casey KS, Ebert C, Fox HE et al. 2008. A global map of human impact on marine ecosystems. Science. 319(5865):948-952.

Halpin PN, Read AJ, Best BD, Hyrenbach KD, Fujioka E, Coyne MS, Crowder LB, Freeman SA, Spoerri C. 2006. OBIS-SEAMAP: Developing a biogeographic research data commons for the ecological studies of marine mammals, seabirds, and sea turtles. Mar Ecol Prog Ser. 316:239-246.

Halpin PN, Read AJ, Fujioka E, Best BD, Donnelly B, Hazen LJ, Kot C, Urian K, LaBrecque E, Dimatteo A et al. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography. 22:104-115.

Hamann M, Godfrey MH, Seminoff JA, Arthur K, Barata PCR, Bjorndal KA, Bolten AB, Broderick AC, Campbell LM, Carreras C. 2010. Global research priorities for sea turtles: Informing management and conservation in the 21st century. Endangered Species Res. 11(3):245-269.

Harms CA, Mallo KM, Ross PM, Segars A. 2003. Venous blood gases and lactates of wild loggerhead sea turtles (*Caretta caretta*) following two capture techniques. J Wildl Dis. 39(2):366-374.

Harris PT, Macmillan-Lawler M, Rupp J, Baker EK. 2014. Geomorphology of the oceans. Mar Geol. 352:4-24.

Hart KM, Sartain AR, Fujisaki I. 2015. Bahamas connection: Residence areas selected by breeding female loggerheads tagged in Dry Tortugas National Park, USA. Anim Biotelem. 3(1):1-17.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2010. Inter-nesting habitat-use patterns of loggerhead sea turtles: enhancing satellite tracking with benthic mapping. Aquat Biol. 11(1):77-90.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2013. Habitat use of breeding green turtles *Chelonia mydas* tagged in Dry Tortugas National Park: Making use of local and regional MPAs. Biol Conserv. 161:142-154.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Godley BJ. 2007. Only some like it hot — quantifying the environmental niche of the loggerhead sea turtle. Divers Distrib. 13(4):447-457.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Lopez-Jurado LF, Lopez-Suarez P, Merino SE, Varo-Cruz N, Godley BJ. 2006. Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Curr Biol. 16(10):990-995.

Hawkins AD, Pembroke AE, Popper AN. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Rev Fish Biol Fish. 25(1):39-64.

Hays GC, Luschi P, Papi F, Marsh R. 1999. Changes in behaviour during the inter-nesting period and post-nesting migration for Ascension Island green turtles. Mar Ecol Prog Ser. 189:263-273.

Hays GC, Scott R. 2013. Global patterns for upper ceilings on migration distance in sea turtles and comparisons with fish, birds and mammals. Funct Ecol. 27:748-756.

Hazekamp N, ten Kate G, Wiertsema W, Wilde-Famsing J. 2016. Dredging in the dark. Amsterdam, Netherlands: Both ENDS and Stichting Onderzoek Multinationale Ondernemingen.

Herbich JB. 1992. Handbook of dredging engineering. London, United Kingdom: McGraw-Hill Companies.

Hobday AJ, Hartog JR, Spillman CM, Alves O, Hilborn R. 2011. Seasonal forecasting of tuna habitat for dynamic spatial management. Can J Fish Aquat Sci. 68(5):898-911.

Hobday AJ, Hartog JR, Timmiss T, Fielding J. 2010. Dynamic spatial zoning to manage southern bluefin tuna (*Thunnus maccoyii*) capture in a multi-species longline fishery. Fish Oceanogr. 19(3):243-253.

Hochscheid S, Bentivegna F, Bradai MN, Hays GC. 2007. Overwintering behaviour in sea turtles: Dormancy is optional. Mar Ecol Prog Ser. 340:287-298.

Hochscheid S, Bentivegna F, Hays GC. 2005. First records of dive durations for a hibernating sea turtle. Biol Lett. 1(1):82-86.

Hochscheid S, Godley BJ, Broderick AC, Wilson RP. 1999. Reptilian diving: Highly variable dive patterns in the green turtle *Chelonia mydas*. Mar Ecol Prog Ser. 185(10):101-112.

Hooker SB, Esaias WE, Feldman GC, Gregg WW, McClain CR. 1992. SeaWiFS technical report series: Volume 1, An overview of SeaWiFS and ocean color. NASA Technical Memorandum 104566. Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center.

Hopkins S, Richardson J. 1984. A recovery plan for marine turtles. Washington (DC): US Government Printing Office.

Hovis WA, Clark DK, Anderson F, Austin RW, Wilson WH, Baker ET, Ball D, Gordon HR, Mueller JL, El-Sayed SZ. 1980. Nimbus-7 Coastal Zone Color Scanner: System description and initial imagery. Science. 210(4465):60-63.

Howell EA, Hoover A, Benson SR, Bailey H, Polovina JJ, Seminoff JA, Dutton PH. 2015. Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat model for ecosystem-based management. Fish Oceanogr. 24(1):57-68.

Howell EA, Kobayashi DR, Parker DM, Balazs GH, Polovina JJ. 2008. TurtleWatch: A tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. Endangered Species Res. 5(1):267-278.

Hurrell JW. 1995. Decadal trends in the North Atlantic oscillation: Regional temperatures and precipitation. Science. 269:676-679.

Hussey NE, Kessel ST, Aarestrup K, Cooke SJ, Cowley PD, Fisk AT, Harcourt RG, Holland KN, Iverson SJ, Kocik JF et al. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. Science. 348(6240):1221-1231.

[IOC, IHO, BODC] Intergovernmental Oceanographic Commission, International Hydrographic Organization, British Oceanographic Data Centre. 2003. Centenary edition of the GEBCO digital atlas, published on CD-ROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans. Liverpool, United Kingdom: British Oceanographic Data Centre.

James MC, Davenport J, Hays GC. 2006a. Expanded thermal niche for a diving vertebrate: A leatherback turtle diving into near-freezing water. J Exp Mar Biol Ecol. 335(2):221-226.

James MC, Ottensmeyer CA, Eckert SA, Myers RA. 2006b. Changes in diel diving patterns accompany shifts between northern foraging and southward migration in leatherback turtles. Can J Zool. 84(5):754-765.

Joyce JC. 1982. Protecting sea turtles while dredging. Military Engineer. 74(481):283-285.

Jutte PC, Van Dolah RF, Gayes PT. 2002. Recovery of benthic communities following offshore dredging, Myrtle Beach, South Carolina. Shore Beach. 70(3):25-30.

Kasul RL, Dickerson DD. 1993. Feasibility of sea turtle detection in coastal waterways using acoustic methods. Draft report. Atlanta (GA): US Army Corps of Engineers, South Atlantic Region.

Kawamura H, OCTS Team. 1998. OCTS mission overview. J Oceanogr. 54(5):383-399.

Kot CY, Fujioka E, DiMatteo A, Wallace BP, Hutchinson BJ, Cleary J, Halpin P, Mast RB. 2016. The state of the world's sea turtles online database: Data provided by the SWOT team and hosted on OBIS-SEAMAP. Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University http://seamapenvdukeedu/swot.

Kot CY, Fujioka E, Hazen LJ, Best BD, Read AJ, Halpin PN. 2010. Spatio-temporal gap analysis of OBIS-SEAMAP project data: Assessment and way forward. PLOS ONE. 5(9):e12990.

Lamont MM, Fujisaki I, Stephens BS, Hackett C. 2015. Home range and habitat use of juvenile green turtles (*Chelonia mydas*) in the northern Gulf of Mexico. Anim Biotelem. 3(1):1-12.

Landry AM, Jr., D. T. Costa, Williams BB, Coyne MS. 1993. Sea turtle capture/population index and habitat characterization: Bolivar Roads and Sabine Pass, TX and Calcasieu Pass, LA. Final Report submitted to the US Army Corps of Engineers, Galveston District. Galveston (TX): US Army Corps of Engineers, Galveston District.

LaSalle MW, Clarke DG, Homziak J, Lunz JD, Fredette TJ. 1991. A framework for assessing the need for seasonal restrictions on dredging and disposal operations. Technical Report D-91-1. Vicksburg (MS): US Waterways Experiment Station.

Lebuff CR, Haverfield EM. 1992. Nesting success of the loggerhead turtle (*Caretta caretta*) on Captiva Island, Florida - a nourished beach. In: Salmon M, Wyneken J, editors. Proceedings of the eleventh annual workshop on sea turtle biology and conservation 26 February - 2 March 1991, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-302. Washington (DC): National Oceanic and Atmospheric Administration. p. 69-71.

Lewison R, Hobday AJ, Maxwell S, Hazen E, Hartog JR, Dunn DC, Briscoe D, Fossette S, O'Keefe CE, Barnes M et al. 2015. Dynamic ocean management: Identifying the critical ingredients of dynamic approaches to ocean resource management. Bioscience. 65(5):486-498.

Long DG, Hicks BR. 2010. Standard BYU QuickSCAT and Seawinds land/ice image products. Revision 3.1. Provo (UT): Brigham Young University, BYU Center for Remote Sensing, Microwave Earth Remote Sensing Laboratory.

Lumpkin R, Johnson GC. 2013. Global ocean surface velocities from drifters: Mean, variance, El Niño–Southern Oscillation response, and seasonal cycle. J Geophys Res Oceans. 118(6):2992-3006.

Luschi P, Hays GC, Papi F. 2003. A review of long-distance movements by marine turtles, and the possible role of ocean currents. Oikos. 103(2):293-302.

Lutcavage M, Musick JA. 1985. Aspects of the biology of sea turtles in Virginia. Copeia. 1985(2):449-456.

Lutcavage ME, Lutz PL. 1991. Voluntary diving metabolism and ventilation in the loggerhead sea turtle. J Exp Mar Biol Ecol. 147(2):287-296.

Magnuson JJ, Bjorndal KA, DuPaul WD, Graham GL, Owens DW, Peterson CH, Pritchard PCH, Richardson JI, Saul GE, West CW. 1990. Decline of the sea turtles: Causes and prevention. Washington (DC): National Academies Press.

Maley CG. 1995. Sea turtle strandings in Georgia in the TED era: A matter of timing. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 77-80.

Mannocci L, Roberts JJ, Miller DL, Halpin PN. 2017. Extrapolating cetacean densities io quantitatively assess human impacts on populations in the high seas. Conserv Biol. 31(3):602-614.

Mansfield KL. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. [PhD dissertation]. Williamsburg (VA): Virginia Institute of Marine Sciences, The College of William and Mary.

Marine Turtle Specialist Group. 1996. *Lepidochelys kempii*. The IUCN Red List of Threatened Species; [accessed 2016 Feb 3]. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T11533A3292342.en.

Maritorena S, d'Andon OHF, Mangin A, Siegel DA. 2010. Merged satellite ocean color data products using a bio-optical model: Characteristics, benefits and issues. Remote Sens Environ. 114(8):1791-1804.

Maritorena S, Siegel DA. 2005. Consistent merging of satellite ocean color data sets using a bio-optical model. Remote Sens Environ. 94(4):429-440.

Maritorena S, Siegel DA, Peterson A. 2002. Optimization of a semi-analytical ocean color model for global scale applications. Appl Opt. 41(15):2705-2714.

Mast RB, Bailey LM, Hutchinson BJ. 2006. Burning issues in sea turtle conservation...leatherback sea turtles of the world. State of the World's Sea Turtles report volume I. Washington (DC): State of the World's Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2007. A global glimpse of loggerhead nesting. State of the World's Sea Turtles report volume II. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2008. Where the hawksbills are. State of the World's Sea Turtles report volume III. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2010. Kemp's and olive ridleys: Small turtles, big secrets. State of the World's Sea Turtles report volume V. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2011. The green turtle: The most valuable reptile in the world. State of the World's Sea Turtles report volume VI. Arlington (VA): State of the World's Sea Turtles.

Mazor T, Beger M, McGowan J, Possingham HP, Kark S. 2016. The value of migration information for conservation prioritization of sea turtles in the Mediterranean. Global Ecol Biogeogr. 25:540-552.

McClellan CM, Braun-McNeill J, Avens L, Wallace BP, Read AJ. 2010. Stable isotopes confirm a foraging dichotomy in juvenile loggerhead sea turtles. J Exp Mar Biol Ecol. 387(1):44-51.

McClellan CM, Read AJ. 2007. Complexity and variation in loggerhead sea turtle life history. Biol Lett. 3(6):592-594.

McClellan CM, Read AJ. 2009. Confronting the gauntlet: Understanding incidental capture of green turtles through fine-scale movement studies. Endangered Species Res. 10:165-179.

Mendonça MT. 1983. Movements and feeding ecology of immature green turtles (*Chelonia mydas*) in a Florida lagoon. Copeia. 1983(4):1013-1023.

Mendonça MT, Pritchard PCH. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempi*). Herpetologica. 42(3):373-381.

Meylan A. 1988. Spongivory in hawksbill turtles: A diet of glass. Science. 239:393-395.

Meylan AB. 1999. International movements of immature and adult hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean region. Chelonian Conserv Biol. 3(2):189-194.

Meylan PA, Meylan AB, Gray JA. 2011. The ecology and migrations of sea turtles 8. Tests of the developmental habitat hypothesis. Bull Am Mus Nat Hist. 357:1-70.

Michel J. 2013. South Atlantic information resources: Data search and literature synthesis. OCS Study BOEM 2013-01157. In: Michel J, editor. New Orleans (LA): Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Michel J, Bejarano AC, Peterson CH, Voss C. 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. OCS Study BOEM 2013-0119. Herndon (VA): Bureau of Ocean Energy Management.

Milton SL, Lutz PL. 2003. Physiological and genetic responses to environmental stress. In: Lutz PL, Musick JA, Wyneken J, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 163–197.

Moein SE. 1994. Auditory-evoked potentials of the loggerhead sea turtle (*Caretta caretta*). [Master's thesis]. Gloucester Point (VA): College of William and Mary, Virginia Institute of Marine Science.

Moein SE, Musick JA, Keinath JA, Barnard DE, Lenhardt M, George R. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final report submitted to the US Army Corps of Engineers Waterways Experiment Station. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Moilanen A. 2007. Landscape Zonation, benefit functions and target-based planning: Unifying reserve selection strategies. Biol Conserv. 134(4):571-579.

Moilanen A, Franco AMA, Early RI, Fox R, Wintle B, Thomas CD. 2005. Prioritizing multiple-use landscapes for conservation: Methods for large multi-species planning problems. Proc R Soc Lond B Biol Sci. 272(1575):1885-1891.

Montague CL. 2006. Analysis of beach nourishment data for Florida's Atlantic coast during the last century, with reference to ecological engineering of sea turtle nesting habitat. 19th annual national conference on beach preservation technology, February 1 - 3, 2006, Sarasota, Florida. Tallahassee (FL): Florida Shore and Beach Preservation Association.

Montague CL. 2008. Recovering the sand deficit from a century of dredging and jetties along Florida's Atlantic coast: A reevaluation of beach nourishment as an essential tool for ecological conservation. J Coast Res. 24(4):899-916.

Montante V. 1990. Opening remarks: Workshop introduction. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, FL Miscellaneous Paper EL-90-5. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory. p. 14-16.

Morreale SJ, Standora EA. 1989. Occurrence, movement and behavior of the Kemp's ridley and other sea turtles in New York waters. Riverhead (NY): Annual Report to Okeanos Ocean Research Foundation and Return a Gift to Wildlife Program, April 1991 - April 1992.

Mortimer JA, Donnelly M. 2008. *Eretmochelys imbricata*. The IUCN red list of threatened species 2008: e.T8005A12881238. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T8005A12881238.en.

Moulding JD. 1981. Sea turtles vs. dredging: A conflict with the Endangered Species Act. Fla Sci. 44(1):35.

Mulligan M. 2016. User guide for the Co$ting Nature Policy Support System Version 2. King's College, London, AmbioTEK, and United Nations Environment Programme, World Conservation Monitoring Centre; [accessed 2016 Mar 9]. https://goo.gl/Grpbnb.

Mulligan M, Guerry A, Arkema K, Bagstad K, Villa F. 2010. Capturing and quantifying the flow of ecosystem services. In: Silvestri S, Kershaw F, editors. Framing the flow: Innovative approaches to understand, protect and value ecosystem services across linked habitats. Cambridge, United Kingdom: United National Environment Programme World Conservation Monitoring Centre. p. 26-33.

Murphy TM, Murphy SR, Griffin DB, Hope CP. 2006. Recent occurrence, spatial distribution, and temporal variability of leatherback turtles (*Dermochelys coriacea*) in nearshore waters of South Carolina, USA. Chelonian Conserv Biol. 5(2):216-224.

Musick JA. 1988. The sea turtles of Virginia with notes on identification and natural history. Virginia Institute of Marine Science, Educational Series 24. Gloucester Point (VA): Virginia Institute of Marine Science.

[NASA] National Aeronautics and Space Administration. 2016a. MODIS-Aqua data. Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group; [accessed 2016 Mar 15]. http://modis.gsfc.nasa.gov.

NASA. 2016b. Photosynthetically available radiation (PAR). Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group; [accessed 2016 Aug 19]. http://oceancolor.gsfc.nasa.gov/cms/atbd/par.

[NASA, NOAA] National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration. 2009. Cross-calibrated multi-platform ocean surface wind vector L3.5A pentad first-look analyses. Version 1. National Aeronautics and Space Administration Goddard Space Flight Center and National Oceanic and Atmospheric Administration Physical Oceanography Distributed Active Archive Center; [accessed 2016 Sep 28]. http://dx.doi.org/10.5067/CCF35-01AD5.

[NPS] National Park Service. 2006. NPS Buck Island Reef National Monument Sea Turtle Research Program seasonal report 2006. Unpublished report. St. Croix, US Virgin Islands: National Park Service, Buck Island Reef National Monument, Division of Resource Management.

NatureServe Vista. 2011. NatureServe VISTA: Decision-support software for land use and conservation planning. User's manual from Vista on-line help. Arlington (VA): NatureServe.

Nelson D, Dickerson D, Berry S, Moulding J. 1989. Methods to minimize dredging impacts on sea turtles. In: Wilson JR, van Dam VL, editors. Proceedings of the twelfth world dredging congress, May 2 - 5, 1989, Orlando, Florida. Fairfax (VA): Western Dredging Association. p. 973-982.

Nelson DA, Dickerson DD, Richardson J, Reine K. 1991. Sea turtle trawling survey associated with hopper dredging at Brunswick, GA. Unpublished report. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

Nelson DA, Shafer DJ. 1996. Effectiveness of a sea turtle-deflecting hopper dredge draghead in Port Canaveral Entrance Channel, Florida. Miscellaneous Paper D-96-3. Vicksburg (MS): US Army Corps of Engineers, Waterways Experiment Station.

Nelson E, Mendoza G, Regetz J, Polasky S, Tallis H, Cameron DR, Chan KMA, Daily GC, Goldstein J, Kareiva PM. 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Front Ecol Environ. 7(1):4-11.

[NMFS] National Marine Fisheries Service. 1979. Determination of critical habitat for the leatherback sea turtle. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 44:17710-17712.

NMFS. 1991. Endangered Species Act Section 7 consultation on US Army Corps of Engineers: Dredging of channels in the southeastern United States from North Carolina through Cape Canaveral, Florida. Biological Opinion, November 25, 1991. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1995a. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE), Galveston District and New Orleans District: Channel maintenance dredging using a hopper dredge. Biological Opinion, September 22, 1995. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1995b. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, South Atlantic Division: Hopper dredging of channels and beach nourishment activities in the southeastern United States from North Carolina through Florida east coast. Biological Opinion, August 25, 1995. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1997. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, South Atlantic Division: The continued hopper dredging of channels and borrow areas in the southeastern United States. Biological Opinion, September 25, 1997. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1998. Designated critical habitat; Green and hawksbill sea turtles. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 63:46693-46701.

NMFS. 2003. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE): Dredging of Gulf of Mexico navigation channels and sand mining ("borrow") areas using hopper dredges by COE Galveston, New Orleans, Mobile, and Jacksonville Districts (Consultation Number F/SER/2000/0 1 2 87). Biological Opinion, November 19, 2003. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2005a. Endangered Species Act Section 7 consultation on Minerals Management Service: Hopper and hydraulic cutterhead dredging associated with sand mining for coastal restoration projects along the coast of Louisiana using sand from Ship Shoal in the Gulf of Mexico Central Planning Area, South Pelto Blocks 12, 13, and 19, and Ship Shoal Block 88. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division, St. Petersburg, FL.

NMFS. 2005b. Revision No. 1 to November 19, 2003, Gulf of Mexico Regional Biological Opinion (GOM RBO) on hopper dredging of navigation channels and borrow Areas in the US Gulf of Mexico to the US Army Corps of Engineers (COE). June 24, 2005. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2006. Sea turtle and smalltooth sawfish construction conditions. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2007. Revision 2 to the National Marine Fisheries Service November 19, 2003, Gulf of Mexico Regional Biological Opinion (GRBO) to the US Army Corps of Engineers (COE) on hopper dredging of navigation channels and borrow Areas in the US Gulf of Mexico. January 9, 2007. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2011. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE), Savannah District: Deepening of the Savannah Harbor federal navigational channel in association with the Savannah Harbor Expansion Project (NMFS Consultation Number F/SERJ2010105579). Biological Opinion, November 4, 2011. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2012a. Endangered Species Act Section 7 consultation Biological Opinion on US Department of the Navy for shoreline protection system repairs, Naval Air Station Oceana, Dam Neck Annex, Virginia Beach, Virginia. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012b. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of outer continental shelf (OCS) sand resources on Sabine Bank to Louisiana's Office of Coastal Protection and Restoration (OCPR) for the Cameron Parish Shoreline Restoration Project (Consultation Number F/SERJ2011!06202). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2012c. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Post-Hurricane Irene Beach Renourishment Project in Carteret County, North Carolina (Consultation Number F/SER/2012/01 054). Biological Opinion, October 3, 2012. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2012d. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Norfolk District (lead) and Bureau of Ocean Energy Management: Use of Sandbridge Shoals Borrow Area for Sandbridge Shoals Hurricane Protection Project, 2012-2013, F/NER/2012t01586. Biological Opinion, September 7, 2012. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012e. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Norfolk District (lead), USACE, Baltimore District, Bureau of Ocean Energy Management, US Environmental Protection Agency, and US Navy: Maintenance of Chesapeake Bay entrance channels and use of sand borrow areas for beach nourishment. F/NERl2012/01586. Biological Opinion, October 16, 2012. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2013a. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement: Programmatic geological and geophysical activities in the Mid- and South Atlantic Planning Areas from 2013 to 2020. Biological Opinion, July 19, 2013. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources.

NMFS. 2013b. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of Borrow Area T1 to the Collier County Parks and Recreation Department for the Collier County Beach Renourishment Project (Consultation Number SER-2012 -9274). Biological Opinion, August 13, 2013. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2013c. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Philadelphia District: Maintenance of the 40-foot Delaware River Federal Navigation Channel. NER-2013-9804. Biological Opinion, August 1, 2013. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2014a. Endangered and threatened species: Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 79(132):39856-39912.

NMFS. 2014b. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, New York District: Beach nourishment projects utilizing the Sea Bright Offshore Borrow Area: Union Beach, Port Monmouth, and Elberon to Loch Arbour, New Jersey. NER-2014-1 0606. Biological Opinion, March 7, 2014. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2014c. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Philadelphia District (lead) and Bureau of Ocean Energy Management: Use of sand borrow areas for beach nourishment and hurricane protection, offshore Delaware and New Jersey. NER-2014-10904. Biological Opinion, June 26, 2014 Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Greater Atlantic Regional Fisheries Office.

NMFS. 2014d. Loggerhead sea turtle critical habitat in the Northwest Atlantic Ocean GIS files. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; [accessed 2016 Apr 22]. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm.

NMFS. 2015a. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of Canaveral Shoals Sand Borrow Area II to the BCBOCC for the Mid Reach Beach Restoration Project. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2015b. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Mobile District, as the lead agency, in cooperation with the Bureau of Ocean Energy Management, and National Park Service (NPS): Mississippi Coastal Improvements Program (MsCIP) Barrier Island Restoration, Mississippi Sound-Hancock, Harrison, and Jackson Counties, Mississippi, and Mobile County, Alabama. NMFS Consultation Number SER-2012-09304. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2016. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Dredging within the Charleston ocean dredged material disposal site. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

[NMFS, FWS] National Marine Fisheries Service, US Fish and Wildlife Service. 1991a. Recovery plan for US population of Atlantic green turtle (*Chelonia mydas*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1991b. Recovery plan for US populations of loggerhead turtle (*Caretta caretta*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1993. Recovery plan for hawksbill turtles in the US Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2007. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013a. Hawksbill sea turtle (*Eretmochlys imbricata*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013b. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2015. Kemp's ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation. Silver Spring (MD) and Albuquerque (NM): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2016. Endangered and threatened wildlife and plants; Final rule to list eleven distinct population segments of the green sea turtle (*Chelonia mydas*) as endangered or threatened and revision of current listings under the Endangered Species Act. National Oceanic and Atmospheric Administration National Marine Fisheries Service and US Fish and Wildlife Service final rule. Federal Register. 81(66):20058-20090.

[OCM] Office for Coastal Management. 2016. Habitat priority planner. Charleston (SC): National Oceanic and Atmospheric Administration National Ocean Service Office for Coastal Management; [accessed 2016 Jul 6]. https://coast.noaa.gov/digitalcoast/tools/hpp.html.

Ogden JC, Robinson L, Whitlock K, Daganhardt H, Cebula R. 1983. Diel foraging patterns in juvenile green turtles (*Chelonia mydas* L.) in St. Croix United States Virgin Islands. J Exp Mar Biol Ecol. 66(3):199-205.

Ogren L, McVea C. 1982. Apparent hibernation by sea turtles in North American waters. In: Bjorndal KA, editor. Biology and conservation of Florida turtles Proceedings of the world conference on sea turtle conservation, 26 - 30 November 1979. Washington (DC): Smithsonian Institute Press.

Ogren LH. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: Preliminary results from the 1984-1987 surveys. In: Caillouet CW, Jr., Landry AM, editors. Proceedings of the first international symposium on Kemp's ridley sea turtle biology, October 1 - 4, 1985, Galveston, Texas TAMU-SG-89-105. Galveston (TX): National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory and Texas A&M University at Galveston. p. 116-123.

Oliver MJ, Glenn S, Kohut JT, Irwin AJ, Schofield OM, Moline MA, Bissett WP. 2004. Bioinformatic approaches for objective detection of water masses on continental shelves. J Geophys Res Oceans. 109:C07S04.

Oliver MJ, Irwin AJ. 2008. Objective global ocean biogeographic provinces. Geophys Res Lett. 35(15):L15601.

Pajuelo M, Bjorndal KA, Reich KJ, Arendt MD, Bolten AB. 2012. Distribution of foraging habitats of male loggerhead turtles (*Caretta caretta*) as revealed by stable isotopes and satellite telemetry. Mar Biol. 159(6):1255-1267.

Palermo MR. 1990. Introduction to alternative dredging methods. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

Pallin LJ, Adams EM, Goyert HF, Friedlaender AS, Johnston DW. 2015. Chapter 12: Density modeling for marine mammals and sea turtles with environmental covariates. In: Williams KA, Connelly EE, Johnson SM, Stenhouse IJ, editors. Baseline wildlife studies in Atlantic waters offshore of Maryland: Final report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015 Report BRI 2015-17. Portland (ME): Biodiversity Research Institute. p. 1-39.

Parametrix. 2013a. Bayesian analysis for spatial siting (BASS) project report v1.3. OCS Study BOEM 2013-201. Camarillo (CA): Bureau of Ocean Energy Management.

Parametrix. 2013b. Bayesian analysis for spatial siting (BASS): Technical manual. OCS Study BOEM 2013-204. Camarillo (CA): Bureau of Ocean Energy Management.

Patel SH, Morreale SJ, Panagopoulou A, Bailey H, Robinson NJ, Paladino FV, Margaritoulis D, Spotila JR. 2015. Changepoint analysis: A new approach for revealing animal movements and behaviors from satellite telemetry data. Ecosphere. 6(12):13.

Patterson T. 2005. Clean TOPO2: Edited SRTM30 plus world elevation data; [accessed 2016 Jun 13]. http://www.shadedrelief.com/cleantopo2/index.html.

Paul EU. 2010. Laboratory experiments and hydrodynamic modeling of a bed leveler used to level the bottom of ship channels after dredging. [Master's thesis]. College Station (TX): Texas A&M University.

PBS&J. 2008. Best management practices (BMPs) for construction, dredge and fill and other activities adjacent to coral reefs. Report completed in fulfillment of contract RM6011 for the Southeast Florida Coral Reef Initiative (SEFCRI), Maritime Industry and Coastal Construction Impacts (MICCI) Focus Team Local Action Strategy Project #6, and Florida Department of Environmental Protection (FDEP) Coral Reef Conservation Program (CRCP). Miami (FL): PBS&J.

Piatkowski D, Culbertson J. 2016. An update on the Bureau of Ocean Energy Management, Marine Minerals Program Studies. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Pilcher NJ. 2008. The MTSG and its involvement in the Dhamra Port, Orissa, India. Mar Turtle Newsl. 121:24-25.

Pilkey OH, Jr., Cooper JAG. 2014. The last beach. Durham (NC): Duke University Press.

Plotkin PT, Wicksten MK, Amos AF. 1993. Feeding ecology of the loggerhead sea turtle *Caretta caretta* in the Northwestern Gulf of Mexico. Mar Biol. 115(1):1-5.

[PSDS] Program for the Study of Developed Shorelines. 2016. Beach nourishment database. Cullowhee (NC): Western Carolina University, Program for the Study of Developed Shorelines; [accessed 2016 May 2]. http://beachnourishment.wcu.edu.

Rabon DR, Jr., Johnson SA, Boettcher R, Dodd M, Lyons M, Murphy S, Ramsey S, Roff S, Stewart K. 2003. Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida. Mar Turtle Newsl. 101:4-8.

Raposa KJV, Frankel AS, Sisson G, Ellison WT, Damon C. 2007. Marine wildlife behavior database for estimating environmental impacts. J Acoust Soc Am. 122(5):3059.

Ray RD. 1999. A global ocean tide model from TOPEX/POSEIDON Altimetry: GOT99.2. Greenbelt (MD): National Aeronautics and Space Administration.

Reid JM, Reid JA, Jenkins CJ, Hastings ME, Williams SJ, Poppe LJ. 2005. usSEABED: Atlantic Coast offshore surficial sediment data release, USGS Data Series 118 (DS-118). Woods Hole (MA): United States Geological Survey Coastal and Marine Geology Program; [accessed 2016 Apr 27]. http://pubs.usgs.gov/ds/2005/118/htmldocs/data_cata.htm.

Reidenauer J, Turner L. 2016. Federal sand resources. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Reine K, Clarke D. 1998. Entrainment by hydraulic dredges - A review of potential impacts. Technical Note DOER-E1. Vicksburg (MS): US Army Engineer Research and Development Center.

Reine KJ, Clarke D, Dickerson CE, Wikel G. 2014. Characterization of underwater sounds produced by trailing suction hopper dredges during sand mining and pump-out operations. ERDC/EL TR 14-3, BOEM 2014-055. Herndon (VA): Bureau of Ocean Energy Management and US Army Corps of Engineers.

Reine KJ, Dickerson DD. 1994. Protective relocation and assessment of sea turtle abundance during hopper dredging activities in Delaware Bay entrance channel. Vicksburg (MS): Environmental Laboratory, Department of the Army Waterways Experiment Station, Corps of Engineers.

Reine KJ, Dickerson DD, Clarke DG. 1998. Environmental windows associated with dredging operations. Defense Technical Information Center Document; [accessed 2015 Nov 30]. http://www.dtic.mil/dtic/tr/fulltext/u2/a361195.pdf.

Renaud ML. 1994. Satellite tracking of juvenile Kemp's ridley sea turtles near Sabine Pass, Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 147.

Renaud ML. 1995. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). J Herpetol. 29(3):370-374.

Renaud ML, Carpenter JA. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bull Mar Sci. 55(1):1-15.

Renaud ML, Carpenter JA, Manzella SA, Williams JA. 1992. Telemetric tracking of green sea turtles (*Chelonia mydas*) in relation to dredged channels at South Padre Island, Texas July through September 1992. Galveston (TX): Southeast Fisheries Center, National Marine Fisheries Service, Galveston Laboratory.

Renaud ML, Carpenter JA, Williams JA, Landry AM. 1996. Kemp's ridley sea turtle (*Lepidochelys kempii*) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conserv Biol. 2:108-109.

Renaud ML, Carpenter JA, Williams JA, Manzella-Tirpak SA. 1995. Activities of juvenile green turtles, *Chelonia mydas*, at a jettied pass in South Texas. Fish Bull. 93:586-593.

Renaud ML, Carpenter JA, Williams JA, Manzella SA. 1994. Telemetric tracking of Kemp's ridley sea turtles (*Lepidochelys kempii*) in relation to dredged channels at Bolivar Roads Pass and Sabine Pass, TX and Calcasieu Pass, LA, May 1993 through February 1994. Final report submitted to US Army Corps of Engineers, Galveston, TX and New Orleans, LA District.

Reynolds KM, Hessburg PF, Bourgeron PS. 2014. Making transparent environmental management decisions: Applications of the ecosystem management decision support system. New York (NY): Springer.

Reynolds RW, Smith TM, Liu C, Chelton DB, Casey KS, Schlax MG. 2007. Daily high-resolution-blended analyses for sea surface temperature. J Clim. 20(22):5473-5496.

Richardson JI. 1990. The sea turtles of the King's Bay area and the endangered species observer program associated with construction dredging of the St. Marys entrance ship channel. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, FL Miscellaneous Paper EL-90-5. Jacksonville (FL): US Army Corps of Engineers, Environmental Laboratory. p. 32-46.

Roberts JJ, Best BD, Dunn DC, Treml EA, Halpin PN. 2010. Marine geospatial ecology tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. Environ Model Software. 25:1197-1207.

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB et al. 2016. Habitat-based cetacean density models for the US Atlantic and Gulf of Mexico. Sci Rep. 6:22615.

Robinson LM, Elith J, Hobday AJ, Pearson RG, Kendall BE, Possingham HP, Richardson AJ. 2011. Pushing the limits in marine species distribution modelling: Lessons from the land present challenges and opportunities. Global Ecol Biogeogr. 20(6):789-802.

Rudloe J. 1981. From the jaws of death. Sports Illustrated. 54(13):60-70.

Saba VS. 2013. Oceanic habits and habitats: *Dermochelys coriacea*. In: Wyneken J, Lohmann KJ, Musick JA, editors. The biology of sea turtles, volume III. New York (NY): CRC Press. p. 163-188.

Savioli JC, Magalhaes M, Pedersen C, Rijmenant JV, Oliver MA, Fen CJ, Rocha C. 2013. Dredging - How can we manage it to minimize impacts. In: Suriamihardja DA, Harianto T, Abdurrahman MA, Rachman T, editors. Proceedings of the 7th International Conference on Asian and Pacific Coasts (APAC 2013) Bali, Indonesia, September 24 - 26, 2013. Tamalanrea, Makassar, Indonesia: Hasanuddin University Press. p. 387-393.

Savtchenko A, Ouzounov D, Ahmad S, Acker J, Leptoukh G, Koziana J, Nickless D. 2004. Terra and Aqua MODIS products available from NASA GES DAAC. Adv Space Res. 34(4):710-714.

Sbrocco EJ, Barber PH. 2013. MARSPEC: Ocean climate layers for marine spatial ecology. Ecology. 94(4):979-979.

Schmid JR. 1995. Marine turtle populations on the east-central coast of Florida: Results of tagging studies at Cape Canaveral, Florida, 1986-1991. Fish Bull. 93(1):139-151.

Schmid JR. 1998. Marine turtle populations on the west-central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fish Bull. 96(3):589-602.

Schmid JR, Bolten AB, Bjorndal KA, Lindberg WJ. 2002. Activity patterns of Kemp's ridley turtles, *Lepidochelys kempii*, in the coastal waters of the Cedar Keys, Florida. Mar Biol. 140(2):215-228.

Schofield G, Katselidis KA, Dimopoulos P, Pantis JD, Hays GC. 2006. Behaviour analysis of the loggerhead sea turtle *Caretta caretta* from direct in-water observation. Endangered Species Res. 2:71-79.

Schroeder BA, Thompson NB. 1987. Distribution of the loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*, in the Cape Canaveral, Florida area: Results of aerial surveys. NOAA Technical Report National Marine Fisheries Service. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 45-53.

Schwartz FJ. 1978. Behavioral and tolerance responses to cold water temperatures by three species of sea turtles (Reptilia, Cheloniidae) in North Carolina. Fla Mar Res Publ. 33:16-18.

Scott-Hayward LAS, Borchers DL, Burt ML. 2014. Use of zero and one-inflated beta regression to model availability of loggerhead turtles off the east coast of the United States. Draft Report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Order 40, issued to HDR Inc., Norfolk, Virginia. St. Andrews, Scotland: University of St. Andrews, Center for Research into Ecological and Environmental Modelling.

Scott JM, Goble DD, Haines AM, Wiens JA, Neel MC. 2010. Conservation-reliant species and the future of conservation. Conserv Lett. 3(2):91-97.

Scott JM, Goble DD, Wiens JA, Wilcove DS, Bean M, Male T. 2005. Recovery of imperiled species under the Endangered Species Act: The need for a new approach. Front Ecol Environ. 3(7):383-389.

[SEAMAP-SA] Southeast Area Monitoring and Assessment Program-South Atlantic. 2001. Distribution of bottom habitats on the continental shelf from North Carolina through the Florida Keys. Washington (DC): Southeast Area Monitoring and Assessment Program-South Atlantic Bottom Mapping Work Group, Atlantic States Marine Fisheries Commission.

Seminoff JA. 2004. *Chelonia mydas*. The IUCN red list of threatened species 2004: e.T4615A11037468. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T4615A11037468.en.

Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Haas HL, Hargrove SA, Jensen MP, Klemm DL, Lauritsen AM et al. 2015. Status review of the green turtle (*Chelonia mydas*) under the US Endangered Species Act. NOAA Technical Memorandum NOAA-NMFS-SWFSC-539. La Jolla (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Seney EE, Landry AM, Jr. 2008. Movements of Kemp's ridley sea turtles nesting on the upper Texas coast: Implications for management. Endangered Species Res. 4(1-2):73-84.

Seney EE, Landry AM, Jr. 2011. Movement patterns of immature and adult female Kemp's ridley sea turtles in the northwestern Gulf of Mexico. Mar Ecol Prog Ser. 440:241-254.

Servis JA, Lovewell G, Tucker AD. 2015. Diet analysis of subadult Kemp's ridley (*Lepidochelys kempii*) turtles from west-central Florida. Chelonian Conserv Biol. 14(2):173-181.

Shaffer SA, Costa DP. 2006. A database for the study of marine mammal behavior: gap analysis, data standardization, and future directions. IEEE Journal of Oceanic Engineering. 31(1):82-86.

Sharp R, Tallis HT, Ricketts T, Guerry AD, Wood SA, Chaplin-Kramer R, Nelson E, Ennaanay D, Wolny S, Olwero N et al. 2015. InVEST user's guide 3.2.0. The Natural Capital Project. Stanford (CA): The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund.

Shaver DJ. 1991. Feeding ecology of wild and head-started Kemp's ridley sea turtles in south Texas waters. J Herpetol. 25(3):327-334.

Shaver DJ. 1994. Relative abundance, temporal patterns, and growth of sea turtles at Mansfield Channel, Texas. J Herpetol. 28(4):491-497.

Shaver DJ. 2005. Analysis of the Kemp's ridley imprinting and headstart project at Padre Island National Seashore, Texas, 1978-88, with subsequent nesting and stranding records on the Texas coast. 4(4):846-859.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain-Iverson AR, Peña J, Gomez Gamez D, de Jesus Gonzales Diaz Miron R, Burchfield PM, Martinez HJ et al. 2016. Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. Biol Conserv. 194:158-167.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain AR, Pena J, Burchfield PM, Gomez Gamez D, Ortiz J. 2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecol Evol. 3(7):2002-2012.

Shellito BA, Lockwood KB. 2006. GIS and 3D analysis applied to sea turtle mortalities and navigation channel dredging. Va J Sci. 57(4):167-183.

Slay C, Richardson JJ. 1988. King's Bay, Georgia: Dredging and turtles. In: Schroeder BA, editor. Proceedings of the eighth annual workshop on sea turtle conservation and biology NOAA Technical Memorandum NMFS-SEFSC-214. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 109-113.

Slay CK. 1991. Endangered species observer program, Brunswick Ship Channel, April 1 - June 19, 1991. Savannah (GA): US Army Corps of Engineers, Planning Division, Environmental, Savannah District.

Slay CK. 1995. Sea turtle mortality related to dredging activities in the southeastern US: 1991. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 132-133.

Smith WHF, Sandwell DT. 1997. Global sea floor topography from satellite altimetry and ship depth soundings. Science. 277(5334):1956-1962.

Snover ML. 2002. Growth and ontogeny of sea turtles using skeletochronology: Methods, validation and application to conservation. [PhD dissertation]. Durham (NC): Duke University.

Spotila JR, O'Connor MP, Paladino FV. 1997. Thermal biology. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 297–314.

Standora E, Ryder M, Edbauer J, Williams K, Morreale S, Bolten A. 1994. Homing behavior of loggerhead turtles relocated from dredging areas in Cape Canaveral Channel, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 141-142.

Standora EA, Eberle MD, Edbauer JM, Morreale SJ, Bolten AB. 1993. Assessment of baseline behavior and trawling efficiency in Canaveral Channel, Florida. Final contract report to US Army Engineer Waterways Experiment Station, Buffalo State College, Buffalo, NY. Hampton Bays (NY) and Gainesville (FL): Okeanos Ocean Research Foundation, Inc. and University of Florida, Gainesville.

Stimmelmayr R, Latchman V, Sullivan M. 2010. In-water observations of hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles in St. Kitts, Lesser Antilles. Mar Turtle Newsl. 127:17-19.

Stokes L. 2011. Bibliography of marine turtle research in the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-613. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Studt JF. 1987. Amelioration of maintenance dredging impacts on sea turtles, Canaveral Harbor, Florida. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida, Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 55-58.

Suedel BC, Kim J, Clarke DG, Linkov I. 2008. A risk-informed decision framework for setting environmental windows for dredging projects. Sci Total Environ. 403(1):1-11.

Taylor AS. 1990. The hopper dredge. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory. p. 59-63.

Thompson NB, Huang H. 1993. Leatherback turtles in southeast US waters. NOAA Technical Memorandum NMFS-SEFSC-318. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Tiwari M, Wallace BP, Girondot M. 2013. *Dermochelys coriacea* (Northwest Atlantic Ocean subpopulation). The IUCN red list of threatened species 2013: e.T46967827A46967830. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967827A46967830.en.

Todd VLG, Todd IB, Gardiner JC, Morrin ECN, MacPherson NA, DiMarzio NA, Thomsen F. 2015. A review of impacts of marine dredging activities on marine mammals. ICES J Mar Sci. 72(2):328-340.

Tucker and Associates, Inc. 1990. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1-3, 1989. OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Tyberghein L, Verbruggen H, Pauly K, Troupin C, Mineur F, De Clerck O. 2012. Bio-ORACLE: A global environmental dataset for marine species distribution modelling. Global Ecol Biogeogr. 21(2):272-281.

US Congress Office of Technology Assessment. 1987. Marine minerals: Exploring our new ocean frontier. OTA-O-342 Washington (DC): US Government Printing Office.

[USACE] US Army Corps of Engineers. 1997. Memorandum on National Marine Fisheries Service, Regional Biological Opinion on hopper dredging along the South Atlantic Coast, October 29, 1997. Hopper dredging protocol for Atlantic Coast FY 98 - FY 03. Atlanta (GA): US Army Corps of Engineers.

USACE. 2006. Management protocol for effective implementation of the National Marine Fisheries Regional Biological Opinion for hopper dredging Gulf of Mexico. Jacksonville (FL): US Army Corps of Engineers.

USACE. 2013. USACE sea turtle data warehouse. US Army Corps of Engineers; [accessed 2016 Feb 9]. http://el.erdc.usace.army.mil/seaturtles.

USACE. 2016a. About dredging. US Army Corps of Engineers; [accessed 2016 Apr 18]. http://dqm.usace.army.mil/Education/Index.aspx.

USACE. 2016b. Operation and dredging endangered species system (ODESS). Mobile (AL): US Army Corps of Engineers; [accessed 2016 Mar 2]. http://dqm.usace.army.mil/odess.

[USACE WES] US Army Corps of Engineers Waterways Experiment Station. 1997. Sea turtle research program summary report. Prepared for the US Army Engineer Division, South Atlantic and US Naval Submarine Base, Kings Bay. Technical report CHL-97-31. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

van Dam RP, Diez CE. 1998. Home range of immature hawksbill turtles *Eretmochelys imbricata* (Linnaeus) at two Caribbean islands. J Exp Mar Biol Ecol. 220(1):15-24.

van Raalte GH. 2006. Dredging techniques; Adaptations to reduce environmental impact. In: Eisma D, editor. Dredging in coastal waters. New York (NY): Taylor and Francis Group. p. 1-40.

Vander Zanden HB, Tucker AD, Hart KM, Lamont MM, Fujisaki I, Addison DS, Mansfield KL, Phillips KF, Wunder MB, Bowen GJ et al. 2015. Determining origin in a migratory marine vertebrate: A novel method to integrate stable isotopes and satellite tracking. Ecol Appl. 25(2):320-335.

Vicente VP. 1994. Spongivory in Caribbean hawksbill turtles, *Eretmochelys imbricata*: Data from stranded specimens. In: Schroeder BA, Witherington BE, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 185–188.

Villa F, Bagstad KJ, Voigt B, Johnson GW, Portela R, Honzák M, Batker D. 2014. A methodology for adaptable and robust ecosystem services assessment. PLOS ONE. 9(3):e91001.

Wallace BP, DiMatteo AD, Bolten AB, Chaloupka MY, Hutchinson BJ, Abreu-Grobois FA, Mortimer JA, Seminoff JA, Amorocho D, Bjorndal KA et al. 2011. Global conservation priorities for marine turtles. PLOS ONE. 6(9):e24510.

Wallace BP, DiMatteo AD, Hurley BJ, Finkbeiner EM, Bolten AB, Chaloupka MY, Hutchinson BJ, Abreu-Grobois FA, Amorocho D, Bjorndal KA et al. 2010. Regional management units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLOS ONE. 5(12):e15465.

Wallace BP, Heppell SS, Lewison RL, Kelez S, Crowder LB. 2008. Impacts of fisheries bycatch on loggerhead turtles worldwide inferred from reproductive value analyses. J Appl Ecol. 45(4):1076-1085.

Wallace BP, Tiwari M, Girondot M. 2013. *Dermochelys coriacea*. The IUCN red list of threatened species 2013: e.T6494A43526147. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T6494A43526147.en.

Watts ME, Ball IR, Stewart RS, Klein CJ, Wilson K, Steinback C, Lourival E, Kircher L, Possingham HP. 2009. Marxan with zones: Software for optimal conservation based land-and sea-use zoning. Environ Model Software. 24(12):1513-1521.

Weber MJ. 1990. Human activities and sea turtle conservation in the Gulf of Mexico. In: Tucker and Associates, Inc, editor. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1 - 3, 1989 OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region. p. 23-38.

Wessel P, Smith WHF. 1996. A global, self-consistent, hierarchical, high-resolution shoreline. J Geophys Res. 101(B4):8741-8743.

Wessel P, Smith WHF. 2016. GSHHG - A global self-consistent, hierarchical, high-resolution geography database. [accessed 2016 Jun 13]. http://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html.

Williams NC, Bjorndal KA, Lamont MM, Carthy RR. 2014. Winter diets of immature green turtles (*Chelonia mydas*) on a northern feeding ground: Integrating stomach contents and stable isotope analyses. Estuar Coasts. 37.

Witham R. 1990. A case report on beach erosion, beach nourishment and sea turtle nesting. In: Richardson TH, Richardson JI, Donnelly M, editors. Proceedings of the tenth annual workshop on sea turtle biology and conservation, 20 - 24 February 1990, Hilton Head Island, South Carolina NOAA Technical Memorandum NMFS-SEFC-278. Washington (DC): National Oceanic and Atmospheric Administration. p. 157-160.

Witt MJ, Broderick AC, Johns DJ, Martin C, Penrose R, Hoogmoed MS, Godley BJ. 2007. Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. Mar Ecol Prog Ser. 337:231-243.

Witzell WN. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis 137. Rome, Italy: Food and Agriculture Organization of the United Nations.

Witzell WN. 1987. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26-27, 1985. NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Witzell WN, Schmid JR. 2005. Diet of immature Kemp's ridley turtles (*Lepidochelys kempi*) from Gullivan Bay, Ten Thousand Islands, southwest Florida. Bull Mar Sci. 77(2):191-200.

Zhang HM, Bates JJ, Reynolds RW. 2006. Assessment of composite global sampling: Sea surface wind speed. Geophys Res Lett. 33(17):1-5.

Appendix A: Subject Bibliography and Number of Sources Related to Sea Turtle Entrainment Risk in TSHD, Listed Under Broad Categories: Background Information, Dredging, Environment, Sea Turtle Biology, Sea Turtle Telemetry Datasets, and Tools (Total = 859 References)

A.1 Background Information (114)

Avens L, Eguchi T, Epperly S, Haas H, Richards P, Seney E, Thompson N, Houtan KSV. 2013. Sea turtle assessment status and research needs. NOAA Technical Memorandum NMFS-F/SPO-131. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Becker E, Forney K, Fiedler P, Barlow J, Chivers S, Edwards C, Moore A, Redfern J. 2016. Moving towards dynamic ocean management: How well do modeled ocean products predict species distributions? Remote Sens. 8(2):149.

[BLM] Bureau of Land Management. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 1. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 2. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 3. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 4. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 2 Master Bibliography. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 3, Appendices. Center for Natural Areas, Bureau of Land Management.

Block BA, Holbrook CM, Simmons SE, Holland KN, Ault JS, Costa DP, Mate BR, Seitz AC, Arendt MD, Payne JC et al. 2016. Toward a national animal telemetry network for aquatic observations in the United States. Anim Biotelem. 4(1):1-8.

Block BA, Jonsen ID, Jorgensen SJ, Winship AJ, Shaffer SA. 2011. Tracking apex marine predators in a dynamic ocean. Nature. 475:86-90.

Boehlert GW, Gill AB. 2010. Environmental and ecological effects of ocean renewable energy development. Oceanography. 23(2):68-81.

[BOEM] Bureau of Ocean Energy Management. 2010. Atlantic NAD 83 OCS planning areas. Herndon (VA): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 4]. http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Atlantic.aspx.

BOEM. 2012. BOEM 2012 - 2017 final program areas. Washington (DC): Bureau of Ocean Energy Management; [accessed 2016 Apr 6]. http://www.data.boem.gov/homepg/pubinfo/repcat/arcinfo/zipped/Boem2012-2017FinalProgramAreas.zip.

BOEM. 2012. Digital offshore cadastre (DOC) – Gulf of Mexico federal outer continental shelf (OCS) administrative boundaries (preliminary). Lakewood (CO): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 6]. http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Mapping_and_Data/Administrative_Boundaries/gom_admn.zip.

BOEM. 2013. Guidelines for providing information on marine mammals and sea turtles for renewable energy development on the Atlantic outer continental shelf. Pursuant to 30 CFR Part 585 Subpart F. Sterling (VA): Bureau of Ocean Energy Management Office of Renewable Energy Programs; [accessed 2016 May 13]. http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Regulatory_Information/BOEM_Renewable_MMandST_Guidelines.pdf.

BOEM. 2017. Marine Minerals Program Current Statistics website. Washington (DC): Bureau of Ocean Energy Management; [accessed 2017 Dec 5]. https://www.boem.gov/MMP-Current-Statistics.

Byrnes MR, Hammer RM, Thibaut TD, Snyder DB. 2004. Physical and biological effects of sand mining offshore Alabama, USA. J Coast Res. 20(1):6-24.

Byrnes MR, Hammert RM, Thibaut TD, Snyder DB. 2004. Effects of sand mining on physical processes and biological communities offshore New Jersey, USA. J Coast Res. 20(1):25-43.

Carroll C, Rohlf DJ, Li Y-W, Hartl B, Phillips MK, Noss RF. 2015. Connectivity conservation and endangered species recovery: A study in the challenges of defining conservation-reliant species. Conserv Lett. 8(2):132-138.

Casale P, Tucker AD. 2015. *Caretta caretta*. The IUCN red list of threatened species 2015: e.T3897A83157651. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T3897A83157651.en.

Caswell H. 1989. Matrix population models. Sunderland (MA): Sinauer.

Ceriani SA, Meylan AB. 2015. *Caretta caretta* (North West Atlantic subpopulation). The IUCN red list of threatened species 2015: e.T84131194A84131608. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T84131194A119339029.en.

Conant TA, Dutton PH, Eguchi T, Epperly SP, Fahy CC, Godfrey MH, MacPherson SL, Possardt EE, Schroeder BA, Seminoff JA et al. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the US Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Donlan CJ, Wingfield DK, Crowder LB, Wilcox C. 2010. Using expert opinion surveys to rank threats to endangered species: A case study with sea turtles. Conserv Biol. 24(6):1586-1595.

Eckert SA. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. In: Epperly SP, Braun J, editors. Proceedings of the seventeenth annual sea turtle symposium, 4 - 8 March 1997, Orlando, Florida, USA NOAA Technical Memorandum NMFS-SEFSC-415 Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 46-48.

Eckert SA. 1999. Data acquisition systems for monitoring sea turtle behavior and physiology. In: Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M, editors. Research and management techniques for the conservation of sea turtles. Washington (DC): IUCN/SSC Marine Turtle Specialist Group Publication. p. 88-93.

Elith J, Leathwick JR. 2009. Species distribution models: Ecological explanation and prediction across space and time. Annu Rev Ecol Evol Syst. 40(1):677-697.

[EPA] Environmental Protection Agency. 1992. Biological populations as indicators of environmental change. DPA/230/R-92/011. Washington (DC): US Environmental Protection Agency, Office of Policy, Planning and Evaluation.

Foley AM, Dutton PH, Singel KE, Redlow AE, Teas WG. 2003. The first records of olive ridleys in Florida, USA. Mar Turtle Newsl. 101:23-25.

[FWS] Fish and Wildlife Service. 2014. Endangered and threatened wildlife and plants; Designation of critical habitat for the Northwest Atlantic Ocean distinct population segment of the loggerhead sea turtle. US Fish and Wildlife Service final rule. Federal Register. 79(132):39756-39854.

FWS. 2016. Critical habitat GIS files. Washington (DC): US Fish and Wildlife Service Environmental Conservation Online System; [accessed 2016 Apr 22]. http://ecos.fws.gov/ecp/report/table/critical-habitat.html?xmlfile=../docs/crithab/metadata/FCH_Caretta_caretta_20140710.shp.xml#Distributor1.

[FWS, NMFS] Fish and Wildlife, National Marine Fisheries Service. 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife.

FWS, NMFS. 1998. Consultation handbook: Procedures for consultation and conference activities under Section 7 of the Endangered Species Act. Washington (DC): US Fish and Wildlife Service and National Marine Fisheries Service.

[GADM] Global Administrative Areas. 2015. GADM database of global administrative areas. Version 2.5. Davis (CA): Global Administrative Areas, University of California, Davis; [accessed 2015 Sep 4]. http://gadm.org.

Good CP. 2008. Spatial ecology of the North Atlantic right whale (*Eubalaena glacialis*). PhD dissertation. Durham (NC): Duke University.

Guisan A, Zimmermann NE. 2000. Predictive habitat distribution models in ecology. Ecol Model. 135(2–3):147-186.

Hamann M, Godfrey MH, Seminoff JA, Arthur K, Barata PCR, Bjorndal KA, Bolten AB, Broderick AC, Campbell LM, Carreras C. 2010. Global research priorities for sea turtles: Informing management and conservation in the 21st century. Endangered Species Res. 11(3):245-269.

Harms CA, Mallo KM, Ross PM, Segars A. 2003. Venous blood gases and lactates of wild loggerhead sea turtles (*Caretta caretta*) following two capture techniques. J Wildl Dis. 39(2):366-374.

Hays GC, Scott R. 2013. Global patterns for upper ceilings on migration distance in sea turtles and comparisons with fish, birds and mammals. Funct Ecol. 27:748-756.

Hildebrand JA. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Mar Ecol Prog Ser. 395:5-20.

Hobday AJ, Hartog JR, Timmiss T, Fielding J. 2010. Dynamic spatial zoning to manage southern bluefin tuna (*Thunnus maccoyii*) capture in a multi-species longline fishery. Fish Oceanogr. 19(3):243-253.

Hopkins S, Richardson J. 1984. A recovery plan for marine turtles. Washington (DC): US Government Printing Office.

Hopkins-Murphy SR, Murphy TM, Hope CP, Coker JW, Griffin DB. 2008. Sea turtle conservation in South Carolina: Three decades. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 126.

Hussey NE, Kessel ST, Aarestrup K, Cooke SJ, Cowley PD, Fisk AT, Harcourt RG, Holland KN, Iverson SJ, Kocik JF et al. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. Science. 348(6240):1221-1231.

Lutcavage ME, Lutz PL. 1991. Voluntary diving metabolism and ventilation in the loggerhead sea turtle. J Exp Mar Biol Ecol. 147(2):287-296.

Magnuson JJ, Bjorndal KA, DuPaul WD, Graham GL, Owens DW, Peterson CH, Pritchard PCH, Richardson JI, Saul GE, West CW. 1990. Decline of the sea turtles: Causes and prevention. Washington (DC): National Academies Press.

Mannocci L, Roberts JJ, Miller DL, Halpin PN. 2017. Extrapolating cetacean densities io quantitatively assess human impacts on populations in the high seas. Conserv Biol. 31(3):602-614.

Marine Turtle Specialist Group. 1996. *Lepidochelys kempii*. The IUCN Red List of Threatened Species; [accessed 2016 Feb 3]. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T11533A3292342.en.

McClintock W. 2013. GeoDesign: Optimizing stakeholder-driven marine spatial planning. Coast Guard Journal of Safety & Security at Sea, Proceedings of the Marine Safety and Security Council. 40(3):63-67.

Michel J. 2004. Regional management strategies for federal offshore borrow areas, US east and Gulf of Mexico coasts. J Coast Res. 20:149-154.

Mortimer JA. 2007. The state of the world's hawksbills. In: Mast RB, Bailey LM, Hutchinson BJ, Hutchinson A, Koenig K, editors. Where the hawksbills are State of the World's Sea Turtles report volume III. Arlington (VA). p. 10-11.

Mortimer JA, Donnelly M. 2008. *Eretmochelys imbricata*. The IUCN red list of threatened species 2008: e.T8005A12881238. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T8005A12881238.en.

Moustahfid H, Grimes CB, Kocik J, Block BA, Holland KN, Payne J, Fox DA, Seitz AC, Alexander CE. 2011. Toward a national animal telemetry observing network (ATN) for our oceans, coasts, and Great Lakes: Workshop synthesis report US IOOS workshop, March 2011, Santa Cruz, California). NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-482. La Jolla (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

National Academies Press. 1987. Sedimentation control to reduce maintenance dredging of navigational facilities in estuaries: Report and symposium proceedings. Washington (DC): National Academies Press.

National Research Council. 2010. Assessment of sea-turtle status and trends: Integrating demography and abundance. Washington (DC): National Academies Press.

[NMFS] National Marine Fisheries Service. 1979. Determination of critical habitat for the leatherback sea turtle. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 44:17710-17712.

NMFS. 1998. Designated critical habitat; Green and hawksbill sea turtles. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 63:46693-46701.

NMFS. 2006. Sea turtle and smalltooth sawfish construction conditions. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2014. Endangered and threatened species: Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 79(132):39856-39912.

[NMFS, FWS] National Marine Fisheries Service, US Fish and Wildlife Service. 1991. Recovery plan for US population of Atlantic green turtle (*Chelonia mydas*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1991. Recovery plan for US populations of loggerhead turtle (*Caretta caretta*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1992. Recovery plan for leatherback turtles *Dermochelys coriacea* in the US Caribbean, Atlantic and Gulf of Mexico. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1993. Recovery plan for hawksbill turtles in the US Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2007. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2007. Loggerhead sea turtle (*Caretta caretta*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2010. Final review: Endangered and threatened species; determination of nine distinct population segments of loggerhead sea turtles as endangered or threatened. 50 CFR Part 17, 223, and 224. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013. Hawksbill sea turtle (*Eretmochlys imbricata*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2015. Kemp's ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation. Silver Spring (MD) and Albuquerque (NM): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2016. Endangered and threatened wildlife and plants; Final rule to list eleven distinct population segments of the green sea turtle (*Chelonia mydas*) as endangered or threatened and revision of current listings under the Endangered Species Act. National Oceanic and Atmospheric Administration National Marine Fisheries Service and US Fish and Wildlife Service final rule. Federal Register. 81(66):20058-20090.

[NMFS, FWS, SEMARNAT] National Marine Fisheries Service, US Fish and Wildlife Service, Secretary of Environment and Natural Resources, Mexico. 2011. Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, US Fish and Wildlife Service, and the Secretary of Environment and Natural Resources, Mexico.

Piatkowski D, Culbertson J. 2016. An update on the Bureau of Ocean Energy Management, Marine Minerals Program Studies. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Plotkin PT. 1995. National Marine Fisheries Service and US Fish and Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Pullen EJ, Naqvi SM. 1983. Biological impacts on beach replenishment and borrowing. Shore Beach. 51(2):27-31.

Reidenauer J, Turner L. 2016. Federal sand resources. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB et al. 2016. Habitat-based cetacean density models for the US Atlantic and Gulf of Mexico. Sci Rep. 6:22615.

Robinson LM, Elith J, Hobday AJ, Pearson RG, Kendall BE, Possingham HP, Richardson AJ. 2011. Pushing the limits in marine species distribution modelling: Lessons from the land present challenges and opportunities. Global Ecol Biogeogr. 20(6):789-802.

Robinson PW, Tremblay Y, Crocker DE, Kappes MA, Kuhn CE, Shaffer SA, Simmons SE, Costa DP. 2007. A comparison of indirect measures of feeding behaviour based on ARGOS tracking data. Deep-Sea Res Part II Top Stud Oceanogr. 54(3-4):356-368.

Rogers KB, White GC. 2007. Analysis of movement and habitat use from telemetry data. In: Guy SC, Brown ML, editors. Analysis and interpretation of freshwater fisheries data. Bethesda (MD): American Fisheries Society.

Rohlf DJ, Carroll C, Hartl B. 2014. Conservation-reliant species: Toward a biology-based definition. Bioscience. 64(7):601-611.

Royer F, Lutcavage M. 2008. Filtering and interpreting location errors in satellite telemetry of marine animals. J Exp Mar Biol Ecol. 359(1):1-10.

Saunders JE, Roberts C. 2010. Improving sustainability indicators for marine aggregate dredging: Final report. No. MEPF/09/P95.

Scott JM, Goble DD, Haines AM, Wiens JA, Neel MC. 2010. Conservation-reliant species and the future of conservation. Conserv Lett. 3(2):91-97.

Scott JM, Goble DD, Wiens JA, Wilcove DS, Bean M, Male T. 2005. Recovery of imperiled species under the Endangered Species Act: The need for a new approach. Front Ecol Environ. 3(7):383-389.

Seminoff JA. 2004. *Chelonia mydas*. The IUCN red list of threatened species 2004: e.T4615A11037468. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T4615A11037468.en.

Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Haas HL, Hargrove SA, Jensen MP, Klemm DL, Lauritsen AM et al. 2015. Status review of the green turtle (*Chelonia mydas*) under the US Endangered Species Act. NOAA Technical Memorandum NOAA-NMFS-SWFSC-539. La Jolla (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Shaffer SA, Costa DP. 2006. A database for the study of marine mammal behavior: gap analysis, data standardization, and future directions. IEEE Journal of Oceanic Engineering. 31(1):82-86.

Stewart K, Johnson C. 2006. The turtles of Florida: *Dermochelys coriacea* - Leatherback sea turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 144-157.

Stokes L. 2011. Bibliography of marine turtle research in the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-613. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Sutton G, Boyd S. 2009. Effects of extraction of marine sediments on the marine environment 1998-2004. Copenhagen, Denmark: International Council for the Exploration of the Sea.

Taylor CM, Smith B, Stein D. 2012. The role of MarineCadastre.gov in offshore energy planning. 2012 oceans, 14 - 19 October 2012, Hampton Roads, Virginia. New York (NY): Intitute of Electrical and Electronics Engineers. p. 1-6.

Thompson N, Henwood T, Epperly S, Lohoefener R, Gitschlag G. 1990. Marine turtle habitat plan. NOAA Technical Memorandum NMFS-SEFC-255. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Thompson NB. 1988. The status of loggerhead, *Caretta caretta*, Kemp's ridley, *Lepidochelys kempi*; and green, *Chelonia mydas*, sea turtles in US waters. Mar Fish Rev. 50:16-23.

Thompson NB, Huang H. 1993. Leatherback turtles in southeast US waters. NOAA Technical Memorandum NMFS-SEFSC-318. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Tillin HM, Houghton AJ, Saunders JE, Drabble R, Hull SC. 2011. Direct and indirect impacts of aggregate dredging. In: Newell RC, Measures J, editors. Marine Aggregate Levy Sustainability Fund Science Monograph Series Number 1 MEPF 10/P144. Lowestoft, United Kingdom: Marine Aggregate Levy Sustainability Fund. p. 1-46.

Tiwari M, Wallace BP, Girondot M. 2013. *Dermochelys coriacea* (Northwest Atlantic Ocean subpopulation). The IUCN red list of threatened species 2013: e.T46967827A46967830. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967827A46967830.en.

Tomlinson BN, Petterson JS, Glazier EW, Lewis J, Selby I, Nairn R, Kenny T, Godde P, Espinasse CJ, Stanley L et al. 2007. Investigation of dredging impacts on commercial and recreational fisheries and analysis of available mitigation measures to protect and preserve resources. OCS Report MMS 2006-0065. Herndon (VA): Minerals Management Service, Leasing Division, Marine Minerals Branch.

Tunnell JW, Jr., Hilbun NL, Withers K. 2002. Comprehensive bibliography of the Laguna Madre of Texas and Tamaulipas. Prepared for the Nature Conservancy of Texas. TAMU-CC-0202-CCS. Corpus Christi (TX): Center for Coastal Studies, Texas A&M University – Corpus Christi.

Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley sea turtle (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Turtle Expert Working Group. 2007. An assessment of the leatherback turtle population in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-555. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

[USACE] US Army Corps of Engineers. 1998. Biological assessment: Use of the sidecast dredges Fry, Merritt, and Schweizer, and the split-hull hopper dredge Currituck in coastal United States waters. Wilmington (NC): US Army Corps of Engineers, Wilmington District.

USACE. 2016. About dredging. US Army Corps of Engineers; [accessed 2016 Apr 18]. http://dqm.usace.army.mil/Education/Index.aspx.

[VLIZ] Vlaams Instituut voor de Zee. 2014. Maritime boundaries geodatabase, version 8. Flanders Marine Institute - Vlaams Instituut voor de Zee. [accessed 2016 Apr 6]. http://www.marineregions.org.

W. F. Baird and Associates, Ltd. 2004. Development of the MMS dredge plume model. Prepared for: Minerals Management Service, Leasing Division Sand and Gravel Unit. Madison (WI): W.F. Baird and Associates, Ltd.

Wallace BP, DiMatteo AD, Bolten AB, Chaloupka MY, Hutchinson BJ, Abreu-Grobois FA, Mortimer JA, Seminoff JA, Amorocho D, Bjorndal KA et al. 2011. Global conservation priorities for marine turtles. PLOS ONE. 6(9):e24510.

Wallace BP, DiMatteo AD, Hurley BJ, Finkbeiner EM, Bolten AB, Chaloupka MY, Hutchinson BJ, Abreu-Grobois FA, Amorocho D, Bjorndal KA et al. 2010. Regional management units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLOS ONE. 5(12):e15465.

Wallace BP, Heppell SS, Lewison RL, Kelez S, Crowder LB. 2008. Impacts of fisheries bycatch on loggerhead turtles worldwide inferred from reproductive value analyses. J Appl Ecol. 45(4):1076-1085.

Wallace BP, Tiwari M, Girondot M. 2013. *Dermochelys coriacea*. The IUCN red list of threatened species 2013: e.T6494A43526147. IUCN Red List of Threatened Species; [accessed 2016 Jan 8]. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T6494A43526147.en.

Waring GT, Wood SA, Josephson E. 2012. Literature search and data synthesis for marine mammals and sea turtles in the US Atlantic from Maine to the Florida Keys. OCS Study BOEM 2012-109. New Orleans (LA): Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Webster MS, Marra PP, Haig SM, Bensch S, Holmes RT. 2002. Links between worlds: Unraveling migratory connectivity. Trends Ecol Evol. 17(2):76-83.

Witherington B, Bresette M, Herren R. 2006. *Caretta caretta* - Loggerhead sea turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 74-89.

Witherington B, Bresette M, Herren R. 2006. *Chelonia mydas* - Green turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 90-104.

Witzell WN. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis 137. Rome, Italy: Food and Agriculture Organization of the United Nations.

A.2 Dredging (277)

ANAMAR Environmental Consulting, Inc., CH2M Hill. 2006. Biological assessment for research and compilation of baseline data for the use of bed-leveling devices at Port Canaveral, Brevard County, Florida. Report submitted to: US Army Corps of Engineers, Jacksonville District. Gainesville (FL) and Jacksonville (FL): ANAMAR Environmental Consulting, Inc.

Banks G, Alexander MP. 1994. Development and evaluation of a sea turtle-deflecting hopper dredge draghead. Miscellaneous Paper HL-94-5. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

Bargo T, Glass J, Fitzpatrick T, Ouellette D. 2008. Sea turtle relocation trawling: Is it effective? In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 116.

Bargo T, Parks W. 2002. Sea turtle relocation trawling: Port Canaveral Harbor channel, Cape Canaveral, Florida, Brevard County. Final report submitted by REMSA, Inc.

Bates PC, Jordan-Sellers T. 2011. Best management practice design criteria for hopper dredge/sea turtle friendly borrow sites. In: Jones TT, Wallace BP, editors. Proceedings of thirty-first annual symposium on sea turtle biology and conservation, 10 to 16 April 2011, San Diego, California, USA NOAA Technical Memorandum NMFS-SEFSC-631. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 258.

Berry SA. 1990. Canaveral Harbor entrance channel operational measures to protect sea turtles. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

BOEM. 2010. Atlantic NAD 83 OCS planning areas. Herndon (VA): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 4]. http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Atlantic.aspx.

BOEM. 2012. BOEM 2012 - 2017 final program areas. Washington (DC): Bureau of Ocean Energy Management; [accessed 2016 Apr 6]. http://www.data.boem.gov/homepg/pubinfo/repcat/arcinfo/zipped/Boem2012-2017FinalProgramAreas.zip.

BOEM. 2012. Digital offshore cadastre (DOC) – Gulf of Mexico federal outer continental shelf (OCS) administrative boundaries (preliminary). Lakewood (CO): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 6]. http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Mapping_and_Data/Administrative_Boundaries/gom_admn.zip.

BOEM. 2015. BOEM Marine Minerals Program fact sheet. Bureau of Ocean Energy Management; [accessed 2016 Feb 2]. http://www.boem.gov/MMP-General-Fact-Sheet.

BOEM. 2015. Federal sand and gravel borrow areas (lease areas). Sterling (VA): Bureau of Ocean Energy Management, Marine Minerals Program; [accessed 2016 Feb 19]. http://marinecadastre.gov/data.

BOEM. 2017. Marine Minerals Program Current Statistics website. Washington (DC): Bureau of Ocean Energy Management; [accessed 2017 Dec 5]. https://www.boem.gov/MMP-Current-Statistics.

BOEM. [date unknown]. Federal sand and gravel borrow areas (lease areas). Sterling (VA): Bureau of Ocean Energy Management, Marine Minerals Program; [accessed 2016 Apr 27]. https://gis.boem.gov/arcgis/rest/services/BOEM_BSEE/MMC_Layers/MapServer/14.

[BOEM-DEA] Bureau of Ocean Energy Management, Division of Environmental Assessment. 2013. Issuance of a negotiated agreement for use of outer continental shelf sand from Canaveral Shoals II in the Brevard County Shore Protection Project (SPP) North Reach and South Reach environmental assessment. OCS EIS/EA BOEM 2013-01151. Herndon (VA): Bureau of Ocean Energy Management, Division of Environmental Assessment.

Bolten AB, Bjorndal KA. 1991. Relocation of sea turtles during dredging at Cape Canaveral, FL, 30 December 1990-15 January 1991. Archie Carr Center for Sea Turtle Research - University of Florida, USACE Cooperative Agreement DACW17-90-H-0015. US Army Corps of Engineers.

Braun J, Epperly SP. 1996. Aerial surveys for sea turtles in Southern Georgia waters, June, 1991. Gulf Mex Sci. 14(1):39-44.

Bray RN, Bates AD, Land JM. 1996. Dredging and the environment. In: Bray RN, Bates AD, Land JM, editors. Dredging (second edition): A handbook for engineers. Oxford, United Kingdom: Butterworth-Heinemann. p. 371-387.

Bridges TS, Walker J. 2011. Engineering with nature. Engineering with nature: Designing navigation infrastructure for greater environmental sustainability, 7 - 8 September 2011, Charleston, South Carolina. US Army Corps of Engineers; [accessed 2016 Apr 29]. http://el.erdc.usace.army.mil/training.cfm?Topic=Workshop&List=11Sept-EWN.

Brooks RA, Purdy CN, Bell SS, Sulak KJ. 2006. The benthic community of the eastern US continental shelf: A literature synopsis of benthic faunal resources. Cont Shelf Res. 26:804-818.

Byrd JI. 2004. The effect of beach nourishment on loggerhead sea turtle (*Caretta caretta*) nesting in South Carolina. [Masters thesis]. Charleston (SC): College of Charleston.

Byrnes MR, Hammer RM, Thibaut TD, Snyder DB. 2004. Physical and biological effects of sand mining offshore Alabama, USA. J Coast Res. 20(1):6-24.

Byrnes MR, Hammer RM, Vittor BA, Kelley SW, Snyder DB, Côté JM, Ramsey JS, Thibaut TD, Phillips NW, Wood JD et al. 2003. Collection of environmental data within sand resource areas offshore North Carolina and the environmental implications of sand removal for coastal and beach restoration. Volume I: Main text. OCS Study MMS 2000-056. Herndon (VA): Minerals Management Service, Leasing Division, Sand and Gravel Unit.

Byrnes MR, Hammert RM, Thibaut TD, Snyder DB. 2004. Effects of sand mining on physical processes and biological communities offshore New Jersey, USA. J Coast Res. 20(1):25-43.

Clausner JE, Dickerson D, Dasilva A, Banks G. 2004. Equipment and operational modifications for hopper dredges to reduce impacts on sea turtles in the southeastern USA. WODCON XVII: Dredging in a sensitive environment, September 27 - October 1, 2004, Hamburg, Germany. Central Dredging Association.

Conti K. 2008. Beach dredging project denied. The Boston Globe. 4 May 2008.

Conti K. 2010. Shoreline restoration plan stalls. The Boston Globe. 14 January 2010.

Conti K. 2011. State proposes new plan to restore Winthrop's eroded shoreline. The Boston Globe. 23 October 2011.

Cooper KM, Curtis M, Wan Hussin WMR, Barrio Frojan CRS, Defew EC, Nye V, Patterson DM. 2011. Implications of dredging induced changes in sediment particle size composition for the structure and function of marine benthic macrofaunal communities. Mar Pollut Bull. 62(10):2087-2094.

Coston-Clements L, Hoss D. 1983. Synopsis of data on the impact of habitat alteration on sea turtles around the southeastern United States. NOAA Technical Memorandum NMFS-SEFC-117. Miami (FL): National Oceanic Atmospheric Administration, Southeast Fisheries Science Center.

Crowe SE, Bergquist DC, Sanger DM, Van Dolah RF. 2016. Physical and biological alterations following dredging in two beach nourishment borrow areas in South Carolina’s coastal zone. J Coast Res. 32(4):875-889.

CSA International, Applied Coastal Research and Engineering, Inc., Barry A. Vittor and Associates, Inc., C. F. Bean, Florida Institute of Technology. 2009. Analysis of potential biological and physical impacts of dredging on offshore ridge and shoal features. OCS Study MMS 2010-010. Herndon (VA): Minerals Management Service, Leasing Division, Marine Minerals Branch.

Dean RG. 2002. Beach nourishment: Theory and practice. River Edge (NJ): World Scientific.

Decker L, Whitmont M. [date unknown]. Using dredge plant operational data to measure dredging intensity and cumulative exposure. OCS Study BOEM 2015. Sterling (VA): Bureau of Ocean Energy Management.

Dickerson D. 2009. Dredging and sea turtles: Potential impacts, assessing risk, and protection methods. Navigating the environment - Management risks and sustaining benefits seminar, October 28, 2009, New Orleans, Louisiana. Alexandria (VA): World Association for Waterborne Transport Infrastructure (PIANC) USA and PIANC International Environmental Commission.

Dickerson D. 2015. Sea turtles and dredging: A historical perspective of research. Dredging Operations Technical Support Program Dredging Workshop, August 26, 2015, Vicksburg, MS. Vicksburg (MS): US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory.

Dickerson D, Richardson JJ, Ferris JS, Bass AL, Wolf M. 1991. Entrainment of sea turtles by hopper dredges in Cape Canaveral and King's Bay Ship Channels. Environmental Effects of Dredging. 91:1-9.

Dickerson D, Theriot C, Wolters M, Slay C, Bargo T, Parks W. 2007. Effectiveness of relocation trawling during hopper dredging for reducing incidental take of sea turtles. In: Randall RE, editor. Proceedings of the eighteenth world dredging congress (WODCON XVIII), May 27 - June 1, 2007, Lake Buena Vista, Florida USA. Bryan (TX): Newman Printing Company.

Dickerson DD, Bargo T. 2011. Occurrence of a sea turtle congregation near Louisiana Chandeleur Islands following the Deepwater Horizon oil spill. In: Jones TT, Wallace BP, editors. Proceedings of thirty-first annual symposium on sea turtle biology and conservation, 10 to 16 April 2011, San Diego, California, USA NOAA Technical Memorandum NMFS-SEFSC-631. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 11-12.

Dickerson DD, Clausner JE. 2003. Summary of sea turtle/dredging issues and recommended action tasks generated by the Improved Draghead Design Meeting, September 4, 2003, Atlanta, Georgia. Vicksburg (MS): US Army Corps of Engineers, Engineering Research and Development Center.

Dickerson DD, Nelson DA. 1990. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

Dickerson DD, Nelson DA, Banks G. 1990. Alternative dredging equipment and operational methods to minimize sea turtle mortalities. Environmental Effects of Dredging Technical Notes EEDP-09-6. Vicksburg (MS): US Army Engineer Waterways Experiment Station.

Dickerson DD, Nelson DA, Dickerson CE, Reine KJ. 1993. Dredging related sea turtle studies along the southeastern US. In: Laska S, Puffer A, editors. Coastlines of the Gulf of Mexico. New York (NY): American Society of Civil Engineers. p. 6-17.

Dickerson DD, Nelson DA, Nye R. 1995. US Army Corps of Engineers sea turtle studies associated with hopper dredging projects. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 175.

Dickerson DD, Reine KJ, Clarke DG. 1998. Economic impacts of environmental windows associated with dredging operations. DOER Technical Notes Collection (TN DOER-E3). Vicksburg (MS): US Army Engineer Research and Development Center.

Dickerson DD, Reine KJ, Nelson DA, Dickerson CE. 1995. Assessment of sea turtle abundance in six South Atlantic US channels. Miscellaneous Paper EL-95-5. Vicksburg (MS): US Army Engineer Waterways Experiment Station.

Dickerson DD, Smith J, Wolters M, Theriot C, Reine KJ, Dolan J. 2007. A review of beach nourishment impacts on marine turtles. Shore Beach. 75(1):49-56.

Dickerson DD, Theriot CT. 2009. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 09 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2009. USACE hopper dredging interactions with sea turtles: Fiscal year 2009 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2010. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 10 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2010. USACE hopper dredging interactions with sea turtles: Fiscal year 2010 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2011. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 11 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2011. USACE hopper dredging interactions with sea turtles: Fiscal year 2011 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2012. USACE hopper dredging interactions with sea turtles and shortnose sturgeon: Fiscal year 12 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Draft final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT. 2012. USACE hopper dredging interactions with sea turtles: Fiscal year 2012 annual summary report for the northern Gulf of Mexico region. Draft final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Theriot CT, Wolters MS. 2008. USACE hopper dredging interactions with sea turtles: Fiscal year 2008 annual summary report for the northern Gulf of Mexico region. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT. 2008. Dredging impacts on sea turtles in the southeastern USA: A historical review of protection. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 26.

Dickerson DD, Wolters MS, Theriot CT. 2008. USACE hopper dredging interactions with sea turtles: Fiscal year 08 annual summary report for the south Atlantic region of the USACE South Atlantic Division. Final report. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT. 2008. USACE hopper dredging interactions with sea turtles: FY07 annual summary report for the northern Gulf of Mexico region. Vicksburg (MS): Sensitive Species Navigation Support Team, Wetlands and Coastal Ecology Branch, Environmental Laboratory, US Army Corps of Engineers Engineer Research and Development Center.

Dickerson DD, Wolters MS, Theriot CT, Slay C. 2004. Dredging impacts on sea turtles in the southeastern USA: A historical review of protection. Proceedings of the world dredging congress XVII, Dredging in a sensitive environment, 27 September - 1 October 2004. Central Dredging Association.

[DoN] Department of the Navy. 2003. Marine resource assessment for the Cherry Point and southern Virginia Capes (VACAPES) inshore and estuarine areas. Final report. Prepared for: Department of the Navy Commander, US Atlantic Fleet. Contract: N62470-95-D-1160, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2005. Marine resources assessment for the northeast operating areas: Atlantic City, Narragansett Bay, and Boston. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0018. Prepared by Geo-Marine, Inc., Newport News, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for southeastern Florida and the AUTEC-Andros operating areas. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6470-02-D-9997, CTO 0034. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for the Gulf of Mexico. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Cherry Point operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9991, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Virginia Capes operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2009. Marine resources assessment for the Chesapeake Bay. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6270-02-D-9997, CTO 0127. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Drabble R. 2012. Monitoring of East Channel dredge areas benthic fish population and its implications. Mar Pollut Bull. 64(2):363-372.

Dredgers Today. 2015. Database of dredgers: The largest dredgers in the world. Dredgers Today; [accessed 2016 Apr 21]. http://www.dredgers-today.com/index.php?/category/47.

Drucker BS, Waskes W, Byrnes MR. 2004. The US Minerals Management Service outer continental shelf sand and gravel program: Environmental studies to assess the potential effects of offshore dredging operations in federal waters. J Coast Res. 20(1):1-5.

Dunkin LM, Reif MK, Swanneack TM, Gerhardt-Smith JM. 2015. Conceptual model development for sea turtle nesting habitat: Support for USACE navigation projects. ERDC TN-DOER-R23. [accessed 2016 Jun 27]. http://www.dtic.mil/get-tr-doc/pdf?AD=ADA621155.

Eberle MD. 1994. The effect of abiotic factors on the position of loggerhead turtles (*Caretta caretta*) in the water column at Cape Canaveral, Florida. [PhD dissertation]. Buffalo (NY): State University of New York College at Buffalo.

Finkl CW, Andrews JL. 2007. Investigation of sand resources on the continental shelf off the central Florida Atlantic coast: Interpretation, exploration and significance to beach renourishment. Boca Raton (FL) and Tallahassee (FL): Coastal Planning and Engineering, Inc. and URS Southern.

Finkl CW, Hobbs CH, III. 2009. Mining sand on the continental shelf of the Atlantic and Gulf coasts of the US. Mar Georesour Geotec. 27(3):230-253.

Finkl CW, Makowski C. 2010. Increasing sustainability of coastal management by merging monitored marine environments with inventoried shelf resources. Int J Environ Stud. 67(6):861-870.

Fitzpatrick TG, Glass JD, Bargo TD, Parks W. 2006. The effects of sea turtle relocation trawling during selected coastal dredging projects. In: Pilcher NJ, editor. Proceedings of the twenty-third annual symposium on sea turtle biology and conservation, 17 to 21 March 2003, Kuala Lumpur, Malaysia NOAA Technical Memorandum NMFS-SEFSC 536. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service. p. 46-50.

Knight AT, Driver A, Cowling RM, Maze K, Desmet PG, Lombard AT, Rouget M, Botha MA, Boshoff AF, Castley JG et al. 2006. Designing systematic conservation assessments that promote effective implementation: Best practice from South Africa. Conserv Biol. 20(3):739-750.

Fredette TJ, French GT. 2004. Understanding the physical and environmental consequences of dredged material disposal: History in New England and current perspectives. Mar Pollut Bull. 49(1):93-102.

Fredette TJ, Suedel BC, Davis AV, Banks CJ. 2015. Engineering with nature geographic project mapping tool (EWN ProMap). ERDC TN-EWN-15-1. Vicksburg (MS): US Army Corps of Engineers, Engineer Research and Development Center.

FWS. 2015. Statewide Programmatic Biological Opinion (revised), February 27, 2015. Service log number: 41910-201 1-F-0170. Vero Beach (FL): US Fish and Wildlife Service, South Florida Ecological Services Office.

FWS, NMFS. 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife.

GEC, Inc. 2012. Final environmental assessment for issuance of a non-competitive negotiated agreement for the use of outer continental shelf sands for Caminada Headland beach and dune restoration (BA-45), Lafourche Parish, Lousiana. Baton Rouge (LA): Coastal Protection and Restorationa Authority of Louisiana.

Goldberg DW, de Almeida DT, Tognin F, Lopez GG, Pizetta GT, Leite NO, Jr., Sforza R. 2015. Hopper dredging impacts on sea turtles on the northern coast of Rio de Janeiro State, Brazil. Mar Turtle Newsl. 147:16-20.

Goldberg WM. 1988. Biological effects of beach restoration in south Florida: The good, the bad, and the ugly. In: Tait LS, editor. Proceedings of the 1988 Florida Shore and Beach Preservation Association, Gainesville, Florida. Tallahassee (FL): Florida Shore and Beach Preservation Association. p. 9.

Gwin V. 2016. National Dredging Quality Management (DQM) Program. Paper presented at the Gulf WEDA Chapter Meeting, November 16, 2016, Galveston, TX. Bonsall (CA): Western Dredging Association; [accessed 2017 Oct 24]. https://www.westerndredging.org/phocadownload/GulfCoast/2016Meeting/027_Gwin-Vern_National_Dredging_Quality_Management_Program.pdf.

Hales LZ. 2003. Bed-leveling following dredging operations. Report submitted to Dredging Operations Technical Support (DOTS) Program. Vicksburg (MS): US Army Corps of Engineers, South Atlantic Division.

Hammer RM, Byrnes MR, Snyder DB, Thibaut TD, Baker JL, Kelley SW, Côté JM, Lagera LM, Jr., Viada ST, Vittor BA et al. 2005. Environmental surveys of potential borrow areas on the central east Florida shelf and the environmental implications of sand removal for coastal and beach restoration. MMS Study 2004-037. Herndon (VA): Minerals Management Service, Leasing Division, Marine Minerals Branch.

Hawk E. 2001. Hopper dredging in the National Marine Fisheries Service Southeast Region. In: Rice T, Bohn C, editors. Proceedings of the coastal ecosystems and federal activities technical training symposium, August 20 - 22, 2001, Gulf Shores, Alabama. Atlanta (GA): US Fish and Wildlife Service.

Hazekamp N, ten Kate G, Wiertsema W, Wilde-Famsing J. 2016. Dredging in the dark. Amsterdam, Netherlands: Both ENDS and Stichting Onderzoek Multinationale Ondernemingen.

HDR Engineering, Inc. 2010. Project manual for beach dune system restoration at West Galveston Island. Project Number CEPRA 1391. RFP Number 01657-HR. Corpus Christi (TX): HDR Engineering, Inc.

Herbich JB. 1992. Handbook of dredging engineering. London, United Kingdom: McGraw-Hill Companies.

Hernandez K. 2014. Protecting beaches and sea turtles: An analysis of beach nourishment in North Carolina, the impacts on nesting loggerhead sea turtles, and how sea level rise will transform the status quo. [Master's Project]. Durham (NC): Duke University.

Holland DS, Sanchirico JN, Johnsont RJ, Joglekar D. 2010. Economic analysis for ecosystem-based management: Applications to marine and coastal environments. Washington (DC): Resources for the Future Press.

Holloway-Adkins K, Provancha J. 2005. Final report: Abundance and foraging activity of marine turtles using nearshore rock resources along the mid reach of Brevard County, Florida. Cape Canaveral (FL): Dynamac Corporation.

Hopkins S, Richardson J. 1984. A recovery plan for marine turtles. Washington (DC): US Government Printing Office.

Hopkins-Murphy SR, Murphy TM, Hope CP, Coker JW, Griffin DB. 2008. Sea turtle conservation in South Carolina: Three decades. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 126.

Houston JR. 1993. The "greening" of coastal engineering research in the United States. Australian Conference on Coastal Engineering: A Partnership With Nature; Preprints of Papers 11th Australasian Conference on Coastal and Ocean Engineering, Townsville Queensland, Australia. Barton, Australian Capital Territory, Australia: Institution of Engineers, Australia. p. 13-18.

Jordan-Sellers T. 2011. Environmental considerations for the future of dredging. Proceedings of the Western Dredging Association (WEDA XXX) Technical Conference and Texas A&M University (TAMU 41) Dredging Seminar, June 5 - 8, 2011, Nashville, Tennessee.

Joyce JC. 1982. Protecting sea turtles while dredging. Military Engineer. 74(481):283-285.

Jutte PC, Van Dolah RF, Gayes PT. 2002. Recovery of benthic communities following offshore dredging, Myrtle Beach, South Carolina. Shore Beach. 70(3):25-30.

Kaplan B. 2011. Literature synthesis for north and central Atlantic Ocean. OCS Study BOEMRE 2011-012. Herndon (VA): Bureau of Ocean Energy Management, Regulation and Enforcement, Alternative Energy Program.

Kunneke JT. 1983. Southwestern Florida ecological characterization: An ecological atlas. A series of maps by the US Fish and Wildlife Service for the US Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. FWS/OBS-82/47. Washington (DC): US Fish and Wildlife Service, Division of Biological Services.

Larson KW. 1988. Entrainment of estuary organisms by hopper dredging. J Shellfish Res. 7(1):194-195.

Larson KW, Patterson K. 1989. Entrainment of dungeness crab by hopper dredge at the mouth of the Columbia River Oregon, and Washington, USA. In: Wilson JR, van Dam VL, editors. Proceedings of the twelfth world dredging congress, May 2 - 5, 1989, Orlando, Florida. Fairfax (VA): Western Dredging Association. p. 267-286.

LaSalle MW, Clarke DG, Homziak J, Lunz JD, Fredette TJ. 1991. A framework for assessing the need for seasonal restrictions on dredging and disposal operations. Technical Report D-91-1. Vicksburg (MS): US Waterways Experiment Station.

Magnuson JJ, Bjorndal KA, DuPaul WD, Graham GL, Owens DW, Peterson CH, Pritchard PCH, Richardson JI, Saul GE, West CW. 1990. Decline of the sea turtles: Causes and prevention. Washington (DC): National Academies Press.

Makowski C, Fisher L. 2008. The effect of beach nourishment on juvenile green turtle distribution along the nearshore of Broward County, Florida. Open Mar Biol J. 2(1):21-28.

Makowski C, Fisher L, Kruempel CJ. 2008. Does beach nourishment affect the distribution of sea turtles: The second post-construction assessment of juvenile green turtles (*Chelonia mydas*) on the nearshore reefs of Broward County, Florida. National Conference on Beach Preservation Technology. Sarasota (FL): Florida Shore and Beach Preservation Association.

Makowski C, Kruempel CJ. 2007. 2007 survey of juvenile green turtles (*Chelonia mydas*) on the nearshore reefs of Broward County: The second post-construction assessment of the Broward County shore protection project. Boca Raton (FL): Prepared for Broward County Environmental Protection Department.

Maley CG. 1995. Sea turtle strandings in Georgia in the TED era: A matter of timing. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 77-80.

Michel J. 2004. Regional management strategies for federal offshore borrow areas, US east and Gulf of Mexico coasts. J Coast Res. 20:149-154.

Michel J. 2013. South Atlantic information resources: Data search and literature synthesis. OCS Study BOEM 2013-01157. In: Michel J, editor. New Orleans (LA): Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Michel J, Bejarano AC, Peterson CH, Voss C. 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. OCS Study BOEM 2013-0119. Herndon (VA): Bureau of Ocean Energy Management.

Michel J, Dunagan H, Boring C, Healy E, Evans W, Dean JM, McGillis A, Hain J. 2007. Worldwide synthesis and analysis of existing information regarding environmental effects of alternative energy uses on the outer continental shelf. MMS OCS Report 2007-038. Herndon (VA): Minerals Management Service.

Michel JM, Nairn RB. 2001. Development and design of biological and physical monitoring protocols to evaluate the long-term impacts of offshore dredging operations on the marine environment. OCS Report MMS 2001-089. Herndon (VA): Minerals Management Service, International Activities and Marine Minerals Division.

[MMS] Minerals Management Service. 2003. Environmental assessment; proposed OCS lease sale 190, central Gulf of Mexico. OCS EIS/EA MMS 2003-066. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Moein SE, Musick JA, Keinath JA, Barnard DE, Lenhardt M, George R. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final report submitted to the US Army Corps of Engineers Waterways Experiment Station. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Moffatt and Nichol Engineers. 2009. Charleston offshore dredged material disposal site sand borrow project. Final environmental assessment for Minerals Management Service. Minerals Management Service, Environmental Division.

Montague CL. 2006. Analysis of beach nourishment data for Florida's Atlantic coast during the last century, with reference to ecological engineering of sea turtle nesting habitat. 19th annual national conference on beach preservation technology, February 1 - 3, 2006, Sarasota, Florida. Tallahassee (FL): Florida Shore and Beach Preservation Association.

Montague CL. 2008. Recovering the sand deficit from a century of dredging and jetties along Florida's Atlantic coast: A reevaluation of beach nourishment as an essential tool for ecological conservation. J Coast Res. 24(4):899-916.

Montante V. 1990. Opening remarks: Workshop introduction. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, FL Miscellaneous Paper EL-90-5. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory. p. 14-16.

Moulding JD. 1981. Sea turtles vs. dredging: A conflict with the Endangered Species Act. Fla Sci. 44(1):35.

Nairn R, Johnson JA, Hardin D, Michel J. 2004. A biological and physical monitoring program to evaluate long-term impacts from sand dredging operations in the United States outer continental shelf. J Coast Res. 20(1):126-137.

Nairn RB, Lu Q, Langendyk SK, Hayes MO, Montagna PA, Palmer TA, Powers SP. 2007. Examination of the physical and biological implications of using buried channel deposits and other non-topographic offshore features as beach nourishment material. OCS Study MMS 2007-048. Madison (WI): Minerals Management Service.

National Research Council. 2001. A process for setting, managing, and monitoring environmental windows for dredging projects. Marine Board, Transportation Research Board, Special Report 262. Washington (DC): National Academies Press.

Nelson D, Dickerson D, Berry S, Moulding J. 1989. Methods to minimize dredging impacts on sea turtles. In: Wilson JR, van Dam VL, editors. Proceedings of the twelfth world dredging congress, May 2 - 5, 1989, Orlando, Florida. Fairfax (VA): Western Dredging Association. p. 973-982.

Nelson DA. 1988. Life history and environmental requirements of loggerhead turtles. US Fish and Wildlife Service Biological Report 88(23). US Army Corps of Engineers Technical Report EL-86-2(Rev.). Washington (DC): US Fish and Wildlife Service.

Nelson DA, Dickerson DD. 1989. Effects of beach nourishment on sea turtles. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 125-127.

Nelson DA, Dickerson DD, Richardson J, Reine K. 1991. Sea turtle trawling survey associated with hopper dredging at Brunswick, GA. Unpublished report. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

Nelson DA, Dickerson DD, Teine KJ, Dickerson CE, Jr. 1994. Sea turtles and dredging: Potential solutions. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 267.

Nelson DA, Shafer DJ. 1996. Effectiveness of a sea turtle-deflecting hopper dredge draghead in Port Canaveral Entrance Channel, Florida. Miscellaneous Paper D-96-3. Vicksburg (MS): US Army Corps of Engineers, Waterways Experiment Station.

Newell RC, Seiderer LJ, Hitchcock DR. 1998. The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanogr Mar Biol Annu Rev. 36:127-178.

Nightingale B, Simenstad CA. 2001. Dredging activities: Marine issues. White paper submitted to Washington Department of Fish and Wildlife Washington Department of Ecology Washington Department of Transportation. Seattle (WA): University of Washington.

NMFS. 1991. Endangered Species Act Section 7 consultation on US Army Corps of Engineers: Dredging of channels in the southeastern United States from North Carolina through Cape Canaveral, Florida. Biological Opinion, November 25, 1991. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1995. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE), Galveston District and New Orleans District: Channel maintenance dredging using a hopper dredge. Biological Opinion, September 22, 1995. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1995. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, South Atlantic Division: Hopper dredging of channels and beach nourishment activities in the southeastern United States from North Carolina through Florida east coast. Biological Opinion, August 25, 1995. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 1997. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, South Atlantic Division: The continued hopper dredging of channels and borrow areas in the southeastern United States. Biological Opinion, September 25, 1997. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2003. Endangered Species Act Section 7 consultation on the US Army Corps of Engineers (COE) on the use of bed-leveling equipment during Brunswick Harbor Deepening Project. Biological Opinion, September 11, 2003. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2003. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE): Dredging of Gulf of Mexico navigation channels and sand mining ("borrow") areas using hopper dredges by COE Galveston, New Orleans, Mobile, and Jacksonville Districts (Consultation Number F/SER/2000/0 1 2 87). Biological Opinion, November 19, 2003. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2005. Endangered Species Act Section 7 consultation on Minerals Management Service: Hopper and hydraulic cutterhead dredging associated with sand mining for coastal restoration projects along the coast of Louisiana using sand from Ship Shoal in the Gulf of Mexico Central Planning Area, South Pelto Blocks 12, 13, and 19, and Ship Shoal Block 88. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division, St. Petersburg, FL.

NMFS. 2005. Revision No. 1 to November 19, 2003, Gulf of Mexico Regional Biological Opinion (GOM RBO) on hopper dredging of navigation channels and borrow Areas in the US Gulf of Mexico to the US Army Corps of Engineers (COE). June 24, 2005. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2006. Endangered Species Act Section 7 consultation on the US Army Corps of Engineers, Baltimore District: Dredging of four borrow areas in the Atlantic Ocean for the Atlantic Coast of Maryland Shoreline Protection Project. F/NER/2006/03915. Biological Opinion, November 30, 2006. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2006. Sea turtle and smalltooth sawfish construction conditions. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2007. Endangered Species Act Section 7 consultation on the US Army Corps of Engineers, New England District: Dredging of sand and gravel from NOMES I borrow area for nourishment of Winthrop Beach, Massachusetts. F/NER/2007/00740. Biological Opinion, July 20, 2007. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2007. Revision 2 to the National Marine Fisheries Service November 19, 2003, Gulf of Mexico Regional Biological Opinion (GRBO) to the US Army Corps of Engineers (COE) on hopper dredging of navigation channels and borrow Areas in the US Gulf of Mexico. January 9, 2007. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2011. Endangered Species Act Section 7 consultation on US Army Corps of Engineers (COE), Savannah District: Deepening of the Savannah Harbor federal navigational channel in association with the Savannah Harbor Expansion Project (NMFS Consultation Number F/SERJ2010105579). Biological Opinion, November 4, 2011. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation Biological Opinion on US Department of the Navy for shoreline protection system repairs, Naval Air Station Oceana, Dam Neck Annex, Virginia Beach, Virginia. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of outer continental shelf (OCS) sand resources on Sabine Bank to Louisiana's Office of Coastal Protection and Restoration (OCPR) for the Cameron Parish Shoreline Restoration Project (Consultation Number F/SERJ2011!06202). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2012. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Post-Hurricane Irene Beach Renourishment Project in Carteret County, North Carolina (Consultation Number F/SER/2012/01 054). Biological Opinion, October 3, 2012. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Louisiana Coastal Area (LCA) projects in the Gulf of Mexico (Gulf) off Louisiana: Barataria Basin Barrier Shoreline Restoration; Terrebonne Basin Barrier Shoreline Restoration; Point Au Fer Island Restoration; and Caillou Lake Land Bridge Restoration. F/SER31:RGH. Biological Assessment, March 22, 2012. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Norfolk District (lead) and Bureau of Ocean Energy Management: Use of Sandbridge Shoals Borrow Area for Sandbridge Shoals Hurricane Protection Project, 2012-2013, F/NER/2012t01586. Biological Opinion, September 7, 2012. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Norfolk District (lead), USACE, Baltimore District, Bureau of Ocean Energy Management, US Environmental Protection Agency, and US Navy: Maintenance of Chesapeake Bay entrance channels and use of sand borrow areas for beach nourishment. F/NERl2012/01586. Biological Opinion, October 16, 2012. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2012. Endangered Species Act Section 7 consultation on US Army Corps of Engineers: Evaluation of bed levelers and closed-net trawling associated with maintenance dredging of Brunswick and Savannah Harbors, Georgia (Consultation Number F/SER/2012/03110). Biological Opinion, December 4, 2012. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2013. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of Borrow Area T1 to the Collier County Parks and Recreation Department for the Collier County Beach Renourishment Project (Consultation Number SER-2012 -9274). Biological Opinion, August 13, 2013. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2013. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement: Programmatic geological and geophysical activities in the Mid- and South Atlantic Planning Areas from 2013 to 2020. Biological Opinion, July 19, 2013. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources.

NMFS. 2013. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Philadelphia District: Maintenance of the 40-foot Delaware River Federal Navigation Channel. NER-2013-9804. Biological Opinion, August 1, 2013. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2014. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, New York District: Beach nourishment projects utilizing the Sea Bright Offshore Borrow Area: Union Beach, Port Monmouth, and Elberon to Loch Arbour, New Jersey. NER-2014-1 0606. Biological Opinion, March 7, 2014. Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office.

NMFS. 2014. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Philadelphia District (lead) and Bureau of Ocean Energy Management: Use of sand borrow areas for beach nourishment and hurricane protection, offshore Delaware and New Jersey. NER-2014-10904. Biological Opinion, June 26, 2014 Gloucester (MA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Greater Atlantic Regional Fisheries Office.

NMFS. 2015. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Lease of Canaveral Shoals Sand Borrow Area II to the BCBOCC for the Mid Reach Beach Restoration Project. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2015. Endangered Species Act Section 7 consultation on US Army Corps of Engineers, Mobile District, as the lead agency, in cooperation with the Bureau of Ocean Energy Management, and National Park Service (NPS): Mississippi Coastal Improvements Program (MsCIP) Barrier Island Restoration, Mississippi Sound-Hancock, Harrison, and Jackson Counties, Mississippi, and Mobile County, Alabama. NMFS Consultation Number SER-2012-09304. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office, Protected Resources Division.

NMFS. 2015. Endangered Species Act Section 7 consultation on US Army Corps of Engineers: Charleston Harbor Post 45 Project SER-2014-15433. Biological Opinion, April 22, 2015. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2016. Endangered Species Act Section 7 consultation on Bureau of Ocean Energy Management: Dredging within the Charleston ocean dredged material disposal site. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office.

NMFS. 2016. Endangered Species Act Section 7 consultation on US Army Corps of Engineers: Five Hawaii commercial harbors maintenance dredging, Hawaii. NMFS File Number PIR-2014-9570, Reference Number I-PI-15-1218-AG. March 3, 2016. Honolulu (HI): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Regional Office, Protected Resources Division.

NMFS, FWS. 1991. Recovery plan for US population of Atlantic green turtle (*Chelonia mydas*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1991. Recovery plan for US populations of loggerhead turtle (*Caretta caretta*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1992. Recovery plan for leatherback turtles *Dermochelys coriacea* in the US Caribbean, Atlantic and Gulf of Mexico. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1993. Recovery plan for hawksbill turtles in the US Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS, SEMARNAT. 2011. Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, US Fish and Wildlife Service, and the Secretary of Environment and Natural Resources, Mexico.

[NTDLP] Northern Territory Department of Lands and Planning. 2011. East Arm Wharf expansion project: Draft environmental impact statement. Prepared for Northern Territory Department of Lands and Planning. Darwin, Northern Territory, Australia: Northern Territory Department of Lands and Planning.

Palermo MR. 1990. Introduction to alternative dredging methods. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory.

Palik TF, Lewis RR, III. 1983. Southwest Florida ecological characterization: An ecological atlas. Map narratives. A series of maps by the US Fish and Wildlife Service for the US Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. FWS/OBS-82/47. Metairie (LA): Minerals Management Service, Gulf of Mexico OCS Office.

Palmer TA, Montagna PA, Nairn RB. 2008. The effects of a dredge excavation pit on benthic macrofauna in offshore Louisiana. Environ Manage. 41(4):573-583.

Paul EU. 2010. Laboratory experiments and hydrodynamic modeling of a bed leveler used to level the bottom of ship channels after dredging. [Master's thesis]. College Station (TX): Texas A&M University.

PBS&J. 2008. Best management practices (BMPs) for construction, dredge and fill and other activities adjacent to coral reefs. Report completed in fulfillment of contract RM6011 for the Southeast Florida Coral Reef Initiative (SEFCRI), Maritime Industry and Coastal Construction Impacts (MICCI) Focus Team Local Action Strategy Project #6, and Florida Department of Environmental Protection (FDEP) Coral Reef Conservation Program (CRCP). Miami (FL): PBS&J.

Peterson CH, Bishop MJ. 2005. Assessing the environmental impacts of beach nourishment. Bioscience. 55(10):887-896.

Piatkowski D, Culbertson J. 2016. An update on the Bureau of Ocean Energy Management, Marine Minerals Program Studies. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Pilcher NJ. 2008. The MTSG and its involvement in the Dhamra Port, Orissa, India. Mar Turtle Newsl. 121:24-25.

Pilkey OH, Jr., Cooper JAG. 2014. The last beach. Durham (NC): Duke University Press.

Prekel S, Hannes A, Barrett C, Ward G, Floyd L, Santos R, Reger C. 2008. 18-month post-construction nearshore environmental monitoring summary report. Prepared for Broward County. Boca Raton (FL): Coastal Planning & Engineering, Inc.

[PSDS] Program for the Study of Developed Shorelines. 2016. Beach nourishment database. Cullowhee (NC): Western Carolina University, Program for the Study of Developed Shorelines; [accessed 2016 May 2]. http://beachnourishment.wcu.edu.

Pullen EJ, Naqvi SM. 1983. Biological impacts on beach replenishment and borrowing. Shore Beach. 51(2):27-31.

Randall RE. 2006. Dredging in the United States. In: Eisma D, editor. Dredging in coastal waters. New York (NY): Taylor and Francis Group. p. 139-166.

Reidenauer J, Turner L. 2016. Federal sand resources. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Reine K, Clarke D. 1998. Entrainment by hydraulic dredges - A review of potential impacts. Technical Note DOER-E1. Vicksburg (MS): US Army Engineer Research and Development Center.

Reine KJ, Clarke D, Dickerson CE, Wikel G. 2014. Characterization of underwater sounds produced by trailing suction hopper dredges during sand mining and pump-out operations. ERDC/EL TR 14-3, BOEM 2014-055. Herndon (VA): Bureau of Ocean Energy Management and US Army Corps of Engineers.

Reine KJ, Dickerson DD. 1994. Protective relocation and assessment of sea turtle abundance during hopper dredging activities in Delaware Bay entrance channel. Vicksburg (MS): Environmental Laboratory, Department of the Army Waterways Experiment Station, Corps of Engineers.

Reine KJ, Dickerson DD, Clarke DG. 1998. Environmental windows associated with dredging operations. Defense Technical Information Center Document; [accessed 2015 Nov 30]. http://www.dtic.mil/dtic/tr/fulltext/u2/a361195.pdf.

Richardson JI. 1990. The sea turtles of the King's Bay area and the endangered species observer program associated with construction dredging of the St. Marys entrance ship channel. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, FL Miscellaneous Paper EL-90-5. Jacksonville (FL): US Army Corps of Engineers, Environmental Laboratory.

Rudloe J. 1981. From the jaws of death. Sports Illustrated. 54(13):60-70.

Rumbold DG, Davis PW, Perretta C. 2001. Estimating the effect of beach nourishment on *Caretta caretta* (loggerhead sea turtle) nesting. Restor Ecol. 9(3):304-310.

Savioli JC, Magalhaes M, Pedersen C, Rijmenant JV, Oliver MA, Fen CJ, Rocha C. 2013. Dredging - How can we manage it to minimize impacts. In: Suriamihardja DA, Harianto T, Abdurrahman MA, Rachman T, editors. Proceedings of the 7th International Conference on Asian and Pacific Coasts (APAC 2013) Bali, Indonesia, September 24 - 26, 2013. Tamalanrea, Makassar, Indonesia: Hasanuddin University Press. p. 387-393.

Shellito BA, Lockwood KB. 2006. GIS and 3D analysis applied to sea turtle mortalities and navigation channel dredging. Va J Sci. 57(4):167-183.

Slay C, Richardson JJ. 1988. King's Bay, Georgia: Dredging and turtles. In: Schroeder BA, editor. Proceedings of the eighth annual workshop on sea turtle conservation and biology NOAA Technical Memorandum NMFS-SEFSC-214. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 109-113.

Slay CK. 1991. Endangered species observer program, Brunswick Ship Channel, April 1 - June 19, 1991. Savannah (GA): US Army Corps of Engineers, Planning Division, Environmental, Savannah District.

Slay CK. 1995. Sea turtle mortality related to dredging activities in the southeastern US: 1991. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 132-133.

Standora E, Ryder M, Edbauer J, Williams K, Morreale S, Bolten A. 1994. Homing behavior of loggerhead turtles relocated from dredging areas in Cape Canaveral Channel, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 141-142.

Steinitz MJ, Salmon M, Wyneken J. 1998. Beach renourishment and loggerhead turtle reproduction: A seven year study at Jupiter Island, Florida. J Coast Res.1000-1013.

Studt JF. 1987. Amelioration of maintenance dredging impacts on sea turtles, Canaveral Harbor, Florida. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida, Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 55-58.

Suedel BC, Kim J, Clarke DG, Linkov I. 2008. A risk-informed decision framework for setting environmental windows for dredging projects. Sci Total Environ. 403(1):1-11.

Sundin GW. 2007. Reducing impacts of hopper dredging on marine turtles in the northwestern Gulf of Mexico. [Master's thesis]. Athens (GA): University of Georgia.

Sundin GW, Schweitzer SH, Dickerson DD, Theriot CT, Wolters MS, Peterson JT, Dickerson V. 2006. Spatial and temporal analysis of incidental sea turtle takes by dredges in the western Gulf of Mexico, USA. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 163.

Sutton G, Boyd S. 2009. Effects of extraction of marine sediments on the marine environment 1998-2004. Copenhagen, Denmark: International Council for the Exploration of the Sea.

Tanski JJ, Bokuniewicz HJ, Schlenk C. 2014. Dredging windows workshop summary. NYSGI-W-11-001. New York (NY): New York Sea Grant.

Tavolaro JF, Wilson JR, Welp TL, Clausner JE, Premo AY. 2007. Overdepth dredging and characterization depth recommendations. ERDC/TN EEDP-04-37. Vicksburg (MS): US Army Corps of Engineers, Engineer Research and Development Center.

Taylor AS. 1990. The hopper dredge. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, Florida. Vicksburg (MS): US Army Corps of Engineers, Environmental Laboratory. p. 59-63.

Tillin HM, Houghton AJ, Saunders JE, Drabble R, Hull SC. 2011. Direct and indirect impacts of aggregate dredging. In: Newell RC, Measures J, editors. Marine Aggregate Levy Sustainability Fund Science Monograph Series Number 1 MEPF 10/P144. Lowestoft, United Kingdom: Marine Aggregate Levy Sustainability Fund. p. 1-46.

Todd VLG, Todd IB, Gardiner JC, Morrin ECN, MacPherson NA, DiMarzio NA, Thomsen F. 2015. A review of impacts of marine dredging activities on marine mammals. ICES J Mar Sci. 72(2):328-340.

Tomlinson BN, Petterson JS, Glazier EW, Lewis J, Selby I, Nairn R, Kenny T, Godde P, Espinasse CJ, Stanley L et al. 2007. Investigation of dredging impacts on commercial and recreational fisheries and analysis of available mitigation measures to protect and preserve resources. OCS Report MMS 2006-0065. Herndon (VA): Minerals Management Service, Leasing Division, Marine Minerals Branch.

Trapani CM, Boyd DD, Bargo PD. 2008. Sea turtle/dredge interactions in Virginia, USA: A diagnostic view of observed takes vs. strandings. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 131.

Tucker and Associates, Inc. 1990. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1-3, 1989. OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Tucker T, Welsh R, Mazzarella K, Beggs J, Clark P. 2009. Sea turtle monitoring, nest evaluation, and protection measures for Longboat Key 2008. Report submitted to: Town of Longboat Key Public Works Department. Mote Marine Laboratory Technical Report No. 1310. Sarasota (FL): Mote Marine Laboratory.

US Congress Office of Technology Assessment. 1987. Marine minerals: Exploring our new ocean frontier. OTA-O-342 Washington (DC): US Government Printing Office.

USACE. 1995. Annual sea turtle monitoring report: Galveston District, fiscal year 1995. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy95.pdf.

USACE. 1996. Annual sea turtle monitoring report: Galveston District, fiscal year 1996. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy96.pdf.

USACE. 1997. Annual sea turtle monitoring report: Galveston District, fiscal year 1997. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy97.pdf.

USACE. 1997. Memorandum on National Marine Fisheries Service, Regional Biological Opinion on hopper dredging along the South Atlantic Coast, October 29, 1997. Hopper dredging protocol for Atlantic Coast FY 98 - FY 03. Atlanta (GA): US Army Corps of Engineers.

USACE. 1998. Annual sea turtle monitoring report: Galveston District, fiscal year 1998. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy98.pdf.

USACE. 1998. Biological assessment: Use of the sidecast dredges Fry, Merritt, and Schweizer, and the split-hull hopper dredge Currituck in coastal United States waters. Wilmington (NC): US Army Corps of Engineers, Wilmington District.

USACE. 1999. Annual sea turtle monitoring report: Galveston District, fiscal year 1999. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy99.pdf.

USACE. 1999. Annual sea turtle monitoring report: Houston-Galveston navigation channels, new-work dredging, fiscal year 1999. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy99-hgnc.pdf.

USACE. 2000. Annual sea turtle monitoring report: Houston-Galveston navigation channels, new-work dredging, fiscal year 2000. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy00-hgnc.pdf.

USACE. 2000. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2000. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy00.pdf.

USACE. 2001. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2001. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy01.pdf.

USACE. 2002. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2002. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy02.pdf.

USACE. 2003. Annual sea turtle monitoring report: Houston-Galveston navigation channels, new-work dredging, fiscal year 2003. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy99-hgnc.pdf.

USACE. 2003. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2003. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy03.pdf.

USACE. 2004. Annual sea turtle monitoring report: Jacksonville District for Atlantic projects, maintenance dredging - Fiscal year 2004. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajfy04.pdf.

USACE. 2004. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2004. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy04.pdf.

USACE. 2005. Annual sea turtle monitoring report: Jacksonville District for Atlantic projects, maintenance dredging - Fiscal year 2005. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajfy05.pdf.

USACE. 2005. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2005. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy05.pdf.

USACE. 2005. Annual sea turtle monitoring report: Maintenance dredging, Gulf coast - Under GRBO, Jacksonville District, fiscal year 2005. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajgrbofy05.pdf.

USACE. 2005. Annual sea turtle report: Fiscal year 2005, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY05.pdf.

USACE. 2006. Annual sea turtle monitoring report, Wilmington District: Hopper dredging - fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SAWfy06-hopper.pdf.

USACE. 2006. Annual sea turtle monitoring report: Maintenance dredging Atlantic coast - under SA RBO Charleston District, fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SACfy06.pdf.

USACE. 2006. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy06.pdf.

USACE. 2006. Annual sea turtle monitoring report: Maintenance dredging, Gulf coast - Under GRBO, Jacksonville District, fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajgrbofy06.pdf.

USACE. 2006. Annual sea turtle monitoring report: Maintenance dredging/beach nourishment Atlantic coast - Under SA RBO, Jacksonville District, fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajfy06.pdf.

USACE. 2006. Annual sea turtle monitoring report: Mobile District for Gulf of Mexico projects, maintenance dredging and beach nourishment - Fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY06.pdf.

USACE. 2006. Annual sea turtle monitoring report: Savannah District, maintenance dredging - Fiscal year 2006. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SASfy06-hopper.pdf.

USACE. 2006. Annual sea turtle report: Fiscal year 2006, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY06.pdf.

USACE. 2006. Management protocol for effective implementation of the National Marine Fisheries Regional Biological Opinion for hopper dredging Gulf of Mexico. Jacksonville (FL): US Army Corps of Engineers.

USACE. 2007. Annual sea turtle monitoring report: Jacksonville District for Atlantic projects, maintenance dredging and beach nourishment - fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajfy07.pdf.

USACE. 2007. Annual sea turtle monitoring report: Jacksonville District for Gulf of Mexico projects, maintenance dredging, fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/sajgrbofy07.pdf.

USACE. 2007. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy07.pdf.

USACE. 2007. Annual sea turtle monitoring report: Maintenance dredging/beach nourishment, Gulf of Mexico coast, Mobile District - Fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY07.pdf.

USACE. 2007. Annual sea turtle monitoring report: Savannah District, maintenance dredging - Fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SASfy07-hopper.pdf.

USACE. 2007. Annual sea turtle monitoring report: Wilmington District, hopper dredging - Fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SAWfy07-hopper.pdf.

USACE. 2007. Annual sea turtle report: Fiscal year 2007, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY07.pdf.

USACE. 2007. Endangered species monitoring report: Maintenance dredging and beach nourishment conducted under South Atlantic Regional Biological Opinion, Charleston District, fiscal year 2007. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SACfy07.pdf.

USACE. 2008. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2008. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy08.pdf.

USACE. 2008. Annual sea turtle monitoring report: Maintenance dredging/beach nourishment, Gulf of Mexico coast, Mobile District - Fiscal year 2008. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY08.pdf.

USACE. 2008. Annual sea turtle monitoring report: Savannah District, maintenance dredging - Fiscal year 2008. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SASfy08-hopper.pdf.

USACE. 2008. Annual sea turtle report: Fiscal year 2008, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY08.pdf.

USACE. 2008. Press release: Corps of Engineers public interest review results in permit denial for Winthrop Beach. Brooklyn (NY): US Army Corps of Engineers, North Atlantic Division.

USACE. 2009. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2009. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy09.pdf.

USACE. 2009. Annual sea turtle monitoring report: Maintenance dredging/beach nourishment, Gulf of Mexico coast, Mobile District - Fiscal year 2009. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY09.pdf.

USACE. 2009. Annual sea turtle report: Fiscal year 2009, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY09.pdf.

USACE. 2010. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2010. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy10.pdf.

USACE. 2010. Annual sea turtle monitoring report: Maintenance dredging, Gulf of Mexico coast, Mobile District - Fiscal year 2010. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY10.pdf.

USACE. 2010. Annual sea turtle report: Fiscal year 2010, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY10.pdf.

USACE. 2011. Annual sea turtle monitoring report: Maintenance dredging, Galveston District, fiscal year 2011. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/swgfy11.pdf.

USACE. 2011. Annual sea turtle monitoring report: New work and maintenance dredging, Gulf of Mexico coast, Mobile District - Fiscal year 2011. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY11.pdf.

USACE. 2011. Annual sea turtle monitoring report: Savannah District, maintenance dredging - Fiscal year 2011. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SASfy11-hopper.pdf.

USACE. 2011. Annual sea turtle report: Fiscal year 2011, New Orleans District. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/mvnFY11.pdf.

USACE. 2012. Annual sea turtle monitoring report: New work and maintenance dredging, Gulf of Mexico coast, Mobile District - Fiscal year 2012. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/samRBOFY12.pdf.

USACE. 2012. Annual sea turtle monitoring report: Savannah District, maintenance dredging - Fiscal year 2012. US Army Corps of Engineers; [accessed 2016 Feb 15]. http://dqm.usace.army.mil/odess/documents/reports/SASfy12-hopper.pdf.

USACE. 2013. USACE sea turtle data warehouse. US Army Corps of Engineers; [accessed 2016 Feb 9]. http://el.erdc.usace.army.mil/seaturtles.

USACE. 2016. About dredging. US Army Corps of Engineers; [accessed 2016 Apr 18]. http://dqm.usace.army.mil/Education/Index.aspx.

USACE. 2016. Operation and dredging endangered species system (ODESS). Mobile (AL): US Army Corps of Engineers; [accessed 2016 Mar 2]. http://dqm.usace.army.mil/odess.

[USACE WES] US Army Corps of Engineers Waterways Experiment Station. 1997. Sea turtle research program summary report. Prepared for the US Army Engineer Division, South Atlantic and US Naval Submarine Base, Kings Bay. Technical report CHL-97-31. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

van Raalte GH. 2006. Dredging techniques; Adaptations to reduce environmental impact. In: Eisma D, editor. Dredging in coastal waters. New York (NY): Taylor and Francis Group. p. 1-40.

W. F. Baird and Associates, Ltd. 2004. Development of the MMS dredge plume model. Prepared for: Minerals Management Service, Leasing Division Sand and Gravel Unit. Madison (WI): W.F. Baird and Associates, Ltd.

W. F. Baird and Associates, Ltd., Research Planning, Inc. 2004. Review of existing and emerging environmentally friendly offshore dredging technologies. Report prepared for: Minerals Management Service, Leasing Division, Sand and Gravel Unit. OCS Report MMS 2004-076. Madison (WI) and Columbia (SC): W.F. Baird and Associates, Ltd. and Research Planning, Inc.

Weber MJ. 1990. Human activities and sea turtle conservation in the Gulf of Mexico. In: Tucker and Associates, Inc, editor. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1 - 3, 1989 OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region. p. 23-38.

Whittock PA, Pendoley KL, Larsen R, Hamann M. 2017. Effects of a dredging operation on the movement and dive behaviour of marine turtles during breeding. Biol Conserv. 206:190-200.

Woolfenden GE. 1983. Rare, threatened, and endangered vertebrates of southwest Florida and potential OCS activity impacts. A final report by the US Fish and Wildlife Service for the US Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. FWS/OBS-82/03. Washington (DC): US Fish and Wildlife Service, Division of Biological Services.

Zarillo G, Reidenaeuer J. 2008. Final biological characterization/numerical wave model analysis within borrow sites offshore of Florida's northeast coast report - Volumes I and II. MMS Study 2008-060. Washington (DC): Minerals Management Service.

A.3 Environment (100)

Amante C, Eakins BW. 2009. ETOPO1 1 arc-minute global relief model: Procedures, data sources and analysis. NOAA Technical Memorandum NESDIS NGDC-24. Boulder (CO): National Oceanic and Atmospheric Administration, National Geophysical Data Center, Marine Geology and Geophysics Division.

Anderson MG, Prince J, Barnett A, Weaver KJ, Conley M, Goodin KL. 2015. Seafloor habitats. Draft report. Boston (MA): The Nature Conservancy.

Atlas R, Hoffman RN, Ardizzone J, Leidner SM, Jusem JC, Smith DK, Gombos D. 2010. A cross-calibrated, multiplatform ocean surface wind velocity product for meteorological and oceanographic applications. Bull Amer Meteor. 92(2):157-174.

[AVISO] Archiving, Validation, and Interpretation of Satellite Oceanographic Data. 2015. SSALTO/DUACS user handbook: (M)SLA and (M)ADT near-real time and delayed time products. CLS-DOS-NT-06-034. Toulouse, France: Archiving, Validation, and Interpretation of Satellite Oceanographic Data.

Becker E, Forney K, Fiedler P, Barlow J, Chivers S, Edwards C, Moore A, Redfern J. 2016. Moving towards dynamic ocean management: How well do modeled ocean products predict species distributions? Remote Sens. 8(2):149.

Becker JJ, Sandwell DT, Smith WHF, Braud J, Binder B, Depner J, Fabre D, Factor J, Ingalls S, Kim SH. 2009. Global bathymetry and elevation data at 30 arc seconds resolution: SRTM30_PLUS. Mar Geod. 32(4):355-371.

Behrenfeld MJ, Falkowski PG. 1997. Photosynthetic rates derived from satellite-based chlorophyll concentration. Limnol Oceanogr. 42(1):1-20.

Belkin IM, Cornillon PC, Sherman K. 2009. Fronts in large marine ecosystems. Prog Oceanogr. 81(1-4):223-236.

Belkin IM, O'Reilly JE. 2009. An algorithm for oceanic front detection in chlorophyll and SST satellite imagery. J Mar Syst. 78(3):319-326.

Best BD, Halpin PN, Read AJ, Fujioka E, Good CP, LaBrecque EA, Schick RS, Roberts JJ, Hazen LJ, Qian SS. 2012. Online cetacean habitat modeling system for the US east coast and Gulf of Mexico. Endangered Species Res. 18(1):1-15.

Bethoney ND, Schondelmeier BP, Stokesbury KDE, Hoffman WS. 2013. Developing a fine scale system to address river herring (*Alosa pseudoharengus*, *A. aestivalis*) and American shad (*A. sapidissima*) bycatch in the US Northwest Atlantic mid-water trawl fishery. Fish Res. 141:79-87.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 1. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 2. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 3. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 4. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 2 Master Bibliography. Washington (DC): Center for Natural Areas, Bureau of Land Management.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 3, Appendices. Center for Natural Areas, Bureau of Land Management.

Bonjean F, Lagerloef GSE. 2002. Diagnostic model and analysis of the surface currents in the tropical Pacific Ocean. J Phys Oceanogr. 32:2938-2954.

Boyer TP, Levitus S, Garcia HE, Locamini RA, Stephens C, Antonov J. 2005. Objective analyses of annual, seasonal, and monthly temperature and salinity for the World Ocean on a 0.25° grid. Int J Climatol. 25:931-945.

Brasnett B. 2008. The impact of satellite retrievals in a global sea-surface-temperature analysis. Q J R Meteorol Soc. 134(636):1745-1760.

Breece MW, Fox FA, Dunton KJ, Frisk MG, Jordaan A, Oliver MJ. 2016. Dynamic seascapes predict the marine occurrence of an endangered species: Atlantic Sturgeon *Acipenser oxyrinchus oxyrinchus*. Methods Ecol Evol. 7:725-733.

Broderick AC, Coyne MS, Fuller WJ, Glen F, Godley BJ. 2007. Fidelity and over-wintering of sea turtles. Proc R Soc Lond B Biol Sci. 274(1617):1533-1539.

Brooks RA, Purdy CN, Bell SS, Sulak KJ. 2006. The benthic community of the eastern US continental shelf: A literature synopsis of benthic faunal resources. Cont Shelf Res. 26:804-818.

Buczkowski BJ, Reid JA, Jenkins CJ, Reid JM, Williams SJ, Flocks JG. 2006. usSEABED: Gulf of Mexico and Caribbean (Puerto Rico and US Virgin Islands) offshore surficial sediment data release. USGS Data Series 146 (DS-146). Woods Hole (MA): United States Geological Survey Coastal and Marine Geology Program; [accessed 2016 Apr 27]. http://pubs.usgs.gov/ds/2006/146/htmldocs/data_cata.htm.

Canny J. 1986. A computational approach to edge detection. IEEE Transactions on Pattern Analysis and Machine Intelligence. PAMI-8(6):679-698.

Chassignet EP, Hurlburt HE, Smedstad OM, Halliwell GR, Hogan PJ, Wallcraft AJ, Baraille R, Bleck R. 2007. The HYCOM (hybrid coordinate ocean model) data assimilative system. J Mar Syst. 65(1):60-83.

Chelton DB, Schlax MG, Samelson RM. 2011. Global observations of nonlinear mesoscale eddies. Prog Oceanogr. 91(2):167-216.

Cooper KM, Curtis M, Wan Hussin WMR, Barrio Frojan CRS, Defew EC, Nye V, Patterson DM. 2011. Implications of dredging induced changes in sediment particle size composition for the structure and function of marine benthic macrofaunal communities. Mar Pollut Bull. 62(10):2087-2094.

DoN. 2007. Navy OPAREA density estimate (NODE) for the GOMEX OPAREA. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Navy OPAREA density estimate (NODE) for the Northeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Navy OPAREA density estimate (NODE) for the Southeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Donlon C, Robinson I, Casey KS, Vazquez-Cuervo J. 2007. The global ocean data assimilation experiment high-resolution sea surface temperature pilot project. Bull Amer Meteor. 88(8):1197-1213.

Duncan RG. 2012. Development of a species distribution model for the east Pacific green sea turtle using ecological geoprocessing tools. [Master's thesis]. College Station (TX): Texas A&M University.

Eldridge PJ. 1988. The Southeast Area Monitoring and Assessment Program (SEAMAP): A state-federal-university program for collection, management, and dissemination of fishery-independent data and information in the southeastern United States. Mar Fish Rev. 50(2):29-39.

Elith J, Leathwick JR. 2009. Species distribution models: Ecological explanation and prediction across space and time. Annu Rev Ecol Evol Syst. 40(1):677-697.

Enfield DB, Mestas-Nuñez AM, Trimble PJ. 2001. The Atlantic multidecadal oscillation and its relation to rainfall and river flows in the continental US. Geophys Res Lett. 28(10):2077-2080.

ESR. 2009. OSCAR third degree resolution ocean surface currents. Version 1. National Aeronautics and Space Administration Physical Oceanography Distributed Active Archive Center; [accessed 2016 Sep 28]. http://dx.doi.org/10.5067/OSCAR-03D01.

FWS. 2014. Endangered and threatened wildlife and plants; Designation of critical habitat for the Northwest Atlantic Ocean distinct population segment of the loggerhead sea turtle. US Fish and Wildlife Service final rule. Federal Register. 79(132):39756-39854.

FWS. 2016. Critical habitat GIS files. Washington (DC): US Fish and Wildlife Service Environmental Conservation Online System; [accessed 2016 Apr 22]. http://ecos.fws.gov/ecp/report/table/critical-habitat.html?xmlfile=../docs/crithab/metadata/FCH_Caretta_caretta_20140710.shp.xml#Distributor1.

Good CP. 2008. Spatial ecology of the North Atlantic right whale (*Eubalaena glacialis*). PhD dissertation. Durham (NC): Duke University.

Graham WM, Pages F, Hamner WM. 2001. A physical context for gelatinous zooplankton aggregations: A review. Hydrobiologia. 451(1-3):199-212.

Greene JK, Anderson MG, Odell J, Steinberg N. 2010. The Northwest Atlantic marine ecoregional assessment: Species, habitats and ecosystems. Phase one. Boston (MA): The Nature Conservancy, Eastern US Division.

Guisan A, Zimmermann NE. 2000. Predictive habitat distribution models in ecology. Ecol Model. 135(2–3):147-186.

Halpern BS, Frazier M, Potapenko J, Casey KS, Koenig K, Longo C, Lowndes JS, Rockwood RC, Selig ER, Selkoe KA. 2015. Spatial and temporal changes in cumulative human impacts on the world's ocean. Nat Commun. 6:7615.

Halpern BS, Walbridge S, Selkoe KA, Kappel CV, Micheli F, D'Agrosa C, Bruno JF, Casey KS, Ebert C, Fox HE et al. 2008. A global map of human impact on marine ecosystems. Science. 319(5865):948-952.

Harris PT, Macmillan-Lawler M, Rupp J, Baker EK. 2014. Geomorphology of the oceans. Mar Geol. 352:4-24.

Hobday AJ, Hartog JR, Spillman CM, Alves O, Hilborn R. 2011. Seasonal forecasting of tuna habitat for dynamic spatial management. Can J Fish Aquat Sci. 68(5):898-911.

Hobday AJ, Hartog JR, Timmiss T, Fielding J. 2010. Dynamic spatial zoning to manage southern bluefin tuna (*Thunnus maccoyii*) capture in a multi-species longline fishery. Fish Oceanogr. 19(3):243-253.

Hooker SB, Esaias WE, Feldman GC, Gregg WW, McClain CR. 1992. SeaWiFS technical report series: Volume 1, An overview of SeaWiFS and ocean color. NASA Technical Memorandum 104566. Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center.

Hovis WA, Clark DK, Anderson F, Austin RW, Wilson WH, Baker ET, Ball D, Gordon HR, Mueller JL, El-Sayed SZ. 1980. Nimbus-7 Coastal Zone Color Scanner: System description and initial imagery. Science. 210(4465):60-63.

Howell EA, Hoover A, Benson SR, Bailey H, Polovina JJ, Seminoff JA, Dutton PH. 2015. Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat model for ecosystem-based management. Fish Oceanogr. 24(1):57-68.

Howell EA, Kobayashi DR, Parker DM, Balazs GH, Polovina JJ. 2008. TurtleWatch: A tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. Endangered Species Res. 5(1):267-278.

Hurrell JW. 1995. Decadal trends in the North Atlantic oscillation: Regional temperatures and precipitation. Science. 269:676-679.

[IOC, IHO, BODC] Intergovernmental Oceanographic Commission, International Hydrographic Organization, ritish Oceanographic Data Centre. 2003. Centenary edition of the GEBCO digital atlas, published on CD-ROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans. Liverpool, United Kingdom: British Oceanographic Data Centre.

Kawamura H, OCTS Team. 1998. OCTS mission overview. J Oceanogr. 54(5):383-399.

Koblinsky CJ, Beckley BD, Ray RD, Wang Y-M, Tsaoussi L, Brenner A, Williamson R. 1998. NASA ocean altimeter pathfinder project - Report 1: Data processing handbook. NASA Technical Memorandum NASA/TM-1998-208605. Greenbelt (MD): National Aeronautics and Space Administration.

Lehodey P, Conchon A, Senina I, Domokos R, Calmettes B, Jouanno J, Hernandez O, Kloser R. 2014. Optimization of a micronekton model with acoustic data. ICES J Mar Sci. 72(5):1399-1412.

Lehodey P, Murtugudde R, Senina I. 2010. Bridging the gap from ocean models to population dynamics of large marine predators: A model of mid-trophic functional groups. Prog Oceanogr. 84(1):69-84.

Lehodey P, Senina I, Murtugudde R. 2008. A spatial ecosystem and populations dynamics model (SEAPODYM) – Modeling of tuna and tuna-like populations. Prog Oceanogr. 78(4):304-318.

Lewison R, Hobday AJ, Maxwell S, Hazen E, Hartog JR, Dunn DC, Briscoe D, Fossette S, O'Keefe CE, Barnes M et al. 2015. Dynamic ocean management: Identifying the critical ingredients of dynamic approaches to ocean resource management. Bioscience. 65(5):486-498.

Lilley MKS, Beggs SE, Doyle TK, Hobson VJ, Stromberg KHP, Hays GC. 2011. Global patterns of epipelagic gelatinous zooplankton biomass. Mar Biol. 158(11):2429-2436.

Long DG, Hicks BR. 2010. Standard BYU QuickSCAT and Seawinds land/ice image products. Revision 3.1. Provo (UT): Brigham Young University, BYU Center for Remote Sensing, Microwave Earth Remote Sensing Laboratory.

Lumpkin R, Johnson GC. 2013. Global ocean surface velocities from drifters: Mean, variance, El Niño–Southern Oscillation response, and seasonal cycle. J Geophys Res Oceans. 118(6):2992-3006.

Mannocci L, Roberts JJ, Miller DL, Halpin PN. 2017. Extrapolating cetacean densities io quantitatively assess human impacts on populations in the high seas. Conserv Biol. 31(3):602-614.

Maritorena S, d'Andon OHF, Mangin A, Siegel DA. 2010. Merged satellite ocean color data products using a bio-optical model: Characteristics, benefits and issues. Remote Sens Environ. 114(8):1791-1804.

Maritorena S, Siegel DA. 2005. Consistent merging of satellite ocean color data sets using a bio-optical model. Remote Sens Environ. 94(4):429-440.

Maritorena S, Siegel DA, Peterson A. 2002. Optimization of a semi-analytical ocean color model for global scale applications. Appl Opt. 41(15):2705-2714.

Martin CS, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, Geffert JL, van Bochove JW, Thomas H et al. 2014. Manual of marine and coastal datasets of biodiversity importance. May 2014 release. Cambridge, United Kingdom: UNEP World Conservation Monitoring Centre.

Mazor T, Beger M, McGowan J, Possingham HP, Kark S. 2016. The value of migration information for conservation prioritization of sea turtles in the Mediterranean. Global Ecol Biogeogr. 25:540-552.

Milton SL, Lutz PL. 2003. Physiological and genetic responses to environmental stress. In: Lutz PL, Musick JA, Wyneken J, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 163–197.

[NASA] National Aeronautics and Space Administration. 2016. MODIS-Aqua data. Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group; [accessed 2016 Mar 15]. http://modis.gsfc.nasa.gov.

NASA. 2016. Photosynthetically available radiation (PAR). Greenbelt (MD): National Aeronautics and Space Administration Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group; [accessed 2016 Aug 19]. http://oceancolor.gsfc.nasa.gov/cms/atbd/par.

[NASA, NOAA] National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration. 2009. Cross-calibrated multi-platform ocean surface wind vector L3.5A pentad first-look analyses. Version 1. National Aeronautics and Space Administration Goddard Space Flight Center and National Oceanic and Atmospheric Administration Physical Oceanography Distributed Active Archive Center; [accessed 2016 Sep 28]. http://dx.doi.org/10.5067/CCF35-01AD5.

NMFS. 1979. Determination of critical habitat for the leatherback sea turtle. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 44:17710-17712.

NMFS. 1998. Designated critical habitat; Green and hawksbill sea turtles. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 63:46693-46701.

NMFS. 2014. Endangered and threatened species: Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 79(132):39856-39912.

NMFS. 2014. Loggerhead sea turtle critical habitat in the Northwest Atlantic Ocean GIS files. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; [accessed 2016 Apr 22]. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm.

Oliver MJ, Glenn S, Kohut JT, Irwin AJ, Schofield OM, Moline MA, Bissett WP. 2004. Bioinformatic approaches for objective detection of water masses on continental shelves. J Geophys Res Oceans. 109:C07S04.

Oliver MJ, Irwin AJ. 2008. Objective global ocean biogeographic provinces. Geophys Res Lett. 35(15):L15601.

Pallin LJ, Adams EM, Goyert HF, Friedlaender AS, Johnston DW. 2015. Chapter 12: Density modeling for marine mammals and sea turtles with environmental covariates. In: Williams KA, Connelly EE, Johnson SM, Stenhouse IJ, editors. Baseline wildlife studies in Atlantic waters offshore of Maryland: Final report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015 Report BRI 2015-17. Portland (ME): Biodiversity Research Institute. p. 1-39.

Patterson T. 2005. Clean TOPO2: Edited SRTM30 plus world elevation data; [accessed 2016 Jun 13]. http://www.shadedrelief.com/cleantopo2/index.html.

Putman NF, Mansfield KL, He RY, Shaver DJ, Verley P. 2013. Predicting the distribution of oceanic-stage Kemp's ridley sea turtles. Biol Lett. 9(5).

Ray RD. 1999. A global ocean tide model from TOPEX/POSEIDON Altimetry: GOT99.2. Greenbelt (MD): National Aeronautics and Space Administration.

Reid JM, Reid JA, Jenkins CJ, Hastings ME, Williams SJ, Poppe LJ. 2005. usSEABED: Atlantic Coast offshore surficial sediment data release, USGS Data Series 118 (DS-118). Woods Hole (MA): United States Geological Survey Coastal and Marine Geology Program; [accessed 2016 Apr 27]. http://pubs.usgs.gov/ds/2005/118/htmldocs/data_cata.htm.

Reynolds RW, Smith TM. 1994. Improved global sea surface temperature analyses using optimum interpolation. J Clim. 7(6):929-948.

Reynolds RW, Smith TM, Liu C, Chelton DB, Casey KS, Schlax MG. 2007. Daily high-resolution-blended analyses for sea surface temperature. J Clim. 20(22):5473-5496.

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB et al. 2016. Habitat-based cetacean density models for the US Atlantic and Gulf of Mexico. Sci Rep. 6:22615.

Sargent S. 2015. Marine spatial planning biological data analysis in the northeast and Mid-Atlantic regions: Gap analysis and fitness for marine spatial planning applications. [Master's thesis]. Durham (NC): Duke University.

Savtchenko A, Ouzounov D, Ahmad S, Acker J, Leptoukh G, Koziana J, Nickless D. 2004. Terra and Aqua MODIS products available from NASA GES DAAC. Adv Space Res. 34(4):710-714.

Sbrocco EJ, Barber PH. 2013. MARSPEC: Ocean climate layers for marine spatial ecology. Ecology. 94(4):979-979.

[SEAMAP-SA] Southeast Area Monitoring and Assessment Program-South Atlantic. 2001. Distribution of bottom habitats on the continental shelf from North Carolina through the Florida Keys. Washington (DC): Southeast Area Monitoring and Assessment Program-South Atlantic Bottom Mapping Work Group, Atlantic States Marine Fisheries Commission.

Simons RA. 2016. ERDDAP: Easier access to scientific data, Version 1.68. Monterey (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Environmental Research Division; [accessed 2016 Feb 23]. http://coastwatch.pfeg.noaa.gov/erddap.

Smith WHF, Sandwell DT. 1997. Global sea floor topography from satellite altimetry and ship depth soundings. Science. 277(5334):1956-1962.

Spotila JR, O'Connor MP, Paladino FV. 1997. Thermal biology. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 297–314.

Tyberghein L, Verbruggen H, Pauly K, Troupin C, Mineur F, De Clerck O. 2012. Bio-ORACLE: A global environmental dataset for marine species distribution modelling. Global Ecol Biogeogr. 21(2):272-281.

Vazquez J, Perry K, Kilpatrick K. 1998. NOAA/NASA AVHRR Oceans Pathfinder sea surface temperature data set. User's Reference Manual Version 4.0. JPL Publication D–14070. National Oceanic and Atmospheric Administration National Oceanographic Data Center; [accessed 2016 Mar 1]. https://www.nodc.noaa.gov/woce/woce_v3/wocedata_2/sat_sst/avhrr/docs/usr_gde4_0.htm.

Weatherdon LV, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, van Geffert JL, Bochove JW, Thomas H et al. 2015. Manual of marine and coastal datasets of biodiversity importance. December 2015 edition. Cambridge, United Kingdom UNEP World Conservation Monitoring Centre.

Wessel P, Smith WHF. 1996. A global, self-consistent, hierarchical, high-resolution shoreline. J Geophys Res. 101(B4):8741-8743.

Wessel P, Smith WHF. 2016. GSHHG - A global self-consistent, hierarchical, high-resolution geography database. [accessed 2016 Jun 13]. http://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html.

Zhang HM, Bates JJ, Reynolds RW. 2006. Assessment of composite global sampling: Sea surface wind speed. Geophys Res Lett. 33(17):1-5.

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Addison DS, Gore JA, Ryder J, Worley K. 2002. Tracking post-nesting movements of loggerhead turtles (*Caretta caretta*) with sonic and radio telemetry on the southwest coast of Florida, USA. Mar Biol. 141(1):201-205.

Alerstam T, Hedenstrom A, Akesson S. 2003. Long-distance migration: Evolution and determinants. Oikos. 103(2):247-260.

Arendt M, Byrd J, Segars A, Maeier P, Schwenter J, Burgess D, Boynton J, Whitaker JD, Liguori L, Parker L et al. 2009. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. Final project report to the National Marine Fisheries Service National Oceanic and Atmospheric Administration. Charleston (SC): South Carolina Department of Natural Resources.

Arendt M, Segars A, Byrd J, Whitaker JD, Owens D, Blanvillain G. 2007. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. Charleston (SC): South Carolina Department of Natural Resources.

Arendt MD, Boynton J, Schwenter JA, Byrd JI, Segars AL, Whitaker JD, Parker L, Owens DW, Blanvillain GM, Quattro JM. 2012. Spatial clustering of loggerhead sea turtles in coastal waters of the NW Atlantic Ocean: Implications for management surveys. Endangered Species Res. 18(3):219-231.

Arendt MD, Schwenter JA, Boynton J, Segars AL, Byrd JI, Whitaker JD, Parker L. 2012. Temporal trends (2000-2011) and influences on fishery-independent catch rates for loggerhead sea turtles (*Caretta caretta*) at an important coastal foraging region in the southeastern United States. Fish Bull. 110(4):470-483.

Arendt MD, Schwenter JA, Segars AL, Byrd JI, Maier PP, Whitaker JD, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Catch rates and demographics of loggerhead sea turtles (*Caretta caretta*) captured from the Charleston, South Carolina, shipping channel during the period of mandatory use of turtle excluder devices (TEDs). Fish Bull. 110(1):98-109.

Arendt MD, Segars AL, Byrd JI, Boynton J, Schwenter JA, Whitaker JD, Parker L. 2012. Migration, distribution, and diving behavior of adult male loggerhead sea turtles (*Caretta caretta*) following dispersal from a major breeding aggregation in the Western North Atlantic. Mar Biol. 159(1):113-125.

Arendt MD, Segars AL, Byrd JI, Boynton J, Whitaker JD, Parker L, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Distributional patterns of adult male loggerhead sea turtles (*Caretta caretta*) in the vicinity of Cape Canaveral, Florida, USA during and after a major annual breeding aggregation. Mar Biol. 159(1):101-112.

Arendt MD, Segars AL, Byrd JI, Boynton J, Whitaker JD, Parker L, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Seasonal distribution patterns of juvenile loggerhead sea turtles (*Caretta caretta*) following capture from a shipping channel in the Northwest Atlantic Ocean. Mar Biol. 159(1):127-139.

Avens L, Braun-McNeill J, Epperly S, Lohmann KJ. 2003. Site fidelity and homing behavior in juvenile loggerhead sea turtles (*Caretta caretta*). Mar Biol. 143:211-220.

Avens L, Eguchi T, Epperly S, Haas H, Richards P, Seney E, Thompson N, Houtan KSV. 2013. Sea turtle assessment status and research needs. NOAA Technical Memorandum NMFS-F/SPO-131. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Avens L, Goshe LR, Harms CA, Anderson ET, Goodman Hall A, Cluse WM. 2012. Population characteristics, age structure, and growth dynamics of neritic juvenile green turtles in the northeastern Gulf of Mexico. Mar Ecol Prog Ser. 458:213-229.

Bailey H, Benson SR, Shillinger GL, Bograd SJ, Dutton PH, Eckert SA, Morreale SJ, Paladino FV, Eguchi T, Foley DG et al. 2012. Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. Ecol Appl. 22(3):735-747.

Bailey H, Fossette S, Bograd SJ, Shillinger GL, Swithenbank AM, Georges J-Y, Gaspar P, Stromberg KHP, Paladino FV, Spotila JR et al. 2012. Movement patterns for a critically endangered species, the leatherback turtle (*Dermochelys coriacea*), linked to foraging success and population status. PLOS ONE. 7(5):e36401.

Bailey H, Shillinger G, Palacios D, Bograd S, Spotila J, Paladino F, Block B. 2008. Identifying and comparing phases of movement by leatherback turtles using state-space models. J Exp Mar Biol Ecol. 356(1-2):128-135.

Barco SG, Lockhart GG. 2014. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: Annual progress report for 2013. VAQF Scientific Report 2014-04. Virginia Beach (VA): Virginia Aquarium & Marine Science Center.

Barco SG, Lockhart GG. 2015. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: 2014 annual progress report. Draft report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Orders 41 and 50. Virginia Beach (VA): HDR.

Bartol SM, Ketten DR. 2006. Turtle and tuna hearing. NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-7. Honolulu (HI): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

Bartol SM, Musick JA. 2003. Sensory biology of sea turtles. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 79.

Bartol SM, Musick JA, Lenhardt ML. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia. 1999(3):836-840.

Bass AL, Chow SM, Bowen BW. 1999. Temporal variation in loggerhead strandings from Georgia: Final report to Georgia Department of Natural Resources. Gainesville (FL): University of Florida.

Bass AL, Epperly SP, Braun-McNeill J. 2004. Multi-year analysis of stock composition of a loggerhead turtle (*Caretta caretta*) foraging habitat using maximum likelihood and Bayesian methods. Conserv Genet. 5(6):783-796.

Bass AL, Epperly SP, Braun-McNeill J. 2006. Green turtle (*Chelonia mydas*) foraging and nesting aggregations in the Caribbean and Atlantic: Impact of currents and behavior on dispersal. J Hered. 97(4):346-354.

Benson SR, Eguchi T, Foley DG, Forney KA, Bailey H, Hitipeuw C, Samber BP, Tapilatu RF, Rei V, Ramohia P et al. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere. 2(7):art84.

Benson SR, Forney KA, Harvey JT, Carretta JV, Dutton PH. 2007. Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990-2003. Fish Bull. 105(3):337-347.

Bjorndal KA. 1980. Nutrition and grazing behavior of the green turtle *Chelonia mydas*. Mar Biol. 56:147-154.

Bjorndal KA. 1997. Foraging ecology and nutrition of sea turtles. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 199–123.

Bjorndal KA, Bolten AB. 1990. Goals for sea turtle research in the Gulf of Mexico with respect to the oil and gas industries. In: Tucker and Associates, Inc., editor. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1-3, 1989 OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region. p. 47-58.

Bjorndal KA, Bolten AB, Martins HR. 2000. Somatic growth model of juvenile loggerhead sea turtles *Caretta caretta*: Duration of pelagic stage. Mar Ecol Prog Ser. 202:265-272.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 1 Book 3. Washington (DC): Center for Natural Areas, Bureau of Land Management.

Blumenthal JM, Austin TJ, Bell CDL, Bothwell JB, Broderick AC, Ebanks-Petrie G, Gibb JA, Luke KE, Olynik JR, Orr MF. 2009. Ecology of hawksbill turtles, *Eretmochelys imbricata*, on a western Caribbean foraging ground. Chelonian Conserv Biol. 8(1):1-10.

Blumenthal JM, Solomon JL, Bell CD, Austin TJ, Ebanks-Petrie G, Coyne MS, Broderick AC, Godley BJ. 2006. Satellite tracking highlights the need for international cooperation in marine turtle management. Endangered Species Res. 3(3):51-61.

Bolten AB. 2003. Variation in sea turtle life history patterns: Neritic vs. oceanic developmental stages. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 243-257.

Bolten AB. 2008. Hawksbill nesting in Bahamas: Personal communication. In: Mast RB, Bailey LM, Hutchinson BJ, editors. Where the hawksbills are State of the World's Sea Turtles report volume III. Arlington (VA): State of the World's Sea Turtles. p. 11.

Bolten AB, Bjorndal KA, Eliazar PJ, Gregory LF. 1994. Seasonal abundance, size distribution, and blood biochemical values of loggerheads (*Caretta caretta*) in Port Canaveral ship channel, Florida. NOAA Technical Report Memorandum NMFS-SEFSC-353. Miami (FL): Southeast Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Bolten AB, Bjorndal KA, Martins HR. 1994. Biology of pelagic-stage loggerheads in the Atlantic. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 19-20.

Bolten AB, Witherington BE. 2003. Loggerhead sea turtles. Washington (DC): Smithsonian Institution Press.

Boulon RH, Jr., Eckert K, Eckert S. 1988. *Dermochelys coriacea* (leatherback sea turtle) migration. Herpetol Rev. 19(4):88.

Bovery CM, Wyneken J. 2013. Sea turtles in Florida's Atlantic waters. Mar Fish Rev. 75(3):1-12.

Bovery CM, Wyneken J. 2015. Seasonal variation in sea turtle density and abundance in the southeast Florida current and surrounding waters. PLOS ONE. 10(12):e0145980.

Bowen BW, Bass AL, Soares L, Toonen RJ. 2005. Conservation implications of complex population structure: Lessons from the loggerhead turtle (*Caretta caretta*). Mol Ecol. 14(8):2389-2402.

Bradshaw CJA, McMahon CR, Hays GC. 2007. Behavioral inference of diving metabolic rate in free-ranging leatherback turtles. Physiol Biochem Zool. 80(2):209-219.

Braun J, Epperly SP. 1996. Aerial surveys for sea turtles in Southern Georgia waters, June, 1991. Gulf Mex Sci. 14(1):39-44.

Braun-McNeill J, Goodman MA, Patton BW. 2010. Surfacing behavior of loggerhead (*Caretta caretta*) sea turtles in estuarine and coastal waters of North Carolina. NOAA Technical Memorandum NMFS-SEFSC-605. Beaufort (NC): National Oceanic and Atmospheric Administration, Southeast Fisheries Science Center.

Broderick AC, Coyne MS, Fuller WJ, Glen F, Godley BJ. 2007. Fidelity and over-wintering of sea turtles. Proc R Soc Lond B Biol Sci. 274(1617):1533-1539.

Brost B. 2008. Hawksbill nesting in Florida, USA: Personal communication. In: Mast RB, Bailey LM, Hutchinson BJ, editors. Where the hawksbills are State of the World's Sea Turtles report volume III. Arlington (VA): State of the World's Sea Turtles.

Brown DD, Kays R, Wikelski M, Wilson R, Klimley AP. 2013. Observing the unwatchable through acceleration logging of animal behavior. Anim Biotelem. 1(1):1-16.

Brown-Saracino J, Smith C, Gilman P. 2013. Final report for the Mid-Atlantic marine wildlife surveys, modeling, and data: Workshop to establish coordination and communication. July 24 - 25, 2012, Silver Spring, MD. US Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office.

Burke VJ, Morreale SJ, Standora EA. 1994. Diet of the Kemp's ridley sea turtle, *Lepidochelys kempii*, in New York waters. Fish Bull. 92(1):26-32.

Burke VJ, Standora EA, Morreale SJ. 1991. Factors affecting strandings of cold-stunned juvenile Kemp's ridley and loggerhead sea turtles in Long Island, New York. Copeia.1136-1138.

Burt ML. 2014. Analysis of aerial surveys conducted in coastal waters of Maryland and Virginia, including Chesapeake Bay, 2011 - 2013: Loggerhead turtles. Unpublished technical report Prepared for: Department of the Navy Naval Facilities Engineering Command, Atlantic. Contract: N624070-10-30, CTO 0040. Prepared by University of St. Andrews, St. Andrews, Scotland. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Butler RW, Nelson WA, Henwood TA. 1987. A trawl survey method for estimating loggerhead turtle, *Caretta caretta*, abundance in five eastern Florida channels and inlets. Fish Bull. 85(3):447-453.

Byles RA. 1988. The behavior and ecology of sea turtles in Virginia. [PhD dissertation]. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Byles RA. 1989. Satellite telemetry of Kemp's ridley sea turtle, *Lepidochelys kempi*, in the Gulf of Mexico. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 25-26.

Caldwell DK. 1968. Baby loggerhead turtles associated with sargassum weed. Quart J Florida Acad Sci. 31:271-272.

Campbell HA, Urbano F, Davidson S, Dettki H, Cagnacci F. 2016. A plea for standards in reporting data collected by animal-borne electronic devices. Anim Biotelem. 4(1):1-4.

Carr A. 1986. New perspectives on the pelagic stage of sea turtle development. NOAA Technical Memorandum NMFS-SEFSC-190. Miami (FL): National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

Carr A. 1987. New perspectives on the pelagic stage of sea turtle development. Conserv Biol. 1(2):103-121.

Carr A, Caldwell DK. 1956. The ecology and migrations of sea turtles, 1. Results of field work in Florida. Am Mus Novit. 1793:1-23.

Carr A, Giovannoli L. 1956. The ecology and migrations of sea turtles, 2. Results of field work in Florida. Am Mus Novit. 1835:1-32.

Carr A, Meylan A, Mortimer J, Bjorndal K, Carr T. 1982. Surveys of sea turtle populations and habitats in the Western Atlantic. NOAA Technical Memorandum NMFS-SEFSC-91. Panama City (FL): National Oceanic and Atmospheric Administration National Marine Fisheries Service Southeast Fisheries Center Panama City Laboratory.

Carr A, Meylan AB. 1980. Evidence of passive migration of green turtle hatchlings in sargassum. Copeia. 1980(2):366-368.

Carr A, Ogren L, McVea C. 1980. Apparent hibernation by the Atlantic loggerhead turtle *Caretta caretta* off Cape Canaveral, Florida. Biol Conserv. 19(1):7-14.

Carvalho A, Fitzpatrick K, Garland J, Veldhuis F. 2015. Artificial reefs, beach restoration, and sea turtle nesting in Martin County, Florida. In: Wright DJ, editor. Ocean solutions, earth solutions. Redlands (CA): ESRI Press. p. 49-71.

Casey J, Garner J, Garner S, Williard AS. 2010. Diel foraging behavior of gravid leatherback sea turtles in deep waters of the Caribbean Sea. J Exp Biol. 213(23):3961-3971.

Ceriani SA, Roth JD, Evans DR, Weishampel JF, Ehrhart LM. 2012. Inferring foraging areas of nesting loggerhead turtles using satellite telemetry and stable isotopes. PLOS ONE. 7(9):e45335.

Ceriani SA, Roth JD, Tucker AD, Evans DR, Addison DS, Sasso CR, Ehrhart LM, Weishampel JF. 2015. Carry-over effects and foraging ground dynamics of a major loggerhead breeding aggregation. Mar Biol. 162(10):1955-1968.

Cetacean Turtle Assessment Program. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the US outer continental shelf. Final report sponsored by the Bureau of Land Management under contract AA551-CT8-48. Kingston (RI): University of Rhode Island.

Chassignet EP, Hurlburt HE, Smedstad OM, Halliwell GR, Hogan PJ, Wallcraft AJ, Baraille R, Bleck R. 2007. The HYCOM (hybrid coordinate ocean model) data assimilative system. J Mar Syst. 65(1):60-83.

Chevallier D. 2016. Satellite tracking of marine turtles in French Guiana: Personal communication. In: Mast RB, Hutchinson BJ, Villegas PE, editors. Special feature: South America State of the World's Sea Turtles report volume XI. Ross (CA): State of the World's Sea Turtles. p. 24-25.

Ciminello C, Deavenport R, Fetherston T, Fulkerson K, Hulton P, Jarvis D, Neales B, Thibodeaux J, Benda-Joubert J, Farak A. 2012. Determination of acoustic effects on marine mammals and sea turtles for the Atlantic fleet training and testing environmental impact statement/overseas environmental impact statement. No. NUWC-NPT Technical Report 12,071. Newport (RI): Naval Undersea Warfare Center Division.

Coleman AT, Pitchford JL, Bailey H, Solangi M. 2016. Seasonal movements of immature Kemp's ridley sea turtles (*Lepidochelys kempii*) in the northern Gulf of Mexico. Aquat Conserv: Mar Freshwat Ecosyst. 27(1):253-267.

Coleman AT, Pulis EE, Pitchford JL, Crocker K, Heaton AJ, Carron AM, Hatchett W, Shannon D, Austin F, Dalton M. 2016. Population ecology and rehabilitation of incidentally captured Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Mississippi Sound, USA. Herpetol Conserv Biol. 11(1):253-264.

Coles W, Keinath J, Keinath D, Musick J. 1994. Sea surface temperatures and sea turtle position correlations. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 211-212.

Conant TA, Dutton PH, Eguchi T, Epperly SP, Fahy CC, Godfrey MH, MacPherson SL, Possardt EE, Schroeder BA, Seminoff JA et al. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the US Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Cooper RW, Ellis E, Merigo C, Murphy SR, Weber S. 2006. Satellite tracking of captive-reared juvenile loggerhead sea turtles (*Caretta caretta*) released in southern New England. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece. p. 87.

Coyne MS, Godley BJ. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing and mapping animal tracking data. Mar Ecol Prog Ser. 301:1-7.

Crain DA, Bolten AB, Bjorndal KA. 1995. Effects of beach nourishment on sea turtles: Review and research initiatives. Restor Ecol. 3(2):95-104.

Davis RW, Evans WE, Würsig B. 2000. Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance, and habitat associations. Volume I: Executive summary. Prepared by Texas A&M University at Galveston and the National Marine Fisheries Service. OCS Study MMS 2000-002. USGS/BRD/CR-1999-0006. New Orleans (LA): US Geological Survey, Biological Resources Division and Minerals Management Service, Gulf of Mexico OCS Region.

Davis RW, Fargion GS. 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Final report. Volume I: Executive summary. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. OCS Study MMS 96-0026. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Dodd CK, Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). Biological Report 88(14). Washington (DC): US Fish and Wildlife Service.

Dodd CK, Jr., Byles R. 2003. Post-nesting movements and behavior of loggerhead sea turtles (*Caretta caretta*) departing from east-central Florida nesting beaches. Chelonian Conserv Biol. 4(3):530-536.

Dodge KL, Galuardi B, Miller TJ, Lutcavage ME. 2014. Leatherback turtle movements, dive behavior, and habitat characteristics in ecoregions of the Northwest Atlantic Ocean. PLOS ONE. 9(3):e91726.

Dodge KL, Logan JM, Lutcavage ME. 2011. Foraging ecology of leatherback sea turtles in the Western North Atlantic determined through multi-tissue stable isotope analyses. Mar Biol. 158(12):2813-2824.

DoN. 2003. Marine resource assessment for the Cherry Point and southern Virginia Capes (VACAPES) inshore and estuarine areas. Final report. Prepared for: Department of the Navy Commander, US Atlantic Fleet. Contract: N62470-95-D-1160, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2005. Marine resources assessment for the northeast operating areas: Atlantic City, Narragansett Bay, and Boston. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0018. Prepared by Geo-Marine, Inc., Newport News, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for southeastern Florida and the AUTEC-Andros operating areas. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6470-02-D-9997, CTO 0034. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for the Gulf of Mexico. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Charleston/Jacksonville operating area. Final report. Prepared for: Department of the Navy US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Cherry Point operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9991, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Virginia Capes operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2009. Marine resources assessment for the Chesapeake Bay. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6270-02-D-9997, CTO 0127. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Donaldson M, Hinch S, Suski C, Fisk A, Heupel MR, Cooke SJ. 2014. Making connections in aquatic ecosystems with acoustic telemetry monitoring. Front Ecol Environ. 12(10):565-573.

Dow Piniak WE, Eckert SA, Harms CA, Stringer EM. 2012. Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. OCS Study BOEM 2012-01156. Herndon (VA): Bureau of Ocean Energy Management.

Dow W, Eckert K, Palmer M, Kramer P. 2007. An atlas of sea turtle nesting habitat for the wider Caribbean region. WIDECAST Technical Report Number 6. Beaufort (NC): The Wider Caribbean Sea Turtle Conservation Network and The Nature Conservancy.

Doyle TK, Houghton JDR, O'Súilleabháin PF, Hobson VJ, Marnell F, Davenport J, Hays GC. 2008. Leatherback turtles satellite-tagged in European waters. Endangered Species Res. 4(1-2):23-31.

Duncan RG. 2012. Development of a species distribution model for the east Pacific green sea turtle using ecological geoprocessing tools. [Master's thesis]. College Station (TX): Texas A&M University.

Duron-Dufrenne M. 1987. First satellite-based tracking in the Atlantic Ocean of a leatherback turtle *Dermochelys coriacea*. Comptes Rendus Acad Sci. 304:399-402.

Eaton C, McMichael E, Witherington B, Foley A, Hardy R, Meylan A. 2008. In-water sea turtle monitoring and research in Florida: Review and recommendations. NOAA Technical Memorandum NMFS-OPR-38. St. Petersburg (FL): National Oceanic and Atmospheric Administration National Marine Fisheries Service.

Eberle MD. 1994. The effect of abiotic factors on the position of loggerhead turtles (*Caretta caretta*) in the water column at Cape Canaveral, Florida. [PhD dissertation]. Buffalo (NY): State University of New York College at Buffalo.

Eberle MD, Standora EA, Edbauer JM, Ryder TS, Williams KL, Morreale SJ, Bolten AB. 1994. The effect of abiotic factors on the position of loggerhead turtles (*Caretta caretta*) in the water column at Cape Canaveral, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 37.

Eckert SA. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. In: Epperly SP, Braun J, editors. Proceedings of the seventeenth annual sea turtle symposium, 4 - 8 March 1997, Orlando, Florida, USA NOAA Technical Memorandum NMFS-SEFSC-415 Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 46-48.

Eckert SA. 1999. Data acquisition systems for monitoring sea turtle behavior and physiology. In: Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M, editors. Research and management techniques for the conservation of sea turtles. Washington (DC): IUCN/SSC Marine Turtle Specialist Group Publication. p. 88-93.

Eckert SA. 2002. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. Mar Ecol Prog Ser. 230:289-293.

Eckert SA. 2006. High-use oceanic areas for Atlantic leatherback sea turtles (*Dermochelys coriacea*) as identified using satellite telemetered location and dive information. Mar Biol. 149(5):1257-1267.

Eckert SA, Bagley D, Kubis S, Ehrhart L, Johnson C, Stewart K, DeFreese D. 2006. Internesting and postnesting movements and foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida. Chelonian Conserv Biol. 5(2):239-248.

Eckert SA, Eckert KL, Ponganis P, Kooyman GL. 1989. Diving and foraging behaivor of leatherback sea turtles (*Dermochelys coriacea*). Can J Zool. 67(11):2834-2840.

Ehrhart L, Redfoot W, Bagley D, Mansfield K. 2014. Long-term trends in loggerhead (*Caretta caretta*) nesting and reproductive success at an important western Atlantic rookery. Chelonian Conserv Biol. 13(2):173-181.

Ehrhart LM. 1992. Turtles of the worm-rock reefs. The Florida Naturalist. 65:9-11.

Ehrhart LM, Bagley DA, Redfoot WE. 2003. Loggerhead turtles in the Atlantic Ocean: Geographic distribution, abundance, and population status. In: Bolten AB, Witherington BE, editors. Loggerhead sea turtles. Washington (DC): Smithsonian Books. p. 157-174.

EPA. 1987. Biological assessment on the effect of EPA's proposed site designation of the Sabine-Neches sites for disposal of dredged material on endangered or threatened sea turtles. Dallas (TX): Environmental Protection Agency Region IV.

Epperly SP, Braun J, Chester AJ, Cross FA, Merriner JV, Tester PA. 1995. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull Mar Sci. 56(2):547-568.

Epperly SP, Braun J, Veishlow A. 1995. Sea turtles in North Carolina waters. Conserv Biol. 9(2):384-394.

Epperly SP, Braun-McNeill J, Richards PM. 2007. Trends in catch rates of sea turtles in North Carolina, USA. Endangered Species Res. 3(3):283-293.

Evans DR, Bilo K. 2016. Satellite tracking of marine turtles in the Guianas: Personal communication. In: Mast RB, Hutchinson BJ, Villegas PE, editors. Special feature: South America State of the World's Sea Turtles report volume XI. Ross (CA): State of the World's Sea Turtles.

Ferraroli S, Georges J-Y, Gaspar P, Le Maho Y. 2004. Endangered species: Where leatherback turtles meet fisheries. Nature. 429(6991):521-522.

Finneran JJ, Jenkins AK. 2012. Criteria and thresholds for US Navy acoustic and explosive effects analysis. San Diego (CA): Space and Naval Warfare Systems Center Pacific.

Fletemeyer J. 1983. Sea turtle monitoring project. Report to Broward County Environmental Quality Control Board, FL. Cooperative Sea Turtle Monitoring Program, Nova University and Broward County Environmental Quality Control Board. New York (NY): Nova University/New York Institute of Technology Press.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M. 2014. Long-term behavior at foraging sites of adult female loggerhead sea turtles (*Caretta caretta*) from three Florida rookeries. Mar Biol. 161(6):1251-1262.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M, Coyne MS. 2013. Postnesting migratory behavior of loggerhead sea turtles *Caretta caretta* from three Florida rookeries. Endangered Species Res. 21(2):129-142.

Foley AM, Singel KE, Dutton PH, Summers TM, Redlow AE, Lessman J. 2007. Characteristics of a green turtle (*Chelonia mydas*) assemblage in Northwestern Florida during a hypothermic stunning event. Gulf Mex Sci. 25:131-143.

Fossette S, Corbel H, Gaspar P, Le Maho Y, Georges J-Y. 2008. An alternative technique for the long-term satellite tracking of leatherback turtles. Endangered Species Res. 4(1-2):33-41.

Fossette S, Hobson VJ, Girard C, Calmettes B, Gaspar P, Georges J-Y, Hays GC. 2010. Spatio-temporal foraging patterns of a giant zooplanktivore, the leatherback turtle. J Mar Syst. 81(3):225-234.

Fossette S, Witt MJ, Miller P, Nalovic MA, Albareda D, Almeida AP, Broderick AC, Chacón-Chaverri D, Coyne MS, Domingo A. 2014. Pan-Atlantic analysis of the overlap of a highly migratory species, the leatherback turtle, with pelagic longline fisheries. Proc R Soc Lond B Biol Sci. 281(1780):20133065.

Frick MG, Slay CK, Quinn CA, Windham-Reid A, Duley PA, Ryder CM, Morse LJ. 2000. Aerial observations of courtship behavior in loggerhead sea turtles (*Caretta caretta*) from southeastern Georgia and northeastern Florida. J Herpetol. 34(1):153-158.

Fritts TH, Hoffman W, McGehee MA. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. J Herpetol. 17(4):327-344.

Fujioka E, Kot CY, Wallace BP, Best BD, Moxley J, Cleary J, Donnelly B, Halpin PN. 2014. Data integration for conservation: Leveraging multiple data types to advance ecological assessments and habitat modeling for marine megavertebrates using OBIS-SEAMAP. Ecol Inform. 20:13-26.

FWS. 2014. Endangered and threatened wildlife and plants; Designation of critical habitat for the Northwest Atlantic Ocean distinct population segment of the loggerhead sea turtle. US Fish and Wildlife Service final rule. Federal Register. 79(132):39756-39854.

FWS. 2016. Critical habitat GIS files. Washington (DC): US Fish and Wildlife Service Environmental Conservation Online System; [accessed 2016 Apr 22]. http://ecos.fws.gov/ecp/report/table/critical-habitat.html?xmlfile=../docs/crithab/metadata/FCH_Caretta_caretta_20140710.shp.xml#Distributor1.

FWS, NMFS. 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife.

Gaspar P, Georges J-Y, Fossette S, Lenoble A, Ferraroli S, Le Maho Y. 2006. Marine animal behaviour: Neglecting ocean currents can lead us up the wrong track. Proc R Soc Lond B Biol Sci. 273(1602):2697-2702.

GEC, Inc. 2012. Final environmental assessment for issuance of a non-competitive negotiated agreement for the use of outer continental shelf sands for Caminada Headland beach and dune restoration (BA-45), Lafourche Parish, Lousiana. Baton Rouge (LA): Coastal Protection and Restorationa Authority of Louisiana.

Girard C, Tucker AD, Calmettes B. 2009. Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: Dispersal in highly dynamic conditions. Mar Biol. 156(9):1827-1839.

Girard C, Tucker AD, Calmettes B. 2009. Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: Dispersal in highly dynamic conditions. Mar Biol. 156(9):1827-1839.

Gitschlag G, Renaud M, Williams J, Hale J. 1992. Movement of Kemp's ridley and loggerhead sea turtles off the Georgia-Florida coast. Submitted to the US Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Contract Number WESCW-92-034. Galveston (TX): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Gitschlag GR. 1996. Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the US southeastern Atlantic coast. J Exp Mar Biol Ecol. 205(1-2):115-135.

Godley BJ, Blumenthal JM, Broderick AC, Coyne MS, Godfrey MH, Hawkes LA, Witt MJ. 2008. Satellite tracking of sea turtles: Where have we been and where do we go next. Endangered Species Res. 4(1-2):3-22.

Godley BJ, Broderick AC, Glen F, Hays GC. 2003. Post-nesting movements and submergence patterns of loggerhead marine turtles in the Mediterranean assessed by satellite tracking. J Exp Mar Biol Ecol. 287(1):119-134.

Goff GG, Lien J, Stenson GB, Fretey J. 1994. The migration of a tagged leatherback turtle, *Dermochelys coriacea*, from French Guiana, South America, to Newfoundland, Canada, in 128 days. Can Field Nat. 108(1):72-73.

Griffin DB. 2002. GIS analysis of inter-nesting habitat, migratory corridors, and resident foraging areas of the loggerhead sea turtle (*Caretta caretta*) along the southeast coast. [Master's thesis]. Charleston (SC): College of Charleston.

Griffin DB, Murphy SR, Frick MG, Broderick AC, Coker JW, Coyne MS, Dodd MG, Godfrey MH, Godley BJ, Hawkes LA et al. 2013. Foraging habitats and migration corridors utilized by a recovering subpopulation of adult female loggerhead sea turtles: Implications for conservation. Mar Biol. 160(12):3071-3086.

Guseman JL, Ehrhart LM. 1991. Ecological geography of Western Atlantic loggerheads and green turtles: Evidence from remote tag recoveries. NOAA Technical Memorandum NMFS-SEFSC-302. In: Salmon M, Wyneken J, editors. Proceedings of the eleventh annual workshop on sea turtle biology and conservation, 26 February - 2 March 1991, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 50.

Haas HL. 2010. Using observed interactions between sea turtles and commercial bottom-trawling vessels to evaluate the conservation value of trawl gear modifications. Mar Coast Fish. 2(1):263-276.

Halpin PN, Read AJ, Best BD, Hyrenbach KD, Fujioka E, Coyne MS, Crowder LB, Freeman SA, Spoerri C. 2006. OBIS-SEAMAP: Developing a biogeographic research data commons for the ecological studies of marine mammals, seabirds, and sea turtles. Mar Ecol Prog Ser. 316:239-246.

Halpin PN, Read AJ, Fujioka E, Best BD, Donnelly B, Hazen LJ, Kot C, Urian K, LaBrecque E, Dimatteo A et al. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography. 22:104-115.

Hamann M, Godfrey MH, Seminoff JA, Arthur K, Barata PCR, Bjorndal KA, Bolten AB, Broderick AC, Campbell LM, Carreras C. 2010. Global research priorities for sea turtles: Informing management and conservation in the 21st century. Endangered Species Res. 11(3):245-269.

Hamelin KM, Kelley DE, Taggart CT, James MC. 2014. Water mass characteristics and solar illumination influence leatherback turtle dive patterns at high latitudes. Ecosphere. 5(2):1-20.

Hammerschlag N, Broderick AC, Coker JW, Coyne MS, Dodd M, Frick MG, Godfrey MH, Godley BJ, Griffin DB, Hartog K et al. 2015. Evaluating the landscape of fear between apex predatory sharks and mobile sea turtles across a large dynamic seascape. Ecology. 96(8):2117-2126.

Hardy RF, Tucker AD, Foley AM, Schroeder BA, Giove RJ, Meylan AB. 2014. Spatiotemporal occurrence of loggerhead turtles (*Caretta caretta*) on the West Florida Shelf and apparent overlap with a commercial fishery. Can J Fish Aquat Sci. 71(12):1924-1933.

Harms CA, Mallo KM, Ross PM, Segars A. 2003. Venous blood gases and lactates of wild loggerhead sea turtles (*Caretta caretta*) following two capture techniques. J Wildl Dis. 39(2):366-374.

Hart KM, Fujisaki I. 2010. Satellite tracking reveals habitat use by juvenile green sea turtles *Chelonia mydas* in the Everglades, Florida, USA. Endangered Species Res. 11:221-232.

Hart KM, Fujisaki I, Autumn RS. 2012. Use of Dry Tortugas National Park by threatened and endangered marine turtles. Tallahassee (FL): Florida Fish and Wildlife Conservation Commission.

Hart KM, Lamont MM, Fujisaki I, Tucker AD, Carthy RR. 2012. Common coastal foraging areas for loggerheads in the Gulf of Mexico: Opportunities for marine conservation. Biol Conserv. 145(1):185-194.

Hart KM, Lamont MM, Sartain AR, Fujisaki I. 2014. Migration, foraging, and residency patterns for Northern Gulf loggerheads: Implications of local threats and international movements. PLOS ONE. 9(7):e103453.

Hart KM, Lamont MM, Sartain AR, Fujisaki I, Stephens BS. 2013. Movements and habitat-use of loggerhead sea turtles in the northern Gulf of Mexico during the reproductive period. PLOS ONE. 8(7):e66921.

Hart KM, Lear KO, Whitney NM, Lamont MM, Cherkiss MS, Crowder AG, Shaver DJ, Pollock C, Hills-Starr Z. 2016. Beyond maps: Combining data-loggers with satellite tags to determine specifics of inter-nesting sea turtle behavior. Paper presented at: Southeast Regional Sea Turtle Meeting, February 9 - 12, 2016. Mobile (AL).

Hart KM, Mooreside P, Crowder LB. 2006. Interpreting the spatio-temporal patterns of sea turtle strandings: Going with the flow. Biol Conserv. 129(2):283-290.

Hart KM, Sartain AR, Fujisaki I. 2015. Bahamas connection: Residence areas selected by breeding female loggerheads tagged in Dry Tortugas National Park, USA. Anim Biotelem. 3(1):1-17.

Hart KM, Sartain AR, Fujisaki I, Pratt HL, Jr., Morley D, Feeley MW. 2012. Home range, habitat use, and migrations of hawksbill turtles tracked from Dry Tortugas National Park, Florida, USA. Mar Ecol Prog Ser. 457:193-207.

Hart KM, White CF, Iverson AR, Whitney N. 2016. Trading shallow safety for deep sleep: Juvenile green turtles select deeper resting sites as they grow. Endangered Species Res. 31:61-73.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2010. Inter-nesting habitat-use patterns of loggerhead sea turtles: enhancing satellite tracking with benthic mapping. Aquat Biol. 11(1):77-90.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2013. Habitat use of breeding green turtles *Chelonia mydas* tagged in Dry Tortugas National Park: Making use of local and regional MPAs. Biol Conserv. 161:142-154.

Hatase H, Sato K, Yamaguchi M, Takahashi K, Tsukamoto K. 2006. Individual variation in feeding habitat use by adult female green sea turtles (*Chelonia mydas*): Are they obligately neritic herbivores? Oecologia. 149(1):52-64.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Godley BJ. 2007. Only some like it hot — quantifying the environmental niche of the loggerhead sea turtle. Divers Distrib. 13(4):447-457.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Lopez-Jurado LF, Lopez-Suarez P, Merino SE, Varo-Cruz N, Godley BJ. 2006. Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Curr Biol. 16(10):990-995.

Hawkes LA, Broderick AC, Godfrey MH, Godley BJ. 2009. Climate change and marine turtles. Endangered Species Res. 7(2):137-154.

Hawkes LA, Tomás J, Revuelta O, León YM, Blumenthal JM, Broderick AC, Fish M, Raga JA, Witt MJ, Godley BJ. 2012. Migratory patterns in hawksbill turtles described by satellite tracking. Mar Ecol Prog Ser. 461:223-232.

Hawkes LA, Witt MJ, Broderick AC, Coker JW, Coyne MS, Dodd M, Frick MG, Godfrey MH, Griffin DB, Murphy SR et al. 2011. Home on the range: spatial ecology of loggerhead turtles in Atlantic waters of the USA. Divers Distrib. 17(4):624-640.

Hawkins AD, Pembroke AE, Popper AN. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Rev Fish Biol Fish. 25(1):39-64.

Hays GC, Adams CR, Broderick AC, Godley BJ, Lucas DJ, Metcalfe JD, Prior AA. 2000. The diving behaviour of green turtles at Ascension Island. Anim Behav. 59(3):577-586.

Hays GC, Hobson VJ, Metcalfe JD, Righton D, Sims DW. 2006. Flexible foraging movements of leatherback turtles across the North Atlantic Ocean. Ecology. 87(10):2647-2656.

Hays GC, Houghton JDR, Isaacs C, King RS, Lloyd C, Lovell P. 2004. First records of oceanic dive profiles for leatherback turtles, *Dermochelys coriacea*, indicate behavioural plasticity associated with long-distance migration. Anim Behav. 67:733-743.

Hays GC, Houghton JDR, Myers AE. 2004. Pan-Atlantic leatherback turtle movements. Nature. 429(6991):522-522.

Hays GC, Luschi P, Papi F, Marsh R. 1999. Changes in behaviour during the inter-nesting period and post-nesting migration for Ascension Island green turtles. Mar Ecol Prog Ser. 189:263-273.

Hays GC, Scott R. 2013. Global patterns for upper ceilings on migration distance in sea turtles and comparisons with fish, birds and mammals. Funct Ecol. 27:748-756.

Hazel J, Lawler IR, Marsh H, Robson S. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. Endangered Species Res. 3(2):105-113.

Henwood TA. 1987. Movements and seasonal changes in loggerhead turtle *Caretta caretta* aggregations in the vicinity of Cape Canaveral, Florida (1978–84). Biol Conserv. 40(3):191-202.

Henwood TA, Ogren LH. 1987. Distribution and migrations of immature Kemp's ridley turtles (*Lepidochelys kempi*) and green turtles (*Chelonia mydas*) off Florida, Georgia, and South Carolina. Northeast Gulf Science. 9(2):153-159.

Hernandez K. 2014. Protecting beaches and sea turtles: An analysis of beach nourishment in North Carolina, the impacts on nesting loggerhead sea turtles, and how sea level rise will transform the status quo. [Master's Project]. Durham (NC): Duke University.

.

Hirth HF. 1971. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Washington (DC): US Fish and Wildlife Service.

Hochscheid S. 2014. Why we mind sea turtles' underwater business: A review on the study of diving behavior. J Exp Mar Biol Ecol. 450:118-136.

Hochscheid S, Bentivegna F, Bradai MN, Hays GC. 2007. Overwintering behaviour in sea turtles: Dormancy is optional. Mar Ecol Prog Ser. 340:287-298.

Hochscheid S, Bentivegna F, Hamza A, Hays GC. 2010. When surfacers do not dive: Multiple significance of extended surface times in marine turtles. J Exp Biol. 213(8):1328-1337.

Hochscheid S, Bentivegna F, Hays GC. 2005. First records of dive durations for a hibernating sea turtle. Biol Lett. 1(1):82-86.

Hochscheid S, Godley BJ, Broderick AC, Wilson RP. 1999. Reptilian diving: Highly variable dive patterns in the green turtle *Chelonia mydas*. Mar Ecol Prog Ser. 185(10):101-112.

Hoffman W, Fritts TH. 1982. Sea turtle distribution along the boundary of the Gulf Stream current off eastern Florida. Herpetologica. 38(3):405-409.

Holloway-Adkins K, Provancha J. 2005. Final report: Abundance and foraging activity of marine turtles using nearshore rock resources along the mid reach of Brevard County, Florida. Cape Canaveral (FL): Dynamac Corporation.

Hopkins S, Richardson J. 1984. A recovery plan for marine turtles. Washington (DC): US Government Printing Office.

Hopkins-Murphy SR. 1992. Status and trends of the loggerhead turtle population in South Carolina. Charleston (SC): South Carolina Wildlife and Marine Resources Department.

Hopkins-Murphy SR, Hope CP, Hoyle ME. 1999. A history of research and management of the loggerhead turtle (*Caretta caretta*) on the South Carolina coast. Final report to the US Fish and Wildlife Service. Charleston (SC): South Carolina Department of Natural Resources, Division of Wildlife and Freshwater Fisheries, Wildlife Diversity Section.

Hopkins-Murphy SR, Murphy TM, Hope CP, Coker JW, Hoyle ME. 2001. Population trends and nesting distribution of the loggerhead turtle (*Caretta caretta*) in South Carolina 1980-1997. Final report to the US Fish and Wildlife Service. Charleston (SC): South Carolina Department of Natural Resources, Division of Wildlife and Freshwater Fisheries Wildlife Diversity Section.

Hopkins-Murphy SR, Owens DW, Murphy TM. 2003. Ecology of immature loggerheads on foraging grounds and adults in interesting habitats in the eastern United States. In: Bolten AB, Witherington BE, editors. Loggerhead sea turtles. Washington (DC): Smithsonian Institution Press. p. 79-92.

Houghton JDR, Doyle TK, Wilson MW, Davenport J, Hays GC. 2006. Jellyfish aggregations and leatherback turtle foraging patterns in a temperate coastal environment. Ecology. 87(8):1967-1972.

Howell EA, Hoover A, Benson SR, Bailey H, Polovina JJ, Seminoff JA, Dutton PH. 2015. Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat model for ecosystem-based management. Fish Oceanogr. 24(1):57-68.

Howell EA, Kobayashi DR, Parker DM, Balazs GH, Polovina JJ. 2008. TurtleWatch: A tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. Endangered Species Res. 5(1):267-278.

Huang H-W. 2015. Conservation hotspots for the turtles on the high seas of the Atlantic Ocean. PLOS ONE. 10(8):e0133614.

Hughes CL. 2014. Characterization of sea turtle nesting on the upper Texas coast. [Master's thesis]. Galveston (TX): Texas A&M University at Galveston.

Hughes CL, Landry AM, Jr. 2016. Long-term movements of an adult male Kemp's ridley sea turtle (*Lepidochelys kempii*) in the northwestern Gulf of Mexico. Gulf Mex Sci. 33(2):206-213.

Hussey NE, Kessel ST, Aarestrup K, Cooke SJ, Cowley PD, Fisk AT, Harcourt RG, Holland KN, Iverson SJ, Kocik JF et al. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. Science. 348(6240):1221-1231.

James MC, Davenport J, Hays GC. 2006. Expanded thermal niche for a diving vertebrate: A leatherback turtle diving into near-freezing water. J Exp Mar Biol Ecol. 335(2):221-226.

James MC, Eckert SA, Myers RA. 2005. Migratory and reproductive movements of male leatherback turtles (*Dermochelys coriacea*). Mar Biol. 147(4):845-853.

James MC, Myers RA, Ottensmeyer CA. 2005. Behaviour of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proc R Soc Lond B Biol Sci. 272(1572):1547-1555.

James MC, Ottensmeyer CA, Eckert SA, Myers RA. 2006. Changes in diel diving patterns accompany shifts between northern foraging and southward migration in leatherback turtles. Can J Zool. 84(5):754-765.

James MC, Ottensmeyer CA, Myers RA. 2005. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: New directions for conservation. Ecol Lett. 8(2):195-201.

James MC, Sherrill-Mix SA, Martin K, Myers RA. 2006. Canadian waters provide critical foraging habitat for leatherback sea turtles. Biol Conserv. 133(3):347-357.

James MC, Sherrill-Mix SA, Myers RA. 2007. Population characteristics and seasonal migrations of leatherback sea turtles at high latitudes. Mar Ecol Prog Ser. 337:245-254.

Jeffers VF, Godley BJ. 2016. Satellite tracking in sea turtles: How do we find our way to the conservation dividends? Biol Conserv. 199:172-184.

Jonsen ID, Myers RA, James MC. 2007. Identifying leatherback turtle foraging behaviour from satellite telemetry using a switching state-space model. Mar Ecol Prog Ser. 337:255-264.

Kasul RL, Dickerson DD. 1993. Feasibility of sea turtle detection in coastal waterways using acoustic methods. Draft report. Atlanta (GA): US Army Corps of Engineers, South Atlantic Region.

Keinath JA, Musick JA, Byles RA. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Va J Sci. 38(4).

Kessel ST. 2015. Location-referenced acoustic and satellite telemetry papers. Ocean Tracking Network; [accessed 2016 Feb 29]. http://dx.doi.org/10.14286/20150203/KESSEL.

Ketten DR, Bartol SM. 2006. Functional measures of sea turtle hearing. Final Report. Woods Hole (MA): Woods Hole Oceanographic Institution, Biology Department.

Kot CY, Fujioka E, DiMatteo A, Wallace BP, Hutchinson BJ, Cleary J, Halpin P, Mast RB. 2016. The state of the world’s sea turtles online database: Data provided by the SWOT team and hosted on OBIS-SEAMAP. Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University http://seamapenvdukeedu/swot.

Kraus SD, Taylor JKD, Wikgren B, Kenney RD, Mayo CM, Ganley L, Huges P, Cark CW, Rice AN. 2013. Field surveys of whales and sea turtles for offshore wind energy planning in Massachusetts. Massachusetts Clean Energy Center.

Lamont MM, Fujisaki I, Stephens BS, Hackett C. 2015. Home range and habitat use of juvenile green turtles (*Chelonia mydas*) in the northern Gulf of Mexico. Anim Biotelem. 3(1):1-12.

Lamont MM, Houser C. 2014. Spatial distribution of loggerhead turtle (*Caretta caretta*) emergences along a highly dynamic beach in the northern Gulf of Mexico. J Exp Mar Biol Ecol. 453:98-107.

Lamont MM, Putman NF, Fujisaki I, Hart KM. 2015. Spatial requirements of different life-stages of the loggerhead turtle (*Caretta caretta*) from a distinct population segment in the northern Gulf of Mexico. Herpetol Conserv Biol. 10(1):26-43.

Landry AM, Jr., D. T. Costa, Williams BB, Coyne MS. 1992. Sea turtle capture and habitat characterization study. Final report to the National Marine Fisheries Service, Southeast Fisheries Science Center, Galveston, TX. College Station (TX): Texas A&M Research Foundation.

Landry AM, Jr., D. T. Costa, Williams BB, Coyne MS. 1993. Sea turtle capture/population index and habitat characterization: Bolivar Roads and Sabine Pass, TX and Calcasieu Pass, LA. Final Report submitted to the US Army Corps of Engineers, Galveston District. Galveston (TX): US Army Corps of Engineers, Galveston District.

Lavender AL, Bartol SM, Bartol IK. 2012. A two-method approach for investigating the hearing capabilities of loggerhead sea turtles (*Caretta caretta*). In: Jones TT, Wallace BP, editors. Proceedings of thirty-first annual symposium on sea turtle biology and conservation, 10 to 16 April 2011, San Diego, California, USA NOAA Technical Memorandum NMFS-SEFSC-631. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Service Center. p. 158.

Lebuff CR, Haverfield EM. 1992. Nesting success of the loggerhead turtle (*Caretta caretta*) on Captiva Island, Florida - a nourished beach. In: Salmon M, Wyneken J, editors. Proceedings of the eleventh annual workshop on sea turtle biology and conservation 26 February - 2 March 1991, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-302. Washington (DC): National Oceanic and Atmospheric Administration. p. 69-71.

Lenhardt ML. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). In: Bjorndal KA, Bolten AB, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 238-241.

Lenhardt ML, Bellmund S, Byles RA, Harkins SW, Musick JA. 1983. Marine turtle reception of bone-conducted sound. J Aud Res. 23(2):119-125.

Lenhardt ML, Moein SE, Musick JA, Barnard D. 1994. Evaluation of the response of loggerhead sea turtles (*Caretta caretta*) to a fixed sound source. Final report submitted to the US Army Corps of Engineers, Waterways Experiment Station. TR CHL-97-31. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Lucchetti A, Pulcinella J, Angelini V, Pari S, Russo T, Cataudella S. 2016. An interaction index to predict turtle bycatch in a Mediterranean bottom trawl fishery. Ecol Indicators. 60:557-564.

Luschi P, Hays GC, Papi F. 2003. A review of long-distance movements by marine turtles, and the possible role of ocean currents. Oikos. 103(2):293-302.

Luschi P, Sale A, Mencacci R, Hughes GR, Lutjeharms JRE, Papi F. 2003. Current transport of leatherback sea turtles (*Dermochelys coriacea*) in the ocean. Proc R Soc Lond B Biol Sci. 270:S129-S132.

Lutcavage M, Musick JA. 1985. Aspects of the biology of sea turtles in Virginia. Copeia. 1985(2):449-456.

Lutcavage ME, Lutz PL. 1991. Voluntary diving metabolism and ventilation in the loggerhead sea turtle. J Exp Mar Biol Ecol. 147(2):287-296.

Lutcavage ME, Lutz PL. 1997. Diving physiology. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 277-296.

Lyn H, Coleman A, Broadway M, Klaus J, Finerty S, Shannon D, Solangi M. 2012. Displacement and site fidelity of rehabilitated immature Kemp's ridley sea turtles (*Lepidochelys kempii*). Mar Turtle Newsl. (135):10-13.

Maier PP, Segars AL, Arendt MD, Whitaker JD, Stender BW, Parker L, Vendetti R, Owens DW, Quattro J, Murphy SR. 2004. Development of an index of sea turtle abundance based upon in-water sampling with trawl gear. Final project report to the National Marine Fisheries Service National Oceanic and Atmospheric Administration. Grant Number NA07FL0499. Charleston (SC): South Carolina Department of Natural Resources Office of Fisheries Management.

Makowski C. 2006. Green turtle (*Chelonia mydas* L.) population estimate for the nearshore reefs of Broward County: A summary after three years of pre-construction monitoring. Shore Beach. 74(2).

Makowski C, Fisher L, Kruempel C, Rubin D, Spadoni R. 2008. The GTD: Creating the first GIS turtle database for juvenile green turtles in Broward County, Florida. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 170.

Makowski C, Fisher L, Kruempel C, Salmon M. 2005. “Turtle tows”: Monitoring protocol for assessing in-water effects of beach construction on sea turtle populations along nearshore reef habitats. 18th annual national conference on beach preservation technology, February 2005, Destin, Florida.

Makowski C, Fisher L, Kruempel CJ. 2006. Population estimate for the nearshore reefs of Broward County: A summary after three years of pre-construction monitoring. Shore Beach. 74(2):26-28.

Makowski C, Kruempel CJ. 2007. 2007 survey of juvenile green turtles (*Chelonia mydas*) on the nearshore reefs of Broward County: The second post-construction assessment of the Broward County shore protection project. Boca Raton (FL): Prepared for Broward County Environmental Protection Department.

Makowski C, Salmon M, Slattery R. 2005. 'Shark Fishing': A new technique to estimate the abundance and distribution of juvenile green turtles. Herpetol Rev. 36(1):36-38.

Makowski C, Seminoff JA, Salmon M. 2006. Home range and habitat use of juvenile Atlantic green turtles (*Chelonia mydas* L.) on shallow reef habitats in Palm Beach, Florida, USA. Mar Biol. 148(5):1167-1179.

Maley CG. 1995. Sea turtle strandings in Georgia in the TED era: A matter of timing. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 77-80.

Mansfield KL. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. [PhD dissertation]. Williamsburg (VA): Virginia Institute of Marine Sciences, The College of William and Mary.

Mansfield KL, Musick JA. 2003. Loggerhead sea turtle diving behavior. 2002 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2004. Sea turtle diving behavior in Virginia. 2003 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2004. Sea turtle surfacing behavior and aerial census: Has Virginia’s sea turtle population been overestimated? In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 80-81.

Mansfield KL, Musick JA. 2005. Loggerhead sea turtle diving behavior. 2004 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2006. Loggerhead sea turtle diving behavior. 2006 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Putman NF. 2013. Oceanic habits and habitats: *Caretta caretta*. In: Wyneken J, Lohmann KJ, Musick JA, editors. The biology of sea turtles, volume III. New York (NY): CRC Press. p. 189-210.

Mansfield KL, Saba VS, Keinath JA, Musick JA. 2009. Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Mar Biol. 156(12):2555-2570.

Mansfield KL, Wyneken J, Porter WP, Luo JG. 2014. First satellite tracks of neonate sea turtles redefine the 'lost years' oceanic niche. Proc R Soc Lond B Biol Sci. 281(1781):20133039.

Mansfield KL, Wyneken J, Rittschof D, Walsh M, Lim CW, Richards PM. 2012. Satellite tag attachment methods for tracking neonate sea turtles. Mar Ecol Prog Ser. 457:181-192.

Manzella SA, Williams JA. 1992. The distribution of Kemp's ridley sea turtles (*Lepidochelys kempi*) along the Texas coast: An atlas. NOAA Technical Report NMFS 110. Galveston (TX): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Galveston Laboratory.

Manzella SA, Williams JA, Caillouet CW, Jr. 1990. Radio and sonic tracking of juvenile sea turtles in inshore waters of Louisiana and Texas. In: Richardson TH, Richardson JI, Donnelly M, editors. Proceedings of the tenth annual workshop on sea turtle biology and conservation, 20 - 24 February 1990, Hilton Head Island, South Carolina NOAA Technical Memorandum NMFS-SEFC-278. Washington (DC): National Oceanic and Atmospheric Administration. p. 115-120.

Marine Turtle Specialist Group. 1996. *Lepidochelys kempii*. The IUCN Red List of Threatened Species; [accessed 2016 Feb 3]. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T11533A3292342.en.

Martin CS, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, Geffert JL, van Bochove JW, Thomas H et al. 2014. Manual of marine and coastal datasets of biodiversity importance. May 2014 release. Cambridge, United Kingdom: UNEP World Conservation Monitoring Centre.

Martin K. 2011. Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. [Master's thesis]. Tampa (FL): University of South Florida Graduate School.

Mast RB, Bailey LM, Hutchinson BJ. 2006. Burning issues in sea turtle conservation...leatherback sea turtles of the world. State of the World’s Sea Turtles report volume I. Washington (DC): State of the World’s Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2007. A global glimpse of loggerhead nesting. State of the World’s Sea Turtles report volume II. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2008. Where the hawksbills are. State of the World’s Sea Turtles report volume III. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Bailey LM. 2006. The state of the world's sea turtles (SWOT): Collaborating for conservation - the leatherback nesting beaches of the world. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 221-222.

Mast RB, Hutchinson BJ, Fernanda Perez M, Best B, Wabnitz C, Fischman D. 2009. The state of the world's sea turtles 2004. In: Demetropoulos A, Turkozan O, editors. Proceedings of the second Mediterranean conference on marine turtles, 4-7 May 2005, Kemer, Turkey. Barcelona Convention – Bern Convention – Bonn Convention; [accessed 2016 Jul 20]. http://www.seaturtle.org/documents/2nd_MedConf_Proceedings.pdf.

Mast RB, Hutchinson BJ, Villegas PE. 2015. Sea turtles of Costa Rica. State of the World’s Sea Turtles report volume X. In: Mast R, Hutchinson BJ, Villegas PE, editors. Ross (CA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Villegas PE, Wallace B, Yarnell L. 2009. Discovering the flatback: Australia's own sea turtle. State of the World’s Sea Turtles report volume IV. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Villegas PE, Wallace BP. 2014. Are we succeeding? How trends in turtle conservation are shaping the future. State of the World’s Sea Turtles report volume IX. Ross (CA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2010. Kemp's and olive ridleys: Small turtles, big secrets. State of the World’s Sea Turtles report volume V. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2011. The green turtle: The most valuable reptile in the world. State of the World’s Sea Turtles report volume VI. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Wallace BP. 2012. The world's most (and least) threatened sea turtles. State of the World’s Sea Turtles report volume VII. Arlington (VA): State of the World’s Sea Turtles.

Mast RB, Hutchinson BJ, Wallace BP. 2013. Persuasion: The case for saving sea turtles. State of the World's Sea Turtles report volume VIII. Ross (CA): State of the World's Sea Turtles.

Mazor T, Beger M, McGowan J, Possingham HP, Kark S. 2016. The value of migration information for conservation prioritization of sea turtles in the Mediterranean. Global Ecol Biogeogr. 25:540-552.

McCarthy AL, Heppell S, Royer F, Freitas C, Dellinger T. 2010. Identification of likely foraging habitat of pelagic loggerhead sea turtles (*Caretta caretta*) in the North Atlantic through analysis of telemetry track sinuosity. Prog Oceanogr. 86(1-2):224-231.

McClellan CM, Braun-McNeill J, Avens L, Wallace BP, Read AJ. 2010. Stable isotopes confirm a foraging dichotomy in juvenile loggerhead sea turtles. J Exp Mar Biol Ecol. 387(1):44-51.

McClellan CM, Read AJ. 2007. Complexity and variation in loggerhead sea turtle life history. Biol Lett. 3(6):592-594.

McClellan CM, Read AJ. 2009. Confronting the gauntlet: Understanding incidental capture of green turtles through fine-scale movement studies. Endangered Species Res. 10:165-179.

McClellan CM, Read AJ, Price BA, Cluse WM, Godfrey MH. 2009. Using telemetry to mitigate the bycatch of long-lived marine vertebrates. Ecol Appl. 19(6):1660-1671.

McMahon CR, Autret E, Houghton JDR, Lovell P, Myers AE, Hays GC. 2005. Animal-borne sensors successfully capture the real-time thermal properties of ocean basins. Limnol Oceanogr Methods. 3:392-398.

Mendez D, Cuevas E, Navarro J, Gonzalez-Garza BI, Guzman-Hernandez V. 2013. Satellite tracking of green turtle females *Chelonia mydas* and the evaluation of their home ranges in the north coast of the Yucatan Peninsula, Mexico. Rev Biol Mar Oceanogr. 48(3):497-509.

Mendonça MT. 1983. Movements and feeding ecology of immature green turtles (*Chelonia mydas*) in a Florida lagoon. Copeia. 1983(4):1013-1023.

Mendonça MT, Pritchard PCH. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempi*). Herpetologica. 42(3):373-381.

Meylan A. 1988. Spongivory in hawksbill turtles: A diet of glass. Science. 239:393-395.

Meylan A, Sadove S. 1986. Cold-stunning in Long Island Sound, New York. Mar Turtle Newsl. 37:7-8.

Meylan A, Schroeder B, Mosier A. 1995. Sea turtle nesting activity in the state of Florida 1979-1992. Florida Marine Research Publication 52. St. Petersburg (FL): Department of Environmental Protection.

Meylan AB. 1999. International movements of immature and adult hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean region. Chelonian Conserv Biol. 3(2):189-194.

Meylan AB, Witherington BE, Brost B, Rivero R, Kubilis PS. 2006. Sea turtle nesting in Florida, USA: Assessments of abundance and trends for regionally significant populations of *Caretta*, *Chelonia*, and *Dermochelys* In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 306-307.

Meylan PA, Meylan AB, Gray JA. 2011. The ecology and migrations of sea turtles 8. Tests of the developmental habitat hypothesis. Bull Am Mus Nat Hist. 357:1-70.

Michel J, Dunagan H, Boring C, Healy E, Evans W, Dean JM, McGillis A, Hain J. 2007. Worldwide synthesis and analysis of existing information regarding environmental effects of alternative energy uses on the outer continental shelf. MMS OCS Report 2007-038. Herndon (VA): Minerals Management Service.

Milton SL, Lutz PL. 2003. Physiological and genetic responses to environmental stress. In: Lutz PL, Musick JA, Wyneken J, editors. The biology of sea turtles, volume II. Boca Raton (FL): CRC Press. p. 163–197.

MMS. 2008. Cape Wind energy project, Nantucket Sound: Biological assessment. Herndon (VA): Minerals Management Service.

Moein SE. 1994. Auditory-evoked potentials of the loggerhead sea turtle (*Caretta caretta*). [Master's thesis]. Gloucester Point (VA): College of William and Mary, Virginia Institute of Marine Science.

Moein SE, Lenhardt ML, Barnard DE, Keinath JA, Musick JA. 1993. Marine turtle auditory behavior. J Acoust Soc Am. 93(4):2378-2378.

Moein SE, Musick JA, Keinath JA, Barnard DE, Lenhardt M, George R. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final report submitted to the US Army Corps of Engineers Waterways Experiment Station. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Morreale SJ, Meylan AB, Sadove SS, Standora EA. 1992. Annual occurrence and winter mortality of marine turtles in New York waters. J Herpetol. 26(3):301-308.

Morreale SJ, Standora EA. 1989. Occurrence, movement and behavior of the Kemp's ridley and other sea turtles in New York waters. Riverhead (NY): Annual Report to Okeanos Ocean Research Foundation and Return a Gift to Wildlife Program, April 1991 - April 1992.

Morreale SJ, Standora EA. 2005. Western North Atlantic waters: Crucial developmental habitat for Kemp's ridley and loggerhead sea turtles. Chelonian Conserv Biol. 4(4):872-882.

Morreale SJ, Standora EA, Spotila JR, Paladino FV. 1996. Migration corridor for sea turtles. Nature. 384(6607):319-320.

Moustahfid H, Grimes CB, Kocik J, Block BA, Holland KN, Payne J, Fox DA, Seitz AC, Alexander CE. 2011. Toward a national animal telemetry observing network (ATN) for our oceans, coasts, and Great Lakes: Workshop synthesis report US IOOS workshop, March 2011, Santa Cruz, California). NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-482. La Jolla (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Murphy TM. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, US. Final report to the National Marine Fisheries Service. Green Pond (SC): LaMER, Inc.

Murphy TM, Murphy SR, Griffin DB, Hope CP. 2006. Recent occurrence, spatial distribution, and temporal variability of leatherback turtles (*Dermochelys coriacea*) in nearshore waters of South Carolina, USA. Chelonian Conserv Biol. 5(2):216-224.

Musick JA. 1988. The sea turtles of Virginia with notes on identification and natural history. Virginia Institute of Marine Science, Educational Series 24. Gloucester Point (VA): Virginia Institute of Marine Science.

Musick JA, Limpus CJ. 1997. Habitat utilization and migration in juvenile sea turtles. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 137-163.

Myers AE, Hays GC. 2006. Do leatherback turtles *Dermochelys coriacea* forage during the breeding season? A combination of data-logging devices provide new insights. Mar Ecol Prog Ser. 322:259-267.

Mysing JO, Vanselous TM. 1989. Status of satellite tracking of Kemp's ridley sea turtles. In: Caillouet CW, Jr., Landry AM, editors. Proceedings of the first international symposium on Kemp's ridley sea turtle biology, October 1 - 4, 1985, Galveston, Texas TAMU-SG-89-105. Galveston (TX): National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory and Texas A&M University at Galveston. p. 112-115.

[NPS] National Park Service. 2006. NPS Buck Island Reef National Monument Sea Turtle Research Program seasonal report 2006. Unpublished report. St. Croix, US Virgin Islands: National Park Service, Buck Island Reef National Monument, Division of Resource Management.

National Research Council. 2010. Assessment of sea-turtle status and trends: Integrating demography and abundance. Washington (DC): National Academies Press.

[NEFSC, SEFSC] Northeast Fisheries Science Center, Southeast Fisheries Science Center. 2010. 2010 annual report to the inter-agency agreement M10PG00075/0001: A comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

NEFSC, SEFSC. 2011. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (*Caretta caretta*) in northwestern Atlantic Ocean continental shelf waters. Reference Document 11-03. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

NEFSC, SEFSC. 2012. Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

Nelson DA. 1988. Life history and environmental requirements of loggerhead turtles. US Fish and Wildlife Service Biological Report 88(23). US Army Corps of Engineers Technical Report EL-86-2(Rev.). Washington (DC): US Fish and Wildlife Service.

Nelson DA. 1996. Subadult loggerhead sea turtle (*Caretta caretta*) behavior in St. Marys entrance channel, Georgia, USA. [PhD dissertation]. Gloucester Point (VA): School of Marine Science, College of William and Mary/Virginia Institute of Marine Science.

Nelson DA, Dickerson DD, Richardson J, Reine K. 1991. Sea turtle trawling survey associated with hopper dredging at Brunswick, GA. Unpublished report. Vicksburg (MS): US Army Corps of Engineers Waterways Experiment Station.

Nelson WR, Benigno J, Burkett S. 1987. Behavioral patterns of loggerhead sea turtles, *Caretta caretta* in the Cape Canaveral area as determined by radio monitoring and acoustic tracking. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 31.

NMFS. 1979. Determination of critical habitat for the leatherback sea turtle. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 44:17710-17712.

NMFS. 1998. Designated critical habitat; Green and hawksbill sea turtles. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 63:46693-46701.

NMFS. 2010. Sea turtle stranding and salvage network online stranding reports. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; [accessed 2016 Feb 25]. http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp.

NMFS. 2014. Endangered and threatened species: Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. National Oceanic and Atmospheric Administration National Marine Fisheries Service final rule. Federal Register. 79(132):39856-39912.

NMFS. 2014. Loggerhead sea turtle critical habitat in the Northwest Atlantic Ocean GIS files. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; [accessed 2016 Apr 22]. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm.

NMFS, FWS. 1991. Recovery plan for US population of Atlantic green turtle (*Chelonia mydas*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1991. Recovery plan for US populations of loggerhead turtle (*Caretta caretta*). Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1992. Recovery plan for leatherback turtles *Dermochelys coriacea* in the US Caribbean, Atlantic and Gulf of Mexico. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 1993. Recovery plan for hawksbill turtles in the US Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. St. Petersburg (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2007. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2007. Loggerhead sea turtle (*Caretta caretta*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2010. Final review: Endangered and threatened species; determination of nine distinct population segments of loggerhead sea turtles as endangered or threatened. 50 CFR Part 17, 223, and 224. Washington (DC): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013. Hawksbill sea turtle (*Eretmochlys imbricata*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2013. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: Summary and evaluation. Silver Spring (MD) and Jacksonville (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2015. Kemp's ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation. Silver Spring (MD) and Albuquerque (NM): National Oceanic and Atmospheric Administration, National Marine Fisheries Service and US Fish and Wildlife Service.

NMFS, FWS. 2016. Endangered and threatened wildlife and plants; Final rule to list eleven distinct population segments of the green sea turtle (*Chelonia mydas*) as endangered or threatened and revision of current listings under the Endangered Species Act. National Oceanic and Atmospheric Administration National Marine Fisheries Service and US Fish and Wildlife Service final rule. Federal Register. 81(66):20058-20090.

NMFS, FWS, SEMARNAT. 2011. Bi-national recovery plan for the Kemp’s ridley sea turtle (*Lepidochelys kempii*), second revision. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, US Fish and Wildlife Service, and the Secretary of Environment and Natural Resources, Mexico.

Ogden JC, Robinson L, Whitlock K, Daganhardt H, Cebula R. 1983. Diel foraging patterns in juvenile green turtles (*Chelonia mydas* L.) in St. Croix United States Virgin Islands. J Exp Mar Biol Ecol. 66(3):199-205.

Ogren L, McVea C. 1982. Apparent hibernation by sea turtles in North American waters. In: Bjorndal KA, editor. Biology and conservation of Florida turtles Proceedings of the world conference on sea turtle conservation, 26 - 30 November 1979. Washington (DC): Smithsonian Institute Press.

Ogren LH. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: Preliminary results from the 1984-1987 surveys. In: Caillouet CW, Jr., Landry AM, editors. Proceedings of the first international symposium on Kemp's ridley sea turtle biology, October 1 - 4, 1985, Galveston, Texas TAMU-SG-89-105. Galveston (TX): National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory and Texas A&M University at Galveston. p. 116-123.

O'Hara J, Wilcox JR. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia. 1990(2):564-567.

Pajuelo M, Bjorndal KA, Reich KJ, Arendt MD, Bolten AB. 2012. Distribution of foraging habitats of male loggerhead turtles (*Caretta caretta*) as revealed by stable isotopes and satellite telemetry. Mar Biol. 159(6):1255-1267.

Pallin LJ, Adams EM, Goyert HF, Friedlaender AS, Johnston DW. 2015. Chapter 12: Density modeling for marine mammals and sea turtles with environmental covariates. In: Williams KA, Connelly EE, Johnson SM, Stenhouse IJ, editors. Baseline wildlife studies in Atlantic waters offshore of Maryland: Final report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015 Report BRI 2015-17. Portland (ME): Biodiversity Research Institute. p. 1-39.

Patel SH, Morreale SJ, Panagopoulou A, Bailey H, Robinson NJ, Paladino FV, Margaritoulis D, Spotila JR. 2015. Changepoint analysis: A new approach for revealing animal movements and behaviors from satellite telemetry data. Ecosphere. 6(12):13.

Paul EU. 2010. Laboratory experiments and hydrodynamic modeling of a bed leveler used to level the bottom of ship channels after dredging. [Master's thesis]. College Station (TX): Texas A&M University.

Phillips KF, Mansfield KL, Die DJ, Addison DS. 2014. Survival and remigration probabilities for loggerhead turtles (*Caretta caretta*) nesting in the eastern Gulf of Mexico. Mar Biol. 161(4):863-870.

Plotkin P. 2003. Adult migrations and habitat use. In: Lutz PL, Musick JA, Wyneken J, editors. The biology of sea turtles, volume II. Baton Rouge (LA): CRC Press. p. 225-241.

Plotkin PT. 1995. National Marine Fisheries Service and US Fish and Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Plotkin PT, Spotila JR. 2002. Post-nesting migrations of loggerhead turtles *Caretta caretta* from Georgia, USA: Conservation implications for a genetically distinct subpopulation. Oryx. 36(04):396-399.

Plotkin PT, Wicksten MK, Amos AF. 1993. Feeding ecology of the loggerhead sea turtle *Caretta caretta* in the Northwestern Gulf of Mexico. Mar Biol. 115(1):1-5.

Polovina JJ, Balazs GH, Howell EA, Parker DM, Seki MP, Dutton PH. 2004. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. Fish Oceanogr. 13(1):36-51.

Polovina JJ, Kobayashi DR, Parker DM, Seki MP, Balazs GH. 2000. Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997-1998. Fish Oceanogr. 9(1):71-82.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB et al. 2014. Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Cham, Switzerland: Springer and ASA Press.

Prekel S, Hannes A, Barrett C, Ward G, Floyd L, Santos R, Reger C. 2008. 18-month post-construction nearshore environmental monitoring summary report. Prepared for Broward County. Boca Raton (FL): Coastal Planning & Engineering, Inc.

Price JT. 2016. Characterization of the juvenile green turtle (*Chelonia mydas*) microbiome associated with the ontogenic shift from pelagic habitats to inshore resident areas. [Master's thesis]. Fort Wayne (IN): Purdue University.

Putman NF, Mansfield KL. 2015. Direct evidence of swimming demonstrates active dispersal in the sea turtle "lost years’’. Curr Biol. 25(9):1221-1227.

Putman NF, Mansfield KL, He RY, Shaver DJ, Verley P. 2013. Predicting the distribution of oceanic-stage Kemp's ridley sea turtles. Biol Lett. 9(5).

Rabon DR, Jr., Johnson SA, Boettcher R, Dodd M, Lyons M, Murphy S, Ramsey S, Roff S, Stewart K. 2003. Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida. Mar Turtle Newsl. 101:4-8.

Ragland JM, Arendt MD, Kucklick JR, Keller JM. 2011. Persistent organic pollutants in blood plasma of satellite-tracked adult male loggerhead sea turtles (*Caretta caretta*). Environ Toxicol Chem. 30(7):1549-1556.

Raposa KJV, Frankel AS, Sisson G, Ellison WT, Damon C. 2007. Marine wildlife behavior database for estimating environmental impacts. J Acoust Soc Am. 122(5):3059.

Reina RD, Abernathy KJ, Marshall GJ, Spotila JR. 2005. Respiratory frequency, dive behaviour and social interactions of leatherback turtles, *Dermochelys coriacea* during the inter-nesting interval. J Exp Mar Biol Ecol. 316(1):1-16.

Renaud M, Carpenter JA, Manzella S, Williams J. 1994. Radio and sonic telemetric monitoring of immature green sea turtles in the Brazos-Santiago Pass area, South Padre Island, Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 148.

Renaud ML. 1994. Satellite tracking of juvenile Kemp's ridley sea turtles near Sabine Pass, Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 147.

Renaud ML. 1995. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). J Herpetol. 29(3):370-374.

Renaud ML. 1995. Radio and sonic tracking of green and loggerhead sea turtles at South Padre Island, Texas. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 96.

Renaud ML, Carpenter JA. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bull Mar Sci. 55(1):1-15.

Renaud ML, Carpenter JA, Manzella SA, Williams JA. 1992. Telemetric tracking of green sea turtles (*Chelonia mydas*) in relation to dredged channels at South Padre Island, Texas July through September 1992. Galveston (TX): Southeast Fisheries Center, National Marine Fisheries Service, Galveston Laboratory.

Renaud ML, Carpenter JA, Williams JA, Landry AM. 1996. Kemp's ridley sea turtle (*Lepidochelys kempii*) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conserv Biol. 2:108-109.

Renaud ML, Carpenter JA, Williams JA, Manzella SA. 1994. Telemetric tracking of Kemp's ridley sea turtles (*Lepidochelys kempii*) in relation to dredged channels at Bolivar Roads Pass and Sabine Pass, TX and Calcasieu Pass, LA, May 1993 through February 1994. Final report submitted to US Army Corps of Engineers, Galveston, TX and New Orleans, LA District.

Renaud ML, Carpenter JA, Williams JA, Manzella-Tirpak SA. 1995. Activities of juvenile green turtles, *Chelonia mydas*, at a jettied pass in South Texas. Fish Bull. 93:586-593.

Renaud ML, Williams JA. 1997. Movements of Kemp's ridley (*Lepidochelys kempii*) and green (*Chelonia mydas*) sea turtles using Lavaca Bay and Matagorda Bay 1996-1997. Final report submitted to the Environmental Protection Agency Office of Planning and Coordination, Region 6. Galveston (TX): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Renaud ML, Williams JA. 2005. Kemp’s ridley sea turtle movements and migrations. Chelonian Conserv Biol. 4(4):808-816.

Ridgway SH, Wever EG, McCormick JG, Palin J, Anderson JH. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences. 64(3):884-890.

Roberts K, Collins J, Paxton CH, Hardy R, Downs J. 2014. Weather patterns associated with green turtle hypothermic stunning events in St. Joseph Bay and Mosquito Lagoon, Florida. Phys Geogr. 35(2):134-150.

Rosman I, Boland GS, Martin L, Chandler C. 1987. Underwater sightings of sea turtles in the northern Gulf of Mexico. OCS Study MMS 87-0107. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Ryder TS, Standora E, Eberle M, Edbauer J, Williams K, Morreale S, Bolten A. 1994. Daily movements of adult male and juvenile loggerhead turtles (*Caretta caretta*) at Cape Canaveral, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 131.

Saba VS. 2013. Oceanic habits and habitats: *Dermochelys coriacea*. In: Wyneken J, Lohmann KJ, Musick JA, editors. The biology of sea turtles, volume III. New York (NY): CRC Press. p. 163-188.

Saba VS, Spotila JR, Chavez FP, Musick JA. 2008. Bottom-up and climatic forcing on the worldwide population of leatherback turtles. Ecology. 89(5):1414-1427.

Samuel Y, Morreale SJ, Clark CW, Greene CH, Richmond ME. 2005. Underwater, low-frequency noise in a coastal sea turtle habitat. J Acoust Soc Am. 117:1465-1472.

Sargent S. 2015. Marine spatial planning biological data analysis in the northeast and Mid-Atlantic regions: Gap analysis and fitness for marine spatial planning applications. [Master's thesis]. Durham (NC): Duke University.

Sasso CR, Epperly SP. 2007. Survival of pelagic juvenile loggerhead turtles in the open ocean. J Wildl Manage. 71(6):1830-1835.

Sasso CR, Epperly SP, Johnson C. 2011. Annual survival of loggerhead sea turtles (*Caretta caretta)* nesting in peninsular Florida: a cause for concern. Herpetol Conserv Biol. 6(3):443-448.

Schmid JR. 1995. Marine turtle populations on the east-central coast of Florida: Results of tagging studies at Cape Canaveral, Florida, 1986-1991. Fish Bull. 93(1):139-151.

Schmid JR. 1998. Marine turtle populations on the west-central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fish Bull. 96(3):589-602.

Schmid JR, Bolten AB, Bjorndal KA, Lindberg WJ. 2002. Activity patterns of Kemp's ridley turtles, *Lepidochelys kempii*, in the coastal waters of the Cedar Keys, Florida. Mar Biol. 140(2):215-228.

Schmid JR, Bolten AB, Bjorndal KA, Lindberg WJ, Percival HF, Zwick PD. 2003. Home range and habitat use by Kemp's ridley turtles in west-central Florida. J Wildl Manage. 67(1):196-206.

Schmid JR, Witzell WN. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempi*): Cumulative results of tagging studies in Florida. Chelonian Conserv Biol. 2(4):532-537.

Schofield G, Hobson V, Lilley M, Kastelidis K, Bishop C, Brown P. 2010. Inter-annual variability in the home range of breeding turtles: Implications for current and future conservation management. Biol Conserv. 143:722-730.

Schofield G, Katselidis KA, Dimopoulos P, Pantis JD, Hays GC. 2006. Behaviour analysis of the loggerhead sea turtle *Caretta caretta* from direct in-water observation. Endangered Species Res. 2:71-79.

Schroeder BA, Foley AM, Bagley DA. 2003. Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. In: Bolten AB, Witherington BE, editors. Loggerhead sea turtles. Washington (DC): Smithsonian Institution. p. 114-124.

Schroeder BA, Maley CA. 1989. 1988 fall/winter strandings of marine turtles along the northeast Florida and Georgia coasts. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 159-162.

Schroeder BA, Thompson NB. 1987. Distribution of the loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*, in the Cape Canaveral, Florida area: Results of aerial surveys. NOAA Technical Report National Marine Fisheries Service. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 45-53.

Schwartz FJ. 1978. Behavioral and tolerance responses to cold water temperatures by three species of sea turtles (Reptilia, Cheloniidae) in North Carolina. Fla Mar Res Publ. 33:16-18.

Scott R, Hodgson DJ, Witt MJ, Coyne MS, Adnyana W, Blumenthal JM, Broderick AC, Canbolat AF, Catry P, Ciccione S. 2012. Global analysis of satellite tracking data shows that adult green turtles are significantly aggregated in marine protected areas. Global Ecol Biogeogr. 21(11):1053-1061.

Scott-Hayward LAS, Borchers DL, Burt ML. 2014. Use of zero and one-inflated beta regression to model availability of loggerhead turtles off the east coast of the United States. Draft Report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Order 40, issued to HDR Inc., Norfolk, Virginia. St. Andrews, Scotland: University of St. Andrews, Center for Research into Ecological and Environmental Modelling.

Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Haas HL, Hargrove SA, Jensen MP, Klemm DL, Lauritsen AM et al. 2015. Status review of the green turtle (*Chelonia mydas*) under the US Endangered Species Act. NOAA Technical Memorandum NOAA-NMFS-SWFSC-539. La Jolla (CA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Seminoff JA, Zarate P, Coyne M, Foley DG, Parker D, Lyon BN, Dutton PH. 2008. Post-nesting migrations of Galapagos green turtles *Chelonia mydas* in relation to oceanographic conditions: Integrating satellite telemetry with remotely sensed ocean data. Endangered Species Res. 4(1-2):57-72.

Seney EE, Landry AM, Jr. 2008. Movements of Kemp's ridley sea turtles nesting on the upper Texas coast: Implications for management. Endangered Species Res. 4(1-2):73-84.

Seney EE, Landry AM, Jr. 2011. Movement patterns of immature and adult female Kemp's ridley sea turtles in the northwestern Gulf of Mexico. Mar Ecol Prog Ser. 440:241-254.

Seney EE, Landry AM, Jr., Higgins BM, Flanagan JP, Kethan SL. 2006. Movements of immature and post-nesting Kemp's ridley sea turtles in the northwestern Gulf of Mexico. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 112-113.

Servis JA, Lovewell G, Tucker AD. 2015. Diet analysis of subadult Kemp's ridley (*Lepidochelys kempii*) turtles from west-central Florida. Chelonian Conserv Biol. 14(2):173-181.

Shamblin BM, Dodd MG, Bagley DA, Ehrhart LM, Tucker AD, Johnson C, Carthy RR, Scarpino RA, McMichael E, Addison DS et al. 2011. Genetic structure of the southeastern United States loggerhead turtle nesting aggregation: evidence of additional structure within the peninsular Florida recovery unit. Mar Biol. 158(3):571-587.

Shaver DJ. 1990. Hypothermic stunning of sea turtles in Texas. Mar Turtle Newsl. 48:25-27.

Shaver DJ. 1991. Feeding ecology of wild and head-started Kemp's ridley sea turtles in south Texas waters. J Herpetol. 25(3):327-334.

Shaver DJ. 1994. Relative abundance, temporal patterns, and growth of sea turtles at Mansfield Channel, Texas. J Herpetol. 28(4):491-497.

Shaver DJ. 2005. Analysis of the Kemp's ridley imprinting and headstart project at Padre Island National Seashore, Texas, 1978-88, with subsequent nesting and stranding records on the Texas coast. 4(4):846-859.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain AR, Pena J, Burchfield PM, Gomez Gamez D, Ortiz J. 2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecol Evol. 3(7):2002-2012.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain-Iverson AR. 2013. Movement mysteries unveiled: Spatial ecology of juvenile green sea turtles. In: Lutterschmidt WI, editor. Reptiles in research: Investigations of ecology, physiology, and behavior from desert to sea. Hauppauge (NY): Nova Science Publishers, Inc. p. 463-484.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain-Iverson AR, Peña J, Gomez Gamez D, de Jesus Gonzales Diaz Miron R, Burchfield PM, Martinez HJ et al. 2016. Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. Biol Conserv. 194:158-167.

Shaver DJ, Rubio C. 2008. Post-nesting movement of wild and head-started Kemp's ridley sea turtles *Lepidochelys kempii* in the Gulf of Mexico. Endangered Species Res. 4:43-55.

Shaver DJ, Schroeder BA, Byles RA, Burchfield PM, Pena J, Marquez R, Martinez HJ. 2005. Movements and home ranges of adult male Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico investigated by satellite telemetry. Chelonian Conserv Biol. 4(4):817-827.

Sherrill-Mix SA, James MC, Myers RA. 2008. Migration cues and timing in leatherback sea turtles. Behav Ecol. 19(2):231-236.

Shillinger GL, Palacios DM, Bailey H, Bograd SJ, Swithenbank AM, Gaspar P, Wallace BP, Spotila JR, Paladino FV, Piedra R et al. 2008. Persistent leatherback turtle migrations present opportunities for conservation. PLoS Biol. 6(7):1408-1416.

Shillinger GL, Swithenbank AM, Bailey H, Bograd SJ, Castelton MR, Wallace BP, Spotila JR, Paladino FV, Piedra R, Block BA. 2011. Vertical and horizontal habitat preferences of post-nesting leatherback turtles in the South Pacific Ocean. Mar Ecol Prog Ser. 422:275-289.

Shoop CR, Ruckdeschel CA, Thompson NB. 1985. Sea turtles in the Southeast United States: Nesting activity as derived from aerial and ground surveys, 1982. Herpetologica. 41(3):252-259.

Slay CK. 1991. Endangered species observer program, Brunswick Ship Channel, April 1 - June 19, 1991. Savannah (GA): US Army Corps of Engineers, Planning Division, Environmental, Savannah District.

Smolowitz RJ, Patel SH, Haas HL, Miller SA. 2015. Using a remotely operated vehicle (ROV) to observe loggerhead sea turtle (*Caretta caretta*) behavior on foraging grounds off the Mid-Atlantic United States. J Exp Mar Biol Ecol. 471:84-91.

Snover ML. 2002. Growth and ontogeny of sea turtles using skeletochronology: Methods, validation and application to conservation. [PhD dissertation]. Durham (NC): Duke University.

Spotila JR, O'Connor MP, Paladino FV. 1997. Thermal biology. In: Lutz PL, Musick JA, editors. The biology of sea turtles, volume I. Boca Raton (FL): CRC Press. p. 297–314.

Stadler M, Salmon M, Roberts C. 2014. Ecological correlates of green turtle (*Chelonia mydas*) abundance on the nearshore worm reefs of southeastern Florida. J Coast Res. 31(2):244-254.

Stancyk SE, Talbert OR, Miller AB. 1979. Estimation of loggerhead turtle nesting activity in South Carolina by aerial surveys. Am Zool. 19(3):954-954.

Standora E, Ryder M, Edbauer J, Williams K, Morreale S, Bolten A. 1994. Homing behavior of loggerhead turtles relocated from dredging areas in Cape Canaveral Channel, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 141-142.

Standora EA, Eberle MD, Edbauer JM, Morreale SJ, Bolten AB. 1993. Assessment of baseline behavior and trawling efficiency in Canaveral Channel, Florida. Final contract report to US Army Engineer Waterways Experiment Station, Buffalo State College, Buffalo, NY. Hampton Bays (NY) and Gainesville (FL): Okeanos Ocean Research Foundation, Inc. and University of Florida, Gainesville.

Standora EA, Eberle MD, Edbauer JM, Ryder TS, Williams KL, Morreale SJ, Bolten AB. 1993. Diving behavior, daily movements, and homing of loggerhead turtles (*Caretta caretta*) at Cape Canaveral, Florida, March and April 1993. Final contract report to US Army Engineer Waterways Experiment Station, Buffalo State College, Buffalo, NY. Hampton Bays (NY) and Gainesville (FL): Okeanos Ocean Research Foundation, Inc., and University of Florida, Gainesville.

Standora EA, Morreale SJ, Bolten AB, Eberle MD, Edbauer JM, Ryder TS, Williams KL. 1994. Diving behavior and vertical distribution of loggerheads, and a preliminary assessment of trawling efficiency for censusing. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 174.

Standora EA, Spotila JR, Foley RE. 1979. Telemetry of movement and body temperature data from green turtles, *Chelonia mydas*, at Tortuguero, Costa Rica. Am Zool. 19:981.

Stewart K, Johnson C. 2006. The turtles of Florida: *Dermochelys coriacea* - Leatherback sea turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 144-157.

Stewart KR, James MC, Roden S, Dutton PH. 2013. Assignment tests, telemetry and tag-recapture data converge to identify natal origins of leatherback turtles foraging in Atlantic Canadian waters. J Anim Ecol. 82(4):791-803.

Still BM, Griffin CR, Prescott R. 2005. Climatic and oceanographic factors affecting daily patterns of juvenile sea turtle cold-stunning in Cape Cod Bay, Massachusetts. Chelonian Conserv Biol. 4(4):883-890.

Stimmelmayr R, Latchman V, Sullivan M. 2010. In-water observations of hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles in St. Kitts, Lesser Antilles. Mar Turtle Newsl. 127:17-19.

Stoneburner DL. 1982. Satellite telemetry of loggerhead sea turtle movement in the Georgia Bight. Copeia. 1982(2):400-408.

Studt JF. 1987. Amelioration of maintenance dredging impacts on sea turtles, Canaveral Harbor, Florida. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida, Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 55-58.

Talbert OR, Stancyk SE, Dean JM, Will JM. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina.1. A rookery in transition. Copeia. 1980(4):709-718.

Teas WG. 1993. Species composition and size class distribution of marine turtle strandings on the Gulf of Mexico and southeast United States coasts, 1985-1991. NOAA Technical Memorandum NMFS-SEFSC-315. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Thompson NB, Huang H. 1993. Leatherback turtles in southeast US waters. NOAA Technical Memorandum NMFS-SEFSC-318. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Thompson NB, Marquez RM. 1991. Insights into the distribution and migratory movements of the Kemp's ridley sea turtle. Unpublished report. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Timko RE, Kolz AL. 1982. Satellite sea turtle tracking. Mar Fish Rev. 44:19-24.

Tucker AD. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. J Exp Mar Biol Ecol. 383(1):48-55.

Tucker AD. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. J Exp Mar Biol Ecol. 383(1):48-55.

Tucker AD, MacDonald BD, Seminoff JA. 2014. Foraging site fidelity and stable isotope values of loggerhead turtles tracked in the Gulf of Mexico and northwest Caribbean. Mar Ecol Prog Ser. 502:267-279.

Tucker AD, MacDonald BD, Seminoff JA. 2014. Foraging site fidelity and stable isotope values of loggerhead turtles tracked in the Gulf of Mexico and northwest Caribbean. Mar Ecol Prog Ser. 502:267-279.

Tucker and Associates, Inc. 1990. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1-3, 1989. OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Tucker T, Welsh R, Mazzarella K, Beggs J, Clark P. 2009. Sea turtle monitoring, nest evaluation, and protection measures for Longboat Key 2008. Report submitted to: Town of Longboat Key Public Works Department. Mote Marine Laboratory Technical Report No. 1310. Sarasota (FL): Mote Marine Laboratory.

Tunnell JW, Jr., Hilbun NL, Withers K. 2002. Comprehensive bibliography of the Laguna Madre of Texas and Tamaulipas. Prepared for the Nature Conservancy of Texas. TAMU-CC-0202-CCS. Corpus Christi (TX): Center for Coastal Studies, Texas A&M University – Corpus Christi.

Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley sea turtle (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Turtle Expert Working Group. 2007. An assessment of the leatherback turtle population in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-555. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Ultsch GR. 2006. The ecology of overwintering among turtles: Where turtles overwinter and its consequences. Biol Rev. 81(03):339-367.

van Dam RP, Diez CE. 1998. Home range of immature hawksbill turtles *Eretmochelys imbricata* (Linnaeus) at two Caribbean islands. J Exp Mar Biol Ecol. 220(1):15-24.

Van Dolah RF, Maier PP. 1993. The distribution of loggerhead turtles (*Caretta caretta*) in the entrance channel of Charleston Harbor, South Carolina, USA. J Coast Res. 9(4):1004-1012.

Vander Zanden HB, Bolten AB, Tucker AD, Hart KM, Lamont MM, Fujisaki I, Reich KJ, Addison DS, Mansfield KL, Phillips KF. 2016. Biomarkers reveal sea turtles remained in oiled areas following the Deepwater Horizon oil spill. Ecol Appl. 26(7):2145-2155.

Vander Zanden HB, Tucker AD, Hart KM, Lamont MM, Fujisaki I, Addison DS, Mansfield KL, Phillips KF, Wunder MB, Bowen GJ et al. 2015. Determining origin in a migratory marine vertebrate: A novel method to integrate stable isotopes and satellite tracking. Ecol Appl. 25(2):320-335.

Vicente VP. 1994. Spongivory in Caribbean hawksbill turtles, *Eretmochelys imbricata*: Data from stranded specimens. In: Schroeder BA, Witherington BE, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 185–188.

Villegas PE. 2012. A preliminary evaluation of the State of the World's Sea Turtles (SWOT) Program. [Master's Project]. Durham (NC): Duke University.

Wallace BP, Heppell SS, Lewison RL, Kelez S, Crowder LB. 2008. Impacts of fisheries bycatch on loggerhead turtles worldwide inferred from reproductive value analyses. J Appl Ecol. 45(4):1076-1085.

Weatherdon LV, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, van Geffert JL, Bochove JW, Thomas H et al. 2015. Manual of marine and coastal datasets of biodiversity importance. December 2015 edition. Cambridge, United Kingdom UNEP World Conservation Monitoring Centre.

Weber MJ. 1990. Human activities and sea turtle conservation in the Gulf of Mexico. In: Tucker and Associates, Inc, editor. Sea turtles and marine mammals of the Gulf of Mexico: Proceedings of a workshop held in New Orleans, August 1 - 3, 1989 OCS Study MMS 90-009. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region. p. 23-38.

Weishampel JF, Bagley DA, Ehrhart LM, Rodenbeck BL. 2003. Spatiotemporal patterns of annual sea turtle nesting behaviors along an East Central Florida beach. Biol Conserv. 110(2):295-303.

Whittock PA, Pendoley KL, Larsen R, Hamann M. 2017. Effects of a dredging operation on the movement and dive behaviour of marine turtles during breeding. Biol Conserv. 206:190-200.

Williams JA, Manzella SA, Tidwell J. 1994. Radio and sonic tracking of sea turtles in south Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 266-268.

Williams JA, Renaud ML. 1998. Tracking of Kemp's ridley (*Lepidochelys kempii*) and green (*Chelonia mydas*) sea turtles in the Matagorda Bay System, Texas. In: Epperly SP, Braun J, editors. Proceedings of the seventeenth annual sea turtle symposium, 4 - 8 March 1997, Orlando, Florida, USA NOAA Technical Memorandum NMFS-SEFSC-415. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 302-305.

Williams NC, Bjorndal KA, Lamont MM, Carthy RR. 2014. Winter diets of immature green turtles (*Chelonia mydas*) on a northern feeding ground: Integrating stomach contents and stable isotope analyses. Estuar Coasts. 37.

Witham R. 1990. A case report on beach erosion, beach nourishment and sea turtle nesting. In: Richardson TH, Richardson JI, Donnelly M, editors. Proceedings of the tenth annual workshop on sea turtle biology and conservation, 20 - 24 February 1990, Hilton Head Island, South Carolina NOAA Technical Memorandum NMFS-SEFC-278. Washington (DC): National Oceanic and Atmospheric Administration. p. 157-160.

Witherington B, Bresette M, Herren R. 2006. *Caretta caretta* - Loggerhead sea turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 74-89.

Witherington B, Bresette M, Herren R. 2006. *Chelonia mydas* - Green turtle. In: Meylan PA, editor. Biology and conservation of Florida turtles Chelonian research monographs number 3. Lunenburg (MA): Chelonian Research Foundation. p. 90-104.

Witherington B, Kullis P, Brost B, Meylan A. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecol Appl. 19(1):30-54.

Witherington BE. 1997. Ecology of neonate loggerhead turtles inhabiting pelagic fronts near the Florida current. Interim report to the National Marine Fisheries Service for FO602-96-11. Taquesta (FL): Department of Environmental Protection Florida Marine Research Institute.

Witherington BE. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. Mar Biol. 140:843-583.

Witherington BE, Ehrhart LM. 1989. Hypothermic stunning and mortality of marine turtles in the Indian River Lagoon System, Florida. Copeia.696-703.

Witt MJ, Bonguno EA, Broderick AC, Coyne MS, Formia A, Gibudi A, Mounguengui Mounguengui GA, Moussounda C, Nsafou M, Nougessono S et al. 2011. Tracking leatherback turtles from the world's largest rookery: Assessing threats across the South Atlantic. Proc R Soc Lond B Biol Sci. 278(1716):2338-2347.

Witt MJ, Broderick AC, Johns DJ, Martin C, Penrose R, Hoogmoed MS, Godley BJ. 2007. Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. Mar Ecol Prog Ser. 337:231-243.

Witzell WN. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis 137. Rome, Italy: Food and Agriculture Organization of the United Nations.

Witzell WN. 1987. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26-27, 1985. NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Witzell WN. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): Suggested changes to the life history model. Herpetol Rev. 33(4):266-268.

Witzell WN, Schmid JR. 2005. Diet of immature Kemp's ridley turtles (*Lepidochelys kempi*) from Gullivan Bay, Ten Thousand Islands, southwest Florida. Bull Mar Sci. 77(2):191-200.

Worth DF, Smith JB. 1976. Marine turtle nesting on Hutchinson Island, Florida, in 1973. Florida Marine Research Publications Number 18. St. Petersburg (FL): Florida Department of Natural Resources, Marine Research Laboratory.

Wyneken J, Lohmann KJ, Musick JA. 2013. The biology of sea turtles, Volume III. Boca Raton (FL): CRC Press.

Yudhana A, Din J, Sunardi, Abdullah S, Hassan RBR. 2010. Green turtle hearing identification based on frequency spectral analysis. Applied Physics Research. 2(1):125-134.

A.5 Sea Turtle Telemetry Datasets (232)

Addison DS, Gore JA, Ryder J, Worley K. 2002. Tracking post-nesting movements of loggerhead turtles (*Caretta caretta*) with sonic and radio telemetry on the southwest coast of Florida, USA. Mar Biol. 141(1):201-205.

Arendt M, Byrd J, Segars A, Maeier P, Schwenter J, Burgess D, Boynton J, Whitaker JD, Liguori L, Parker L et al. 2009. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. Final project report to the National Marine Fisheries Service National Oceanic and Atmospheric Administration. Charleston (SC): South Carolina Department of Natural Resources.

Arendt M, Segars A, Byrd J, Whitaker JD, Owens D, Blanvillain G. 2007. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. Charleston (SC): South Carolina Department of Natural Resources.

Arendt MD, Boynton J, Schwenter JA, Byrd JI, Segars AL, Whitaker JD, Parker L, Owens DW, Blanvillain GM, Quattro JM. 2012. Spatial clustering of loggerhead sea turtles in coastal waters of the NW Atlantic Ocean: Implications for management surveys. Endangered Species Res. 18(3):219-231.

Arendt MD, Schwenter JA, Segars AL, Byrd JI, Maier PP, Whitaker JD, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Catch rates and demographics of loggerhead sea turtles (*Caretta caretta*) captured from the Charleston, South Carolina, shipping channel during the period of mandatory use of turtle excluder devices (TEDs). Fish Bull. 110(1):98-109.

Arendt MD, Segars AL, Byrd JI, Boynton J, Schwenter JA, Whitaker JD, Parker L. 2012. Migration, distribution, and diving behavior of adult male loggerhead sea turtles (*Caretta caretta*) following dispersal from a major breeding aggregation in the Western North Atlantic. Mar Biol. 159(1):113-125.

Arendt MD, Segars AL, Byrd JI, Boynton J, Whitaker JD, Parker L, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Distributional patterns of adult male loggerhead sea turtles (*Caretta caretta*) in the vicinity of Cape Canaveral, Florida, USA during and after a major annual breeding aggregation. Mar Biol. 159(1):101-112.

Arendt MD, Segars AL, Byrd JI, Boynton J, Whitaker JD, Parker L, Owens DW, Blanvillain G, Quattro JM, Roberts MA. 2012. Seasonal distribution patterns of juvenile loggerhead sea turtles (*Caretta caretta*) following capture from a shipping channel in the Northwest Atlantic Ocean. Mar Biol. 159(1):127-139.

Avens L, Eguchi T, Epperly S, Haas H, Richards P, Seney E, Thompson N, Houtan KSV. 2013. Sea turtle assessment status and research needs. NOAA Technical Memorandum NMFS-F/SPO-131. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Bailey H, Fossette S, Bograd SJ, Shillinger GL, Swithenbank AM, Georges J-Y, Gaspar P, Stromberg KHP, Paladino FV, Spotila JR et al. 2012. Movement patterns for a critically endangered species, the leatherback turtle (*Dermochelys coriacea*), linked to foraging success and population status. PLOS ONE. 7(5):e36401.

Barco SG, Lockhart GG. 2014. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: Annual progress report for 2013. VAQF Scientific Report 2014-04. Virginia Beach (VA): Virginia Aquarium & Marine Science Center.

Barco SG, Lockhart GG. 2015. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: 2014 annual progress report. Draft report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Orders 41 and 50. Virginia Beach (VA): HDR.

Bass AL, Chow SM, Bowen BW. 1999. Temporal variation in loggerhead strandings from Georgia: Final report to Georgia Department of Natural Resources. Gainesville (FL): University of Florida.

Best BD, Halpin PN, Read AJ, Fujioka E, Good CP, LaBrecque EA, Schick RS, Roberts JJ, Hazen LJ, Qian SS. 2012. Online cetacean habitat modeling system for the US east coast and Gulf of Mexico. Endangered Species Res. 18(1):1-15.

BLM. 1977. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. Volume 3, Appendices. Center for Natural Areas, Bureau of Land Management.

Blumenthal JM, Solomon JL, Bell CD, Austin TJ, Ebanks-Petrie G, Coyne MS, Broderick AC, Godley BJ. 2006. Satellite tracking highlights the need for international cooperation in marine turtle management. Endangered Species Res. 3(3):51-61.

BOEM. 2010. Atlantic NAD 83 OCS planning areas. Herndon (VA): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 4]. http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Atlantic.aspx.

BOEM. 2012. BOEM 2012 - 2017 final program areas. Washington (DC): Bureau of Ocean Energy Management; [accessed 2016 Apr 6]. http://www.data.boem.gov/homepg/pubinfo/repcat/arcinfo/zipped/Boem2012-2017FinalProgramAreas.zip.

BOEM. 2012. Digital offshore cadastre (DOC) – Gulf of Mexico federal outer continental shelf (OCS) administrative boundaries (preliminary). Lakewood (CO): Bureau of Ocean Energy Management, Mapping and Boundary Branch; [accessed 2016 Apr 6]. http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Mapping_and_Data/Administrative_Boundaries/gom_admn.zip.

BOEM. 2013. Guidelines for providing information on marine mammals and sea turtles for renewable energy development on the Atlantic outer continental shelf. Pursuant to 30 CFR Part 585 Subpart F. Sterling (VA): Bureau of Ocean Energy Management Office of Renewable Energy Programs; [accessed 2016 May 13]. http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Regulatory_Information/BOEM_Renewable_MMandST_Guidelines.pdf.

BOEM. 2015. Federal sand and gravel borrow areas (lease areas). Sterling (VA): Bureau of Ocean Energy Management, Marine Minerals Program; [accessed 2016 Feb 19]. http://marinecadastre.gov/data.

Boulon RH, Jr., Eckert K, Eckert S. 1988. *Dermochelys coriacea* (leatherback sea turtle) migration. Herpetol Rev. 19(4):88.

Bovery CM, Wyneken J. 2015. Seasonal variation in sea turtle density and abundance in the southeast Florida current and surrounding waters. PLOS ONE. 10(12):e0145980.

Bradshaw CJA, McMahon CR, Hays GC. 2007. Behavioral inference of diving metabolic rate in free-ranging leatherback turtles. Physiol Biochem Zool. 80(2):209-219.

Braun-McNeill J, Goodman MA, Patton BW. 2010. Surfacing behavior of loggerhead (*Caretta caretta*) sea turtles in estuarine and coastal waters of North Carolina. NOAA Technical Memorandum NMFS-SEFSC-605. Beaufort (NC): National Oceanic and Atmospheric Administration, Southeast Fisheries Science Center.

Burt ML. 2014. Analysis of aerial surveys conducted in coastal waters of Maryland and Virginia, including Chesapeake Bay, 2011 - 2013: Loggerhead turtles. Unpublished technical report Prepared for: Department of the Navy Naval Facilities Engineering Command, Atlantic. Contract: N624070-10-30, CTO 0040. Prepared by University of St. Andrews, St. Andrews, Scotland. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Byles RA. 1988. The behavior and ecology of sea turtles in Virginia. [PhD dissertation]. Gloucester Point (VA): Virginia Institute of Marine Science, College of William and Mary.

Byles RA. 1989. Satellite telemetry of Kemp's ridley sea turtle, *Lepidochelys kempi*, in the Gulf of Mexico. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 25-26.

Campbell HA, Urbano F, Davidson S, Dettki H, Cagnacci F. 2016. A plea for standards in reporting data collected by animal-borne electronic devices. Anim Biotelem. 4(1):1-4.

Carvalho A, Fitzpatrick K, Garland J, Veldhuis F. 2015. Artificial reefs, beach restoration, and sea turtle nesting in Martin County, Florida. In: Wright DJ, editor. Ocean solutions, earth solutions. Redlands (CA): ESRI Press. p. 49-71.

Ceriani SA, Roth JD, Evans DR, Weishampel JF, Ehrhart LM. 2012. Inferring foraging areas of nesting loggerhead turtles using satellite telemetry and stable isotopes. PLOS ONE. 7(9):e45335.

Ceriani SA, Roth JD, Tucker AD, Evans DR, Addison DS, Sasso CR, Ehrhart LM, Weishampel JF. 2015. Carry-over effects and foraging ground dynamics of a major loggerhead breeding aggregation. Mar Biol. 162(10):1955-1968.

Cetacean Turtle Assessment Program. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the US outer continental shelf. Final report sponsored by the Bureau of Land Management under contract AA551-CT8-48. Kingston (RI): University of Rhode Island.

Chevallier D. 2016. Satellite tracking of marine turtles in French Guiana: Personal communication. In: Mast RB, Hutchinson BJ, Villegas PE, editors. Special feature: South America State of the World's Sea Turtles report volume XI. Ross (CA): State of the World's Sea Turtles. p. 24-25.

Cooper RW, Ellis E, Merigo C, Murphy SR, Weber S. 2006. Satellite tracking of captive-reared juvenile loggerhead sea turtles (*Caretta caretta*) released in southern New England. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece. p. 87.

Coyne MS, Godley BJ. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing and mapping animal tracking data. Mar Ecol Prog Ser. 301:1-7.

Davis RW, Evans WE, Würsig B. 2000. Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance, and habitat associations. Volume I: Executive summary. Prepared by Texas A&M University at Galveston and the National Marine Fisheries Service. OCS Study MMS 2000-002. USGS/BRD/CR-1999-0006. New Orleans (LA): US Geological Survey, Biological Resources Division and Minerals Management Service, Gulf of Mexico OCS Region.

Davis RW, Fargion GS. 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Final report. Volume I: Executive summary. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. OCS Study MMS 96-0026. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Dodd CK, Jr., Byles R. 2003. Post-nesting movements and behavior of loggerhead sea turtles (*Caretta caretta*) departing from east-central Florida nesting beaches. Chelonian Conserv Biol. 4(3):530-536.

Dodge KL, Galuardi B, Miller TJ, Lutcavage ME. 2014. Leatherback turtle movements, dive behavior, and habitat characteristics in ecoregions of the Northwest Atlantic Ocean. PLOS ONE. 9(3):e91726.

DoN. 2003. Marine resource assessment for the Cherry Point and southern Virginia Capes (VACAPES) inshore and estuarine areas. Final report. Prepared for: Department of the Navy Commander, US Atlantic Fleet. Contract: N62470-95-D-1160, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2005. Marine resources assessment for the northeast operating areas: Atlantic City, Narragansett Bay, and Boston. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0018. Prepared by Geo-Marine, Inc., Newport News, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for southeastern Florida and the AUTEC-Andros operating areas. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6470-02-D-9997, CTO 0034. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Marine resources assessment for the Gulf of Mexico. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Navy OPAREA density estimate (NODE) for the GOMEX OPAREA. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Navy OPAREA density estimate (NODE) for the Northeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2007. Navy OPAREA density estimate (NODE) for the Southeast OPAREAs. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Plano, TX. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Charleston/Jacksonville operating area. Final report. Prepared for: Department of the Navy US Fleet Forces Command. Contract: N62470-02-D-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Cherry Point operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-D-9991, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2008. Marine resources assessment update for the Virginia Capes operating area. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N62470-02-9997, CTO 0056. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

DoN. 2009. Marine resources assessment for the Chesapeake Bay. Final report. Prepared for: Department of the Navy, US Fleet Forces Command. Contract: N6270-02-D-9997, CTO 0127. Prepared by Geo-Marine, Inc., Hampton, VA. Norfolk (VA): Department of the Navy Naval Facilities Engineering Command, Atlantic.

Dwyer RG, Brooking C, Brimblecombe W, Campbell HA, Hunter J, Watts M, Franklin CE. 2015. An open Web-based system for the analysis and sharing of animal tracking data. Anim Biotelem. 3(1):1-11.

Eaton C, McMichael E, Witherington B, Foley A, Hardy R, Meylan A. 2008. In-water sea turtle monitoring and research in Florida: Review and recommendations. NOAA Technical Memorandum NMFS-OPR-38. St. Petersburg (FL): National Oceanic and Atmospheric Administration National Marine Fisheries Service.

Eckert SA. 1999. Data acquisition systems for monitoring sea turtle behavior and physiology. In: Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M, editors. Research and management techniques for the conservation of sea turtles. Washington (DC): IUCN/SSC Marine Turtle Specialist Group Publication. p. 88-93.

Eckert SA. 2002. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. Mar Ecol Prog Ser. 230:289-293.

Eckert SA, Bagley D, Kubis S, Ehrhart L, Johnson C, Stewart K, DeFreese D. 2006. Internesting and postnesting movements and foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida. Chelonian Conserv Biol. 5(2):239-248.

Epperly SP, Braun J, Veishlow A. 1995. Sea turtles in North Carolina waters. Conserv Biol. 9(2):384-394.

Epperly SP, Braun-McNeill J, Richards PM. 2007. Trends in catch rates of sea turtles in North Carolina, USA. Endangered Species Res. 3(3):283-293.

Evans DR, Bilo K. 2016. Satellite tracking of marine turtles in the Guianas: Personal communication. In: Mast RB, Hutchinson BJ, Villegas PE, editors. Special feature: South America State of the World's Sea Turtles report volume XI. Ross (CA): State of the World's Sea Turtles.

Ferraroli S, Georges J-Y, Gaspar P, Le Maho Y. 2004. Endangered species: Where leatherback turtles meet fisheries. Nature. 429(6991):521-522.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M. 2014. Long-term behavior at foraging sites of adult female loggerhead sea turtles (*Caretta caretta*) from three Florida rookeries. Mar Biol. 161(6):1251-1262.

Foley AM, Schroeder BA, Hardy R, MacPherson SL, Nicholas M, Coyne MS. 2013. Postnesting migratory behavior of loggerhead sea turtles *Caretta caretta* from three Florida rookeries. Endangered Species Res. 21(2):129-142.

Fossette S, Corbel H, Gaspar P, Le Maho Y, Georges J-Y. 2008. An alternative technique for the long-term satellite tracking of leatherback turtles. Endangered Species Res. 4(1-2):33-41.

Fossette S, Hobson VJ, Girard C, Calmettes B, Gaspar P, Georges J-Y, Hays GC. 2010. Spatio-temporal foraging patterns of a giant zooplanktivore, the leatherback turtle. J Mar Syst. 81(3):225-234.

Frick MG, Slay CK, Quinn CA, Windham-Reid A, Duley PA, Ryder CM, Morse LJ. 2000. Aerial observations of courtship behavior in loggerhead sea turtles (*Caretta caretta*) from southeastern Georgia and northeastern Florida. J Herpetol. 34(1):153-158.

Fritts TH, Hoffman W, McGehee MA. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. J Herpetol. 17(4):327-344.

Fujioka E, Kot CY, Wallace BP, Best BD, Moxley J, Cleary J, Donnelly B, Halpin PN. 2014. Data integration for conservation: Leveraging multiple data types to advance ecological assessments and habitat modeling for marine megavertebrates using OBIS-SEAMAP. Ecol Inform. 20:13-26.

GADM. 2015. GADM database of global administrative areas. Version 2.5. Davis (CA): Global Administrative Areas, University of California, Davis; [accessed 2015 Sep 4]. http://gadm.org.

Girard C, Tucker AD, Calmettes B. 2009. Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: Dispersal in highly dynamic conditions. Mar Biol. 156(9):1827-1839.

Girard C, Tucker AD, Calmettes B. 2009. Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: Dispersal in highly dynamic conditions. Mar Biol. 156(9):1827-1839.

Gitschlag G, Renaud M, Williams J, Hale J. 1992. Movement of Kemp's ridley and loggerhead sea turtles off the Georgia-Florida coast. Submitted to the US Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Contract Number WESCW-92-034. Galveston (TX): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center.

Godley BJ, Blumenthal JM, Broderick AC, Coyne MS, Godfrey MH, Hawkes LA, Witt MJ. 2008. Satellite tracking of sea turtles: Where have we been and where do we go next. Endangered Species Res. 4(1-2):3-22.

Grassle JF. 2000. The Ocean Biogeographic Information System (OBIS): An on-line, worldwide atlas for accessing, modeling and mapping marine biological data in a multidimensional geographic context. Oceanography. 13(3):5-7.

Griffin DB. 2002. GIS analysis of inter-nesting habitat, migratory corridors, and resident foraging areas of the loggerhead sea turtle (*Caretta caretta*) along the southeast coast. [Master's thesis]. Charleston (SC): College of Charleston.

Griffin DB, Murphy SR, Frick MG, Broderick AC, Coker JW, Coyne MS, Dodd MG, Godfrey MH, Godley BJ, Hawkes LA et al. 2013. Foraging habitats and migration corridors utilized by a recovering subpopulation of adult female loggerhead sea turtles: Implications for conservation. Mar Biol. 160(12):3071-3086.

Guseman JL, Ehrhart LM. 1991. Ecological geography of Western Atlantic loggerheads and green turtles: Evidence from remote tag recoveries. NOAA Technical Memorandum NMFS-SEFSC-302. In: Salmon M, Wyneken J, editors. Proceedings of the eleventh annual workshop on sea turtle biology and conservation, 26 February - 2 March 1991, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 50.

Halpin PN, Read AJ, Best BD, Hyrenbach KD, Fujioka E, Coyne MS, Crowder LB, Freeman SA, Spoerri C. 2006. OBIS-SEAMAP: Developing a biogeographic research data commons for the ecological studies of marine mammals, seabirds, and sea turtles. Mar Ecol Prog Ser. 316:239-246.

Halpin PN, Read AJ, Fujioka E, Best BD, Donnelly B, Hazen LJ, Kot C, Urian K, LaBrecque E, Dimatteo A et al. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography. 22:104-115.

Hammerschlag N, Broderick AC, Coker JW, Coyne MS, Dodd M, Frick MG, Godfrey MH, Godley BJ, Griffin DB, Hartog K et al. 2015. Evaluating the landscape of fear between apex predatory sharks and mobile sea turtles across a large dynamic seascape. Ecology. 96(8):2117-2126.

Hardy RF, Tucker AD, Foley AM, Schroeder BA, Giove RJ, Meylan AB. 2014. Spatiotemporal occurrence of loggerhead turtles (*Caretta caretta*) on the West Florida Shelf and apparent overlap with a commercial fishery. Can J Fish Aquat Sci. 71(12):1924-1933.

Hart KM, Fujisaki I. 2010. Satellite tracking reveals habitat use by juvenile green sea turtles *Chelonia mydas* in the Everglades, Florida, USA. Endangered Species Res. 11:221-232.

Hart KM, Fujisaki I, Autumn RS. 2012. Use of Dry Tortugas National Park by threatened and endangered marine turtles. Tallahassee (FL): Florida Fish and Wildlife Conservation Commission.

Hart KM, Lamont MM, Fujisaki I, Tucker AD, Carthy RR. 2012. Common coastal foraging areas for loggerheads in the Gulf of Mexico: Opportunities for marine conservation. Biol Conserv. 145(1):185-194.

Hart KM, Lamont MM, Sartain AR, Fujisaki I. 2014. Migration, foraging, and residency patterns for Northern Gulf loggerheads: Implications of local threats and international movements. PLOS ONE. 9(7):e103453.

Hart KM, Lamont MM, Sartain AR, Fujisaki I, Stephens BS. 2013. Movements and habitat-use of loggerhead sea turtles in the northern Gulf of Mexico during the reproductive period. PLOS ONE. 8(7):e66921.

Hart KM, Lear KO, Whitney NM, Lamont MM, Cherkiss MS, Crowder AG, Shaver DJ, Pollock C, Hills-Starr Z. 2016. Beyond maps: Combining data-loggers with satellite tags to determine specifics of inter-nesting sea turtle behavior. Paper presented at: Southeast Regional Sea Turtle Meeting, February 9 - 12, 2016. Mobile (AL).

Hart KM, Mooreside P, Crowder LB. 2006. Interpreting the spatio-temporal patterns of sea turtle strandings: Going with the flow. Biol Conserv. 129(2):283-290.

Hart KM, Sartain AR, Fujisaki I. 2015. Bahamas connection: Residence areas selected by breeding female loggerheads tagged in Dry Tortugas National Park, USA. Anim Biotelem. 3(1):1-17.

Hart KM, Sartain AR, Fujisaki I, Pratt HL, Jr., Morley D, Feeley MW. 2012. Home range, habitat use, and migrations of hawksbill turtles tracked from Dry Tortugas National Park, Florida, USA. Mar Ecol Prog Ser. 457:193-207.

Hart KM, White CF, Iverson AR, Whitney N. 2016. Trading shallow safety for deep sleep: Juvenile green turtles select deeper resting sites as they grow. Endangered Species Res. 31:61-73.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2010. Inter-nesting habitat-use patterns of loggerhead sea turtles: enhancing satellite tracking with benthic mapping. Aquat Biol. 11(1):77-90.

Hart KM, Zawada DG, Fujisaki I, Lidz BH. 2013. Habitat use of breeding green turtles *Chelonia mydas* tagged in Dry Tortugas National Park: Making use of local and regional MPAs. Biol Conserv. 161:142-154.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Godley BJ. 2007. Only some like it hot — quantifying the environmental niche of the loggerhead sea turtle. Divers Distrib. 13(4):447-457.

Hawkes LA, Broderick AC, Coyne MS, Godfrey MH, Lopez-Jurado LF, Lopez-Suarez P, Merino SE, Varo-Cruz N, Godley BJ. 2006. Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Curr Biol. 16(10):990-995.

Hawkes LA, Witt MJ, Broderick AC, Coker JW, Coyne MS, Dodd M, Frick MG, Godfrey MH, Griffin DB, Murphy SR et al. 2011. Home on the range: spatial ecology of loggerhead turtles in Atlantic waters of the USA. Divers Distrib. 17(4):624-640.

Hays GC, Hobson VJ, Metcalfe JD, Righton D, Sims DW. 2006. Flexible foraging movements of leatherback turtles across the North Atlantic Ocean. Ecology. 87(10):2647-2656.

Hays GC, Houghton JDR, Myers AE. 2004. Pan-Atlantic leatherback turtle movements. Nature. 429(6991):522-522.

Henwood TA, Ogren LH. 1987. Distribution and migrations of immature Kemp's ridley turtles (*Lepidochelys kempi*) and green turtles (*Chelonia mydas*) off Florida, Georgia, and South Carolina. Northeast Gulf Science. 9(2):153-159.

Hoffman W, Fritts TH. 1982. Sea turtle distribution along the boundary of the Gulf Stream current off eastern Florida. Herpetologica. 38(3):405-409.

Holloway-Adkins K, Provancha J. 2005. Final report: Abundance and foraging activity of marine turtles using nearshore rock resources along the mid reach of Brevard County, Florida. Cape Canaveral (FL): Dynamac Corporation.

Hopkins-Murphy SR. 1992. Status and trends of the loggerhead turtle population in South Carolina. Charleston (SC): South Carolina Wildlife and Marine Resources Department.

Hopkins-Murphy SR, Murphy TM, Hope CP, Coker JW, Hoyle ME. 2001. Population trends and nesting distribution of the loggerhead turtle (*Caretta caretta*) in South Carolina 1980-1997. Final report to the US Fish and Wildlife Service. Charleston (SC): South Carolina Department of Natural Resources, Division of Wildlife and Freshwater Fisheries Wildlife Diversity Section.

Huang H-W. 2015. Conservation hotspots for the turtles on the high seas of the Atlantic Ocean. PLOS ONE. 10(8):e0133614.

Hughes CL. 2014. Characterization of sea turtle nesting on the upper Texas coast. [Master's thesis]. Galveston (TX): Texas A&M University at Galveston.

Hughes CL, Landry AM, Jr. 2016. Long-term movements of an adult male Kemp’s ridley sea turtle (*Lepidochelys kempii*) in the northwestern Gulf of Mexico. Gulf Mex Sci. 33(2):206-213.

Hussey NE, Kessel ST, Aarestrup K, Cooke SJ, Cowley PD, Fisk AT, Harcourt RG, Holland KN, Iverson SJ, Kocik JF et al. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. Science. 348(6240):1221-1231.

James MC, Eckert SA, Myers RA. 2005. Migratory and reproductive movements of male leatherback turtles (*Dermochelys coriacea*). Mar Biol. 147(4):845-853.

James MC, Myers RA, Ottensmeyer CA. 2005. Behaviour of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proc R Soc Lond B Biol Sci. 272(1572):1547-1555.

James MC, Ottensmeyer CA, Myers RA. 2005. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: New directions for conservation. Ecol Lett. 8(2):195-201.

Jeffers VF, Godley BJ. 2016. Satellite tracking in sea turtles: How do we find our way to the conservation dividends? Biol Conserv. 199:172-184.

Kessel ST. 2015. Location-referenced acoustic and satellite telemetry papers. Ocean Tracking Network; [accessed 2016 Feb 29]. http://dx.doi.org/10.14286/20150203/KESSEL.

Kot CY, Fujioka E, DiMatteo A, Wallace BP, Hutchinson BJ, Cleary J, Halpin P, Mast RB. 2016. The state of the world's sea turtles online database: Data provided by the SWOT team and hosted on OBIS-SEAMAP. Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University http://seamapenvdukeedu/swot.

Kot CY, Fujioka E, Hazen LJ, Best BD, Read AJ, Halpin PN. 2010. Spatio-temporal gap analysis of OBIS-SEAMAP project data: Assessment and way forward. PLOS ONE. 5(9):e12990.

Kranstauber B, Cameron A, Weinzerl R, Fountain T, Tilak S, Wikelski M, Kays R. 2011. The Movebank data model for animal tracking. Environ Model Software. 26(6):834-835.

Kraus SD, Taylor JKD, Wikgren B, Kenney RD, Mayo CM, Ganley L, Huges P, Cark CW, Rice AN. 2013. Field surveys of whales and sea turtles for offshore wind energy planning in Massachusetts. Massachusetts Clean Energy Center.

Lamont MM, Putman NF, Fujisaki I, Hart KM. 2015. Spatial requirements of different life-stages of the loggerhead turtle (*Caretta caretta*) from a distinct population segment in the northern Gulf of Mexico. Herpetol Conserv Biol. 10(1):26-43.

Lyn H, Coleman A, Broadway M, Klaus J, Finerty S, Shannon D, Solangi M. 2012. Displacement and site fidelity of rehabilitated immature Kemp's ridley sea turtles (*Lepidochelys kempii*). Mar Turtle Newsl. (135):10-13.

Makowski C, Fisher L, Kruempel C, Rubin D, Spadoni R. 2008. The GTD: Creating the first GIS turtle database for juvenile green turtles in Broward County, Florida. In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia, USA. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 170.

Makowski C, Seminoff JA, Salmon M. 2006. Home range and habitat use of juvenile Atlantic green turtles (*Chelonia mydas* L.) on shallow reef habitats in Palm Beach, Florida, USA. Mar Biol. 148(5):1167-1179.

Maley CG. 1995. Sea turtle strandings in Georgia in the TED era: A matter of timing. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 77-80.

Mansfield KL. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. [PhD dissertation]. Williamsburg (VA): Virginia Institute of Marine Sciences, The College of William and Mary.

Mansfield KL, Musick JA. 2003. Loggerhead sea turtle diving behavior. 2002 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2004. Sea turtle diving behavior in Virginia. 2003 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2004. Sea turtle surfacing behavior and aerial census: Has Virginia's sea turtle population been overestimated? In: Kalb H, Rohde AS, Gayheart K, Shanker K, editors. Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation, 18 to 22 January 2005, Savannah, Georgia NOAA Technical Memorandum NMFS-SEFSC-582. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 80-81.

Mansfield KL, Musick JA. 2005. Loggerhead sea turtle diving behavior. 2004 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Musick JA. 2006. Loggerhead sea turtle diving behavior. 2006 final report submitted to: The US Army Corps of Engineers, Norfolk, VA. Gloucester Point (VA): Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary.

Mansfield KL, Saba VS, Keinath JA, Musick JA. 2009. Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Mar Biol. 156(12):2555-2570.

Mansfield KL, Wyneken J, Porter WP, Luo JG. 2014. First satellite tracks of neonate sea turtles redefine the 'lost years' oceanic niche. Proc R Soc Lond B Biol Sci. 281(1781):20133039.

Mansfield KL, Wyneken J, Rittschof D, Walsh M, Lim CW, Richards PM. 2012. Satellite tag attachment methods for tracking neonate sea turtles. Mar Ecol Prog Ser. 457:181-192.

Martin CS, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, Geffert JL, van Bochove JW, Thomas H et al. 2014. Manual of marine and coastal datasets of biodiversity importance. May 2014 release. Cambridge, United Kingdom: UNEP World Conservation Monitoring Centre.

Mast RB, Bailey LM, Hutchinson BJ. 2006. Burning issues in sea turtle conservation...leatherback sea turtles of the world. State of the World's Sea Turtles report volume I. Washington (DC): State of the World's Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2007. A global glimpse of loggerhead nesting. State of the World's Sea Turtles report volume II. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Bailey LM, Hutchinson BJ. 2008. Where the hawksbills are. State of the World's Sea Turtles report volume III. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Bailey LM. 2006. The state of the world's sea turtles (SWOT): Collaborating for conservation - the leatherback nesting beaches of the world. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 221-222.

Mast RB, Hutchinson BJ, Fernanda Perez M, Best B, Wabnitz C, Fischman D. 2009. The state of the world's sea turtles 2004. In: Demetropoulos A, Turkozan O, editors. Proceedings of the second Mediterranean conference on marine turtles, 4-7 May 2005, Kemer, Turkey. Barcelona Convention – Bern Convention – Bonn Convention; [accessed 2016 Jul 20]. http://www.seaturtle.org/documents/2nd_MedConf_Proceedings.pdf.

Mast RB, Hutchinson BJ, Villegas PE. 2015. Sea turtles of Costa Rica. State of the World's Sea Turtles report volume X. In: Mast R, Hutchinson BJ, Villegas PE, editors. Ross (CA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Villegas PE, Wallace B, Yarnell L. 2009. Discovering the flatback: Australia's own sea turtle. State of the World's Sea Turtles report volume IV. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Villegas PE, Wallace BP. 2014. Are we succeeding? How trends in turtle conservation are shaping the future. State of the World's Sea Turtles report volume IX. Ross (CA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2010. Kemp's and olive ridleys: Small turtles, big secrets. State of the World's Sea Turtles report volume V. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace B, Yarnell L, Hoyt S. 2011. The green turtle: The most valuable reptile in the world. State of the World's Sea Turtles report volume VI. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace BP. 2012. The world's most (and least) threatened sea turtles. State of the World's Sea Turtles report volume VII. Arlington (VA): State of the World's Sea Turtles.

Mast RB, Hutchinson BJ, Wallace BP. 2013. Persuasion: The case for saving sea turtles. State of the World's Sea Turtles report volume VIII. Ross (CA): State of the World's Sea Turtles.

McClellan CM, Read AJ. 2007. Complexity and variation in loggerhead sea turtle life history. Biol Lett. 3(6):592-594.

McClellan CM, Read AJ. 2009. Confronting the gauntlet: Understanding incidental capture of green turtles through fine-scale movement studies. Endangered Species Res. 10:165-179.

McClellan CM, Read AJ, Price BA, Cluse WM, Godfrey MH. 2009. Using telemetry to mitigate the bycatch of long-lived marine vertebrates. Ecol Appl. 19(6):1660-1671.

McMahon CR, Autret E, Houghton JDR, Lovell P, Myers AE, Hays GC. 2005. Animal-borne sensors successfully capture the real-time thermal properties of ocean basins. Limnol Oceanogr Methods. 3:392-398.

Mendez D, Cuevas E, Navarro J, Gonzalez-Garza BI, Guzman-Hernandez V. 2013. Satellite tracking of green turtle females *Chelonia mydas* and the evaluation of their home ranges in the north coast of the Yucatan Peninsula, Mexico. Rev Biol Mar Oceanogr. 48(3):497-509.

Mendonça MT, Pritchard PCH. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempi*). Herpetologica. 42(3):373-381.

Meylan A, Schroeder B, Mosier A. 1995. Sea turtle nesting activity in the state of Florida 1979-1992. Florida Marine Research Publication 52. St. Petersburg (FL): Department of Environmental Protection.

Meylan AB, Witherington BE, Brost B, Rivero R, Kubilis PS. 2006. Sea turtle nesting in Florida, USA: Assessments of abundance and trends for regionally significant populations of *Caretta*, *Chelonia*, and *Dermochelys* In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 306-307.

Meylan PA, Meylan AB, Gray JA. 2011. The ecology and migrations of sea turtles 8. Tests of the developmental habitat hypothesis. Bull Am Mus Nat Hist. 357:1-70.

Michel J. 2013. South Atlantic information resources: Data search and literature synthesis. OCS Study BOEM 2013-01157. In: Michel J, editor. New Orleans (LA): Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Michel J, Dunagan H, Boring C, Healy E, Evans W, Dean JM, McGillis A, Hain J. 2007. Worldwide synthesis and analysis of existing information regarding environmental effects of alternative energy uses on the outer continental shelf. MMS OCS Report 2007-038. Herndon (VA): Minerals Management Service.

MMS. 2008. Cape Wind energy project, Nantucket Sound: Biological assessment. Herndon (VA): Minerals Management Service.

Murphy TM. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, US. Final report to the National Marine Fisheries Service. Green Pond (SC): LaMER, Inc.

Mysing JO, Vanselous TM. 1989. Status of satellite tracking of Kemp's ridley sea turtles. In: Caillouet CW, Jr., Landry AM, editors. Proceedings of the first international symposium on Kemp's ridley sea turtle biology, October 1 - 4, 1985, Galveston, Texas TAMU-SG-89-105. Galveston (TX): National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory and Texas A&M University at Galveston. p. 112-115.

NEFSC, SEFSC. 2010. 2010 annual report to the inter-agency agreement M10PG00075/0001: A comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

NEFSC, SEFSC. 2011. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (*Caretta caretta*) in northwestern Atlantic Ocean continental shelf waters. Reference Document 11-03. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

NEFSC, SEFSC. 2012. Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean. Woods Hole (MA) and Miami (FL): National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center and Southeast Fisheries Science Center.

Nelson WR, Benigno J, Burkett S. 1987. Behavioral patterns of loggerhead sea turtles, *Caretta caretta* in the Cape Canaveral area as determined by radio monitoring and acoustic tracking. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 31.

NMFS. 2010. Sea turtle stranding and salvage network online stranding reports. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; [accessed 2016 Feb 25]. http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp.

NMFS. 2014. Loggerhead sea turtle critical habitat in the Northwest Atlantic Ocean GIS files. Silver Spring (MD): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; [accessed 2016 Apr 22]. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm.

Pajuelo M, Bjorndal KA, Reich KJ, Arendt MD, Bolten AB. 2012. Distribution of foraging habitats of male loggerhead turtles (*Caretta caretta*) as revealed by stable isotopes and satellite telemetry. Mar Biol. 159(6):1255-1267.

Pallin LJ, Adams EM, Goyert HF, Friedlaender AS, Johnston DW. 2015. Chapter 12: Density modeling for marine mammals and sea turtles with environmental covariates. In: Williams KA, Connelly EE, Johnson SM, Stenhouse IJ, editors. Baseline wildlife studies in Atlantic waters offshore of Maryland: Final report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015 Report BRI 2015-17. Portland (ME): Biodiversity Research Institute. p. 1-39.

Plotkin PT, Spotila JR. 2002. Post-nesting migrations of loggerhead turtles *Caretta caretta* from Georgia, USA: Conservation implications for a genetically distinct subpopulation. Oryx. 36(04):396-399.

Price JT. 2016. Characterization of the juvenile green turtle (*Chelonia mydas*) microbiome associated with the ontogenic shift from pelagic habitats to inshore resident areas. [Master's thesis]. Fort Wayne (IN): Purdue University.

Putman NF, Mansfield KL. 2015. Direct evidence of swimming demonstrates active dispersal in the sea turtle "lost years’’. Curr Biol. 25(9):1221-1227.

Ragland JM, Arendt MD, Kucklick JR, Keller JM. 2011. Persistent organic pollutants in blood plasma of satellite-tracked adult male loggerhead sea turtles (*Caretta caretta*). Environ Toxicol Chem. 30(7):1549-1556.

Raposa KJV, Frankel AS, Sisson G, Ellison WT, Damon C. 2007. Marine wildlife behavior database for estimating environmental impacts. J Acoust Soc Am. 122(5):3059.

Reidenauer J, Turner L. 2016. Federal sand resources. 2016 National Conference on Beach Preservation Technology, February 3 - 5, 2016, Jacksonville, Florida. Florida Shore and Beach Preservation Association; [accessed 2016 Apr 18]. http://www.fsbpa.com/publications/2016-tech.html.

Renaud M, Carpenter JA, Manzella S, Williams J. 1994. Radio and sonic telemetric monitoring of immature green sea turtles in the Brazos-Santiago Pass area, South Padre Island, Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 148.

Renaud ML. 1994. Satellite tracking of juvenile Kemp's ridley sea turtles near Sabine Pass, Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 147.

Renaud ML. 1995. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). J Herpetol. 29(3):370-374.

Renaud ML. 1995. Radio and sonic tracking of green and loggerhead sea turtles at South Padre Island, Texas. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 96.

Renaud ML, Carpenter JA. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bull Mar Sci. 55(1):1-15.

Renaud ML, Carpenter JA, Manzella SA, Williams JA. 1992. Telemetric tracking of green sea turtles (*Chelonia mydas*) in relation to dredged channels at South Padre Island, Texas July through September 1992. Galveston (TX): Southeast Fisheries Center, National Marine Fisheries Service, Galveston Laboratory.

Renaud ML, Carpenter JA, Williams JA, Landry AM. 1996. Kemp's ridley sea turtle (*Lepidochelys kempii*) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conserv Biol. 2:108-109.

Renaud ML, Carpenter JA, Williams JA, Manzella SA. 1994. Telemetric tracking of Kemp's ridley sea turtles (*Lepidochelys kempii*) in relation to dredged channels at Bolivar Roads Pass and Sabine Pass, TX and Calcasieu Pass, LA, May 1993 through February 1994. Final report submitted to US Army Corps of Engineers, Galveston, TX and New Orleans, LA District.

Renaud ML, Williams JA. 1997. Movements of Kemp's ridley (*Lepidochelys kempii*) and green (*Chelonia mydas*) sea turtles using Lavaca Bay and Matagorda Bay 1996-1997. Final report submitted to the Environmental Protection Agency Office of Planning and Coordination, Region 6. Galveston (TX): National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Renaud ML, Williams JA. 2005. Kemp’s ridley sea turtle movements and migrations. Chelonian Conserv Biol. 4(4):808-816.

Rosman I, Boland GS, Martin L, Chandler C. 1987. Underwater sightings of sea turtles in the northern Gulf of Mexico. OCS Study MMS 87-0107. New Orleans (LA): Minerals Management Service, Gulf of Mexico OCS Region.

Sargent S. 2015. Marine spatial planning biological data analysis in the northeast and Mid-Atlantic regions: Gap analysis and fitness for marine spatial planning applications. [Master's thesis]. Durham (NC): Duke University.

Sasso CR, Epperly SP. 2007. Survival of pelagic juvenile loggerhead turtles in the open ocean. J Wildl Manage. 71(6):1830-1835.

Sasso CR, Epperly SP, Johnson C. 2011. Annual survival of loggerhead sea turtles (*Caretta caretta)* nesting in peninsular Florida: a cause for concern. Herpetol Conserv Biol. 6(3):443-448.

Schmid JR. 1995. Marine turtle populations on the east-central coast of Florida: Results of tagging studies at Cape Canaveral, Florida, 1986-1991. Fish Bull. 93(1):139-151.

Schmid JR, Bolten AB, Bjorndal KA, Lindberg WJ, Percival HF, Zwick PD. 2003. Home range and habitat use by Kemp's ridley turtles in west-central Florida. J Wildl Manage. 67(1):196-206.

Schmid JR, Witzell WN. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempi*): Cumulative results of tagging studies in Florida. Chelonian Conserv Biol. 2(4):532-537.

Schroeder BA, Foley AM, Bagley DA. 2003. Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. In: Bolten AB, Witherington BE, editors. Loggerhead sea turtles. Washington (DC): Smithsonian Institution. p. 114-124.

Schroeder BA, Maley CA. 1989. 1988 fall/winter strandings of marine turtles along the northeast Florida and Georgia coasts. In: Eckert SA, Eckert KL, Richardson TH, editors. Proceedings of the ninth annual workshop on sea turtle conservation and biology, 7 - 11 February 1989, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFC-232. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 159-162.

Schroeder BA, Thompson NB. 1987. Distribution of the loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*, in the Cape Canaveral, Florida area: Results of aerial surveys. NOAA Technical Report National Marine Fisheries Service. In: Witzell WN, editor. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop, Miami, Florida, February 26 - 27, 1985 NOAA Technical Report NMFS 53. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. p. 45-53.

Scott R, Hodgson DJ, Witt MJ, Coyne MS, Adnyana W, Blumenthal JM, Broderick AC, Canbolat AF, Catry P, Ciccione S. 2012. Global analysis of satellite tracking data shows that adult green turtles are significantly aggregated in marine protected areas. Global Ecol Biogeogr. 21(11):1053-1061.

Scott-Hayward LAS, Borchers DL, Burt ML. 2014. Use of zero and one-inflated beta regression to model availability of loggerhead turtles off the east coast of the United States. Draft Report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Order 40, issued to HDR Inc., Norfolk, Virginia. St. Andrews, Scotland: University of St. Andrews, Center for Research into Ecological and Environmental Modelling.

Seney EE, Higgins BM, Landry AM, Jr. 2010. Satellite transmitter attachment techniques for small juvenile sea turtles. J Exp Mar Biol Ecol. 384:61-67.

Seney EE, Landry AM, Jr. 2008. Movements of Kemp's ridley sea turtles nesting on the upper Texas coast: Implications for management. Endangered Species Res. 4(1-2):73-84.

Seney EE, Landry AM, Jr. 2011. Movement patterns of immature and adult female Kemp's ridley sea turtles in the northwestern Gulf of Mexico. Mar Ecol Prog Ser. 440:241-254.

Seney EE, Landry AM, Jr., Higgins BM, Flanagan JP, Kethan SL. 2006. Movements of immature and post-nesting Kemp's ridley sea turtles in the northwestern Gulf of Mexico. In: Frick M, Panagopoulou A, Rees AF, Williams K, editors. Book of abstracts: 26th annual symposium on sea turtle biology and conservation, Island of Crete, Greece, 3 - 8 April 2006. Athens, Greece: International Sea Turtle Society. p. 112-113.

Shaffer SA, Costa DP. 2006. A database for the study of marine mammal behavior: gap analysis, data standardization, and future directions. IEEE Journal of Oceanic Engineering. 31(1):82-86.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain AR, Pena J, Burchfield PM, Gomez Gamez D, Ortiz J. 2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecol Evol. 3(7):2002-2012.

Shaver DJ, Hart KM, Fujisaki I, Rubio C, Sartain-Iverson AR, Peña J, Gomez Gamez D, de Jesus Gonzales Diaz Miron R, Burchfield PM, Martinez HJ et al. 2016. Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. Biol Conserv. 194:158-167.

Shaver DJ, Rubio C. 2008. Post-nesting movement of wild and head-started Kemp's ridley sea turtles *Lepidochelys kempii* in the Gulf of Mexico. Endangered Species Res. 4:43-55.

Shaver DJ, Schroeder BA, Byles RA, Burchfield PM, Pena J, Marquez R, Martinez HJ. 2005. Movements and home ranges of adult male Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico investigated by satellite telemetry. Chelonian Conserv Biol. 4(4):817-827.

Sherrill-Mix SA, James MC, Myers RA. 2008. Migration cues and timing in leatherback sea turtles. Behav Ecol. 19(2):231-236.

Shoop CR, Ruckdeschel CA, Thompson NB. 1985. Sea turtles in the Southeast United States: Nesting activity as derived from aerial and ground surveys, 1982. Herpetologica. 41(3):252-259.

Slay CK. 1995. Sea turtle mortality related to dredging activities in the southeastern US: 1991. In: Richardson JI, Richardson TH, editors. Proceedings of the twelfth annual workshop on sea turtle biology and conservation, 25 - 29 February 1992, Jekyll Island, Georgia. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 132-133.

Stadler M, Salmon M, Roberts C. 2014. Ecological correlates of green turtle (*Chelonia mydas*) abundance on the nearshore worm reefs of southeastern Florida. J Coast Res. 31(2):244-254.

Stancyk SE, Talbert OR, Miller AB. 1979. Estimation of loggerhead turtle nesting activity in South Carolina by aerial surveys. Am Zool. 19(3):954-954.

Standora E, Ryder M, Edbauer J, Williams K, Morreale S, Bolten A. 1994. Homing behavior of loggerhead turtles relocated from dredging areas in Cape Canaveral Channel, Florida. In: Bjorndal KA, Bolten AB, Johnson DA, Eliazar PJ, editors. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation, 1 - 5 March 1994, Hilton Head, South Carolina NOAA Technical Memorandum NMFS-SEFSC-351. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 141-142.

Standora EA, Eberle MD, Edbauer JM, Ryder TS, Williams KL, Morreale SJ, Bolten AB. 1993. Diving behavior, daily movements, and homing of loggerhead turtles (*Caretta caretta*) at Cape Canaveral, Florida, March and April 1993. Final contract report to US Army Engineer Waterways Experiment Station, Buffalo State College, Buffalo, NY. Hampton Bays (NY) and Gainesville (FL): Okeanos Ocean Research Foundation, Inc., and University of Florida, Gainesville.

Standora EA, Morreale SJ, Bolten AB, Eberle MD, Edbauer JM, Ryder TS, Williams KL. 1994. Diving behavior and vertical distribution of loggerheads, and a preliminary assessment of trawling efficiency for censusing. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 174.

Stewart KR, James MC, Roden S, Dutton PH. 2013. Assignment tests, telemetry and tag-recapture data converge to identify natal origins of leatherback turtles foraging in Atlantic Canadian waters. J Anim Ecol. 82(4):791-803.

Stoneburner DL. 1982. Satellite telemetry of loggerhead sea turtle movement in the Georgia Bight. Copeia. 1982(2):400-408.

Talbert OR, Stancyk SE, Dean JM, Will JM. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina.1. A rookery in transition. Copeia. 1980(4):709-718.

Taylor CM, Smith B, Stein D. 2012. The role of MarineCadastre.gov in offshore energy planning. 2012 oceans, 14 - 19 October 2012, Hampton Roads, Virginia. New York (NY): Intitute of Electrical and Electronics Engineers. p. 1-6.

Thompson NB, Huang H. 1993. Leatherback turtles in southeast US waters. NOAA Technical Memorandum NMFS-SEFSC-318. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Thompson NB, Marquez RM. 1991. Insights into the distribution and migratory movements of the Kemp's ridley sea turtle. Unpublished report. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center.

Timko RE, Kolz AL. 1982. Satellite sea turtle tracking. Mar Fish Rev. 44:19-24.

Tucker AD. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. J Exp Mar Biol Ecol. 383(1):48-55.

Tucker AD. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. J Exp Mar Biol Ecol. 383(1):48-55.

Tucker AD, MacDonald BD, Seminoff JA. 2014. Foraging site fidelity and stable isotope values of loggerhead turtles tracked in the Gulf of Mexico and northwest Caribbean. Mar Ecol Prog Ser. 502:267-279.

Tucker AD, MacDonald BD, Seminoff JA. 2014. Foraging site fidelity and stable isotope values of loggerhead turtles tracked in the Gulf of Mexico and northwest Caribbean. Mar Ecol Prog Ser. 502:267-279.

USACE. 2016. Operation and dredging endangered species system (ODESS). Mobile (AL): US Army Corps of Engineers; [accessed 2016 Mar 2]. http://dqm.usace.army.mil/odess.

Villegas PE. 2012. A preliminary evaluation of the State of the World’s Sea Turtles (SWOT) Program. [Master's Project]. Durham (NC): Duke University.

VLIZ. 2014. Maritime boundaries geodatabase, version 8. Flanders Marine Institute - Vlaams Instituut voor de Zee. [accessed 2016 Apr 6]. http://www.marineregions.org.

Weatherdon LV, Fletcher R, Jones MC, Kaschner K, Sullivan E, Tittensor DP, Mcowen C, van Geffert JL, Bochove JW, Thomas H et al. 2015. Manual of marine and coastal datasets of biodiversity importance. December 2015 edition. Cambridge, United Kingdom UNEP World Conservation Monitoring Centre.

Weishampel JF, Bagley DA, Ehrhart LM, Rodenbeck BL. 2003. Spatiotemporal patterns of annual sea turtle nesting behaviors along an East Central Florida beach. Biol Conserv. 110(2):295-303.

Wessel P, Smith WHF. 1996. A global, self-consistent, hierarchical, high-resolution shoreline. J Geophys Res. 101(B4):8741-8743.

Williams JA, Manzella SA, Tidwell J. 1994. Radio and sonic tracking of sea turtles in south Texas. In: Schroeder B, Witherington B, editors. Proceedings of the thirteenth annual workshop on sea turtle conservation and biology, 23 - 27 February 1993, Jekyll Island, Georgia NOAA Technical Memorandum NMFS-SEFSC-341. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 266-268.

Williams JA, Renaud ML. 1998. Tracking of Kemp's ridley (*Lepidochelys kempii*) and green (*Chelonia mydas*) sea turtles in the Matagorda Bay System, Texas. In: Epperly SP, Braun J, editors. Proceedings of the seventeenth annual sea turtle symposium, 4 - 8 March 1997, Orlando, Florida, USA NOAA Technical Memorandum NMFS-SEFSC-415. Miami (FL): National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. p. 302-305.

Witherington B, Kullis P, Brost B, Meylan A. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecol Appl. 19(1):30-54.

Witherington BE. 1997. Ecology of neonate loggerhead turtles inhabiting pelagic fronts near the Florida current. Interim report to the National Marine Fisheries Service for FO602-96-11. Taquesta (FL): Department of Environmental Protection Florida Marine Research Institute.

Witherington BE. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. Mar Biol. 140:843-583.

Worth DF, Smith JB. 1976. Marine turtle nesting on Hutchinson Island, Florida, in 1973. Florida Marine Research Publications Number 18. St. Petersburg (FL): Florida Department of Natural Resources, Marine Research Laboratory.

A.6 Tools (28)

Ball IR, Possingham HP, Watts M. 2009. Marxan and relatives: Software for spatial conservation prioritisation. In: Moilanen A, Wilson KA, Possingham HP, editors. Spatial conservation prioritisation: Quantitative methods and computational tools. Oxford, United Kingdom: Oxford University Press. p. 185-195.

Bamford D, Ye Y, McGuinn R, Stroh C, Beard S, Burkhalter S, Hadley B, Love R. 2009. Habitat priority planner, version 2: Help document. Charleston (SC): National Oceanic and Atmospheric Administration, Coastal Services Center.

Best BD. 2016. Data to decision in a dynamic ocean: Robust species distribution models and spatial decision frameworks. [PhD dissertation]. Durham (NC): Duke University.

Boumans R, Roman J, Altman I, Kaufman L. 2015. The multiscale integrated model of ecosystem services (MIMES): Simulating the interactions of coupled human and natural systems. Ecosyst Serv. 12:30-41.

Coleman H, Foley M, Prahler E, Armsby M, Shillinger G. 2011. Decision guide: Selecting decision support tools for marine spatial planning. Stanford (CA): The Woods Institute for the Environment, Stanford University.

Crist P, Maybury K, Carr SD, Hak J. 2014. Tools for landscape-level assessment and planning: A guide for the North Pacific landscape conservation cooperative. Arlington (VA): NatureServe.

FWS, Warren Pinnacle Consulting Inc., Image Matters LLC, The Nature Conservancy, Federation NW. 2012. Sea level affecting marshes visualization (SLAMM View). [accessed 2016 Aug 17]. http://www.slammview.org.

Hobday AJ, Hartog JR, Timmiss T, Fielding J. 2010. Dynamic spatial zoning to manage southern bluefin tuna (*Thunnus maccoyii*) capture in a multi-species longline fishery. Fish Oceanogr. 19(3):243-253.

Moilanen A. 2007. Landscape Zonation, benefit functions and target-based planning: Unifying reserve selection strategies. Biol Conserv. 134(4):571-579.

Moilanen A, Franco AMA, Early RI, Fox R, Wintle B, Thomas CD. 2005. Prioritizing multiple-use landscapes for conservation: Methods for large multi-species planning problems. Proc R Soc Lond B Biol Sci. 272(1575):1885-1891.

Mulligan M. 2016. User guide for the Co$ting Nature Policy Support System Version 2. King's College, London, AmbioTEK, and United Nations Environment Programme, World Conservation Monitoring Centre; [accessed 2016 Mar 9]. https://goo.gl/Grpbnb.

Mulligan M, Guerry A, Arkema K, Bagstad K, Villa F. 2010. Capturing and quantifying the flow of ecosystem services. In: Silvestri S, Kershaw F, editors. Framing the flow: Innovative approaches to understand, protect and value ecosystem services across linked habitats. Cambridge, United Kingdom: United National Environment Programme World Conservation Monitoring Centre. p. 26-33.

NatureServe Vista. 2011. NatureServe VISTA: Decision-support software for land use and conservation planning. User's manual from Vista on-line help. Arlington (VA): NatureServe.

Nelson E, Mendoza G, Regetz J, Polasky S, Tallis H, Cameron DR, Chan KMA, Daily GC, Goldstein J, Kareiva PM. 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Front Ecol Environ. 7(1):4-11.

[OCM] Office for Coastal Management. 2016. Habitat priority planner. Charleston (SC): National Oceanic and Atmospheric Administration National Ocean Service Office for Coastal Management; [accessed 2016 Jul 6]. https://coast.noaa.gov/digitalcoast/tools/hpp.html.

Parametrix. 2013. Bayesian analysis for spatial siting (BASS) project report v1.3. OCS Study BOEM 2013-201. Camarillo (CA): Bureau of Ocean Energy Management.

Parametrix. 2013. Bayesian analysis for spatial siting (BASS): Technical manual. OCS Study BOEM 2013-204. Camarillo (CA): Bureau of Ocean Energy Management.

Reynolds KM, Hessburg PF, Bourgeron PS. 2014. Making transparent environmental management decisions: Applications of the ecosystem management decision support system. New York (NY): Springer.

Roberts JJ, Best BD, Dunn DC, Treml EA, Halpin PN. 2010. Marine geospatial ecology tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. Environ Model Software. 25:1197-1207.

Rozum JS, Carr SD. 2013. Tools for coastal climate adaptation planning: A guide for selecting tools to assist with ecosystem-based climate planning. Arlington (VA): NatureServe.

Sarkar S, Pressey RL, Faith DP, Margules CR, Fuller T, Stoms DM, Moffett A, Wilson KA, Williams KJ, Williams PH. 2006. Biodiversity conservation planning tools: Present status and challenges for the future. Annu Rev Environ Resour. 31:123-159.

Sharp R, Tallis HT, Ricketts T, Guerry AD, Wood SA, Chaplin-Kramer R, Nelson E, Ennaanay D, Wolny S, Olwero N et al. 2015. InVEST user's guide 3.2.0. The Natural Capital Project. Stanford (CA): The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund.

Sprague RH, Carlson ED. 1982. Building effective decision support systems. Englewood Clifts (NJ): Prentice-Hall, Inc.

Stelzenmüller V, Lee J, South A, Foden J, Rogers SI. 2013. Practical tools to support marine spatial planning: a review and some prototype tools. Mar Policy. 38:214-227.

The Nature Conservancy. 2012. Spatial tools for Arctic mapping and planning (STAMP): Decision support tool use and applicability report. Alaska Ocean Observing System; [accessed 2016 Mar 16]. http://www.aoos.org/stamp/stamp-tools-report-final-low-res.

Turner RK, Schaafsma M. 2015. Coastal zones ecosystem services: From science to values and decision making. New York (NY): Springer International Publishing.

Villa F, Bagstad KJ, Voigt B, Johnson GW, Portela R, Honzák M, Batker D. 2014. A methodology for adaptable and robust ecosystem services assessment. PLOS ONE. 9(3):e91001.

Watts ME, Ball IR, Stewart RS, Klein CJ, Wilson K, Steinback C, Lourival E, Kircher L, Possingham HP. 2009. Marxan with zones: Software for optimal conservation based land-and sea-use zoning. Environ Model Software. 24(12):1513-1521.

Appendix B: Sea Turtle Satellite Telemetry Datasets Within the US Atlantic and Gulf of Mexico Waters Publicly Available Online Through Two Major Databases (n = 126). Sources: a) Duke University's OBIS-SEAMAP (Halpin et al. 2006, Halpin et al. 2009), and b) seaturtle.org's STAT (Coyne and Godley 2005). Data were accessed between February and March 2016. The number in the "Source" column refers to the unique identification number within the respective database; when telemetry datasets were available on both databases, only the OBIS-SEAMAP source/dataset unique identification number (ID) is listed, since OBIS-SEAMAP receives data from seaturtle.org's STAT and is the terminal data node. General region of sea turtle locations: Atl = Atlantic, GoM = Gulf of Mexico, Atl/GoM = Atlantic and Gulf of Mexico. For more information on each dataset, see datasets listed by ID in Table 3.

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
1	Cayman Islands Department of Environment	Cayman Islands 2005: Green Turtles	Janice Blumenthal	jblumenthal@seaturtle.org	a: 929	GoM
2	Conservancy of Southwest Florida	Conservancy of SW Florida Keewaydin Island Turtle Tracking Project	Kate Mansfield; Dave Addison	kate.mansfield@gmail.com; davea@conservancy.org	b: 410	GoM
3	Conservancy of Southwest Florida	Ten Thousand Islands - Kemp's Ridleys	Jeffrey Schmid	jeffs@conservancy.org	b: 1032	GoM
4	Duke University	Duke North Atlantic Turtle Tracking	Catherine McClellan	catherinemcclellan6@gmail.com	a: 316	Atl
5	Eastman Environmental	Northeast Florida Green Turtle Tracking Project	Scott Eastman	scottfeastman@gmail.com	a: 1142	Atl
6	Environmental Studies Center; University of Central Florida	Track Me at the ESC	Dianne Pierce; Dean Bagley	pierced@martin.k12.fl.us; dbagley@ucf.edu	b: 643	Atl
7	Environmental Studies Center; University of Central Florida	Track Me at the ESC II	Dianne Pierce; Dean Bagley	pierced@martin.k12.fl.us; dbagley@ucf.edu	b: 890	Atl
8	Florida Cooperative Fish & Wildlife Research Unit, University of Florida	Juvenile Green Turtles in Northwest Florida	Erin McMichael	auximenes1@yahoo.com	b: 16	GoM
9	Florida Cooperative Fish & Wildlife Research Unit, University of Florida	Juvenile Green Turtles in NW Florida II	Erin McMichael	auximenes1@yahoo.com	b: 50	GoM

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
10	Florida Cooperative Fish & Wildlife Research Unit, University of Florida	Northern Gulf of Mexico Sea Turtles	Margaret Lamont	mmlamont@mindspring.com	b: 535	GoM
11	Florida Fish and Wildlife Conservation Commission	Movements and Habitat Associations of Neonate Sea Turtles	Florida Fish and Wildlife Conservation Commission	none provided	b: 636	GoM
12	Florida Fish and Wildlife Conservation Commission; Mote Marine Laboratory	FWC-Mote Florida Loggerheads	Tony Tucker	tucker@mote.org	a: 658	GoM
13	Georgia Aquarium Research Center	Sea Turtle Rehabilitation Project	Alistair Dove	adove@georgiaaquarium.org	a: 796	Atl
14	Georgia Department of Natural Resources	Georgia Loggerhead Tracking Project 2004	Mark Dodd	mark.dodd@dnr.state.ga.us	a: 952	Atl
15	Georgia Department of Natural Resources	Georgia Loggerhead Tracking Project 2005	Mark Dodd	mark.dodd@dnr.state.ga.us	a: 953	Atl
16	Georgia Sea Turtle Center	Georgia Sea Turtle Center - Monitoring of Rehabilitated Patients	Georgia Sea Turtle Center	georgiaseaturtlecenter@jekyllisland.com	b: 262	Atl
17	Georgia Sea Turtle Center	Georgia Sea Turtle Center and Georgia Aquarium Monitoring of Released Turtles	Georgia Sea Turtle Center	georgiaseaturtlecenter@jekyllisland.com	b: 296	Atl/GoM
18	Gumbo Limbo Nature Center	Gumbo Limbo Nature Center's Rehabilitated Turtle Tracking	Kirt Rusenko	krusenko@myboca.us	b: 1004	Atl
19	Institute for Marine Mammal Studies	IMMS Ridley 1	Andy Coleman	acoleman@imms.org	a: 1080	GoM
20	Institute for Marine Mammal Studies	IMMS Ridley 2	Andy Coleman	acoleman@imms.org	a: 1081	GoM
21	Institute for Marine Mammal Studies	IMMS Ridley 3	Andy Coleman	acoleman@imms.org	a: 1082	GoM
22	Institute for Marine Mammal Studies	IMMS Ridley 4	Andy Coleman	acoleman@imms.org	a: 1083	GoM
23	Institute for Marine Mammal Studies	IMMS Ridley 5	Andy Coleman	acoleman@imms.org	a: 1084	GoM
24	Institute for Marine Mammal Studies	IMMS Ridley 6	Andy Coleman	acoleman@imms.org	a: 1085	GoM

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
25	Institute for Marine Mammal Studies	IMMS Ridley 7	Andy Coleman	acoleman@imms.org	a: 1211	GoM
26	Karen Beasley Sea Turtle Rescue and Rehabilitation Center	Rehabilitated Sea Turtles from Topsail Island, North Carolina	Jean Beasley; Matthew Godfrey	loggrhead@aol.com; godfreym@coastalnet.com	b: 23	Atl
27	Large Pelagics Research Center	2012 Massachusetts Leatherback Research	Kara Dodge	kara.dodge@post.harvard.edu	b: 666	Atl
28	Loggerhead Marinelife Center	LMC Tracking	Sarah Hirsch	shirsch@marinelife.org	b: 970	Atl/GoM
29	Louisiana Marine Mammal and Sea Turtle Rescue Program	LMMSTRP-Kemp's Ridley 1	Jamie Mullins	jmullins@auduboninstitute.org	a: 547	GoM
30	Louisiana Marine Mammal and Sea Turtle Rescue Program	Louisiana Sea Turtle Rescue Program	Kate Mansfield	kate.mansfield@noaa.gov	b: 560	GoM
31	Marine Conservation Society	Turks and Caicos Islands Turtle Project 2009 to 2015: Green & Hawksbill Turtles	Peter Richardson	peter.richardson@mcsuk.org	b: 398	Atl
32	Marine Turtle Research Group	Bald Head Island 2006: Loggerhead Turtles	Michael Coyne	mcoyne@seaturtle.org	a: 954	Atl
33	Marine Turtle Research Group	Bald Head Island 2007: Loggerhead Turtles	Michael Coyne	mcoyne@seaturtle.org	a: 955	Atl
34	Marine Turtle Research Group	Bald Head Island 2008: Loggerhead Turtles	Michael Coyne	mcoyne@seaturtle.org	a: 956	Atl
35	Marine Turtle Research Group; Karen Beasley Sea Turtle Rescue and Rehabilitation Center	Topsail Turtle Hospital 2007: Rehabilitated Loggerhead Turtle	Jean Beasley	loggrhead@aol.com	b: 218	Atl
36	Marine Turtle Research Group; seaturtle.org	Bald Head Island 2003: Loggerhead Turtles	Brendan Godley	b.j.godley@exeter.ac.uk	a: 368	Atl
37	Marine Turtle Research Group; seaturtle.org	Bald Head Island 2004: Loggerhead Turtles	Brendan Godley	b.j.godley@exeter.ac.uk	a: 402	Atl
38	Marine Turtle Research Group; seaturtle.org	Bald Head Island 2005: Loggerhead Turtles	Michael Coyne	mcoyne@seaturtle.org	a: 405	Atl
39	Marine Turtle Research Group; seaturtle.org	Newport Aquarium 2004: Loggerhead Turtle	Brendan Godley	b.j.godley@exeter.ac.uk	a: 403	Atl

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
40	Mote Marine Laboratory	Casey Key Loggerheads 2005–2006	Tony Tucker	tucker@mote.org	a: 336	Atl/GoM
41	Mote Marine Laboratory	Casey Key Loggerheads 2007	Tony Tucker	tucker@mote.org	a: 390	Atl/GoM
42	Mote Marine Laboratory	Casey Key Loggerheads 2008	Tony Tucker	tucker@mote.org	b: 260	Atl/GoM
43	Mote Marine Laboratory	Casey Key Loggerheads 2009	Tony Tucker	tucker@mote.org	a: 510	Atl/GoM
44	Mote Marine Laboratory	Casey Key Loggerheads 2010	Tony Tucker	tucker@mote.org	b: 470	Atl/GoM
45	Mote Marine Laboratory	Casey Key Loggerheads 2011	Tony Tucker	tucker@mote.org	a: 760	Atl/GoM
46	Mote Marine Laboratory	Casey Key Loggerheads 2012–2013	Tony Tucker	tucker@mote.org	a: 846	Atl/GoM
47	Mote Marine Laboratory	Charlotte Harbor - Kemp's Ridleys	Tony Tucker	tucker@mote.org	b: 569	Atl/GoM
48	Mote Marine Laboratory	Mote Marine Laboratory - Sea Turtle Rehabilitation Hospital	Kristen Mazzarella	kristen@mote.org	b: 141	Atl/GoM
49	National Aquarium Animal Rescue	National Aquarium Animal Rescue	National Aquarium Animal Rescue	animalrescue@aqua.org	b: 187	Atl
50	National Environmental Research Institute, Denmark	Transatlantic Migration and Foraging Behaviour of Azorean Loggerheads	Jesper Møller; Rikke Danø	jmr@dmu.dk; rsd@dmu.dk	b: 140	Atl/GoM
51	NMFS Northeast Fisheries Science Center	NOAA Northeast Fisheries Science Center - Satellite Tracking - AMAPPS	Heather Haas	heather.haas@noaa.gov	b: 537	Atl
52	NMFS Office of Protected Resources	Florida Loggerhead Migrations	Barbara Schroeder	barbara.schroeder@noaa.gov	a: 1342	Atl/GoM

ID	Organization	Dataset name	Primary contact	Primary contact’s email	Source	Region
53	NMFS Office of Protected Resources; Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute	Study of Loggerheads in Florida Bay	NMFS Office of Protected Resources; Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute	none provided	b: 597	Atl/GoM
54	NMFS Southeast Fisheries Science Center	Chazzahowtizka NWR Sea Turtles	Chris Sasso	chris.sasso@noaa.gov	b: 1009	GoM
55	NMFS Southeast Fisheries Science Center	NOAA Southeast Fisheries Science Center - Satellite Tracking - AMAPPS	Chris Sasso	chris.sasso@noaa.gov	b: 510	Atl
56	NMFS Southeast Fisheries Science Center	NOAA Southeast Fisheries Science Center - Satellite Tracking - Gulf of Mexico	Chris Sasso	chris.sasso@noaa.gov	b: 638	Atl
57	NMFS Southeast Fisheries Science Center	Punta Allen, Mexico	Chris Sasso	chris.sasso@noaa.gov	b: 672	GoM
58	National Marine Life Center	National Marine Life Center: Sea Turtle Releases	Sea Williams	rwilliams@nmlc.org	a: 500	Atl
59	New England Aquarium	Cape Cod Sea Turtle Release 2006	Connie Merigo	cmerigo@neaq.org	b: 174	Atl
60	New England Aquarium	Cape Cod Sea Turtle Release 2007	Connie Merigo	cmerigo@neaq.org	a: 421	Atl
61	New England Aquarium	New England Aquarium Cape Cod Release 2015	Connie Merigo	cmerigo@neaq.org	b: 1122	Atl
62	New England Aquarium	New England Aquarium Loggerhead Release Maryland 2014	Cynthia Rubio	cynthia_rubio@nps.gov	b: 1015	Atl
63	New England Aquarium	New England Aquarium loggerhead turtle release	Bob Cooper	bcoop@neaq.org	b: 43	Atl

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
64	New England Aquarium	New England Aquarium Sea Turtle Release	Connie Merigo	cmerigo@neaq.org	b: 98	Atl
65	New England Aquarium	New England Aquarium Sea Turtle Release 2013	Connie Merigo	cmerigo@neaq.org	b: 905	Atl
66	New England Aquarium	New England Aquarium Sea Turtle Release 2014	Connie Merigo	cmerigo@neaq.org	b: 1027	Atl
67	New England Aquarium	New England Aquarium Sea Turtle Tracking	Connie Merigo	cmerigo@neaq.org	b: 432	Atl
68	North Carolina Aquarium at Fort Fisher	NC Aquariums Turtle Trails	JoAnne Harcke	joanne.harcke@ncmail.net	b: 58	Atl
69	North Carolina Aquarium at Fort Fisher	NC Aquariums Turtle Trails/Topsail Sea Turtle Hospital	JoAnne Harcke	joanne.harcke@ncmail.net	b: 81	Atl
70	North Carolina Aquarium at Fort Fisher	North Carolina Aquarium at Fort Fisher Yearling Loggerheads 2012	North Carolina Aquarium at Fort Fisher	none provided	b: 796	Atl
71	North Carolina Aquarium at Fort Fisher	North Carolina Aquarium at Fort Fisher Yearling Loggerheads 2013	North Carolina Aquarium at Fort Fisher	none provided	b: 949	Atl
72	North Carolina Aquarium at Pine Knoll Shores	North Carolina Aquarium at Pine Knoll Shores Sea Turtle Awareness	Michelle Lamping	michele.lamping@ncaquariums.com	a: 491	Atl
73	North Carolina Aquariums	NC Aquariums Cold Stunned Sea Turtle Monitoring	Michelle Lamping	michele.lamping@ncaquariums.com	a: 817	Atl
74	Oceanic Resource Foundation/NOAA, National Marine Fisheries Service	Satellite Telemetry of Green Turtles (*Chelonia mydas*) Nesting in Lechuguillas, Veracruz-Mexico	Graciela Tiburcio Pintos	gtiburcio@prodigy.net.mx	b: 528	GoM

ID	Organization	Dataset name	Primary contact	Primary contact’s email	Source	Region
75	Padre Island National Seashore, US NPS	Padre Island Juvenile Kemp's Ridley	Cynthia Rubio	cynthia_rubio@nps.gov	b: 769	GoM
76	Padre Island National Seashore, US NPS	Padre Island National Seashore Green Sea Turtle Tracking Program	Cynthia Rubio	cynthia_rubio@nps.gov	b: 639	Atl/GoM
77	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2005	Cynthia Rubio	cynthia_rubio@nps.gov	b: 96	GoM
78	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2006	Cynthia Rubio	cynthia_rubio@nps.gov	b: 250	GoM
79	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2007	Cynthia Rubio	cynthia_rubio@nps.gov	b: 144	GoM
80	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2008	Cynthia Rubio	cynthia_rubio@nps.gov	b: 281	GoM
81	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2010	Cynthia Rubio	cynthia_rubio@nps.gov	b: 495	GoM
82	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2011	Cynthia Rubio	cynthia_rubio@nps.gov	b: 610	GoM
83	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2012	Cynthia Rubio	cynthia_rubio@nps.gov	b: 732	GoM
84	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2013	Cynthia Rubio	cynthia_rubio@nps.gov	b: 846	GoM

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
85	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2014	Cynthia Rubio	cynthia_rubio@nps.gov	b: 990	GoM
86	Padre Island National Seashore, US NPS	Padre Island National Seashore Kemp's Ridley Tracking Program - 2015	Cynthia Rubio	cynthia_rubio@nps.gov	b: 1087	GoM
87	Padre Island National Seashore, US NPS	Padre Island National Seashore Male Kemp's Ridley Tracking Program	Cynthia Rubio	cynthia_rubio@nps.gov	b: 770	GoM
88	Padre Island National Seashore, US NPS	Rancho Nuevo, Mexico Kemp's Ridley Tracking - 2014	Cynthia Rubio	cynthia_rubio@nps.gov	b: 991	GoM
89	Padre Island National Seashore, US NPS	Rancho Nuevo, Mexico Kemp's Ridley Tracking - 2015	Cynthia Rubio	cynthia_rubio@nps.gov	b: 1088	GoM
90	Padre Island National Seashore, US NPS	Rancho Nuevo, Mexico Kemp's Ridley Tracking 2010–2011	Cynthia Rubio	cynthia_rubio@nps.gov	b: 526	GoM
91	Padre Island National Seashore, US NPS	Veracruz, Mexico Kemp's Ridley Tracking - 2014	Cynthia Rubio	cynthia_rubio@nps.gov	b: 992	GoM
92	Padre Island National Seashore, US NPS	Veracruz, Mexico Kemp's Ridley Tracking - 2015	Cynthia Rubio	cynthia_rubio@nps.gov	b: 1089	GoM
93	Padre Island National Seashore, US NPS	Veracruz, Mexico Kemp's Ridley Tracking 2012 and 2013	Cynthia Rubio	cynthia_rubio@nps.gov	b: 739	GoM
94	Pronatura Península de Yucatán, A. C.	Migratory Routes and Husbandry Areas Identification for Marine Turtles in Yucatan Peninsula	Pronatura Península de Yucatán, A. C.	none provided	b: 667	GoM
95	seaturtle.org	North Carolina Rehabilitated Sea Turtle Monitoring Project	Michael Coyne	mcoyne@seaturtle.org	a: 996	Atl

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
96	seaturtle.org; North Carolina Wildlife Resources Commission; Duke University	North Carolina Long-Term Sea Turtle Monitoring Project	Michael Coyne	mcoyne@seaturtle.org	a: 655	Atl
97	South Carolina Aquarium Sea Turtle Rescue Program	South Carolina Aquarium Sea Turtle Rescue Program	South Carolina Aquarium Sea Turtle Rescue Program	turtlerescue@scaquarium.org	b: 215	Atl
98	South Carolina Department of Natural Resources Marine Resources Research Institute	Distributional Patterns of Reproductively Mature Adult Male Loggerheads from Cape Canaveral, FL	Mike Arendt	ArendtM@dnr.sc.gov	b: 130	Atl/GoM
99	South Carolina Department of Natural Resources (SCDNR) Marine Turtle Conservation Program	SCDNR Nesting Female Satellite Telemetry Project	Michelle Pate	coastbio@dnr.sc.gov	b: 4	Atl
100	South Carolina Department of Natural Resources, Marine Resources Research Institute	Seasonal Distributional Patterns of Juvenile Loggerheads from the Southeast	Mike Arendt	arendtM@dnr.sc.gov	b: 27	Atl
101	Texas A&M at Galveston	Movement patterns of Kemp's Ridley Sea Turtles in the Northwestern Gulf of Mexico 2004–2007	Erin Seney; Andre Landry	eeseney@gmail.com	a: 960	GoM
102	Texas A&M at Galveston	TAMUG Green Turtle Tracking	Tasha Metz	metzt@tamug.edu	b: 157	GoM
103	Texas A&M at Galveston	TAMUG Kemp's Ridley Nesters - 2011	Kimberly Reich	reichk@tamug.edu	b: 617	GoM
104	Texas A&M at Galveston	TAMUG Kemp's Ridley Nesters 2007–2008	Christie Hughes	hughesc@tamug.edu	a: 932	GoM
105	Texas A&M at Galveston	TAMUG Kemp's Ridley Tracking	Tasha Metz	metzt@tamug.edu	b: 389	GoM
106	Texas A&M at Galveston	TAMUG Kemp's Ridley Tracking 2004–2006	Tasha Metz	metzt@tamug.edu	b: 45	GoM
107	Texas A&M at Galveston	TAMUG Kemp's Ridley Tracking 2007	Erin Seney	eseney@tamu.edu	b: 208	GoM
108	Texas A&M at Galveston	TAMUG Loggerhead Tracking	Tasha Metz	metzt@tamug.edu	b: 221	GoM

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
109	Texas A&M at Galveston	TAMUG/NPS/NRDA Kemp's Ridley Nesters 2012	Kimberly Reich	reichk@tamug.edu	a: 841	GoM
110	Texas A&M at Galveston	TAMUG/NRDA Kemp's Ridley 2013	Texas A&M at Galveston	tamugturtle@yahoo.com	b: 854	GoM
111	The Aquarium at Moody Gardens	"Atlas" Loggerhead Sea Turtle Release	The Aquarium at Moody Gardens	none provided	b: 652	GoM
112	Turtle Hospital - Marathon	Turtle Hospital, Marathon Florida	Tony Tucker	turtlehosp@aol.com, tucker@mote.org	a: 583	GoM
113	University of Central Florida	Male Green Turtles of the Archie Carr NWR	Dean Bagley	dean.bagley@ucf.edu	b: 1103	Atl/GoM
114	University of Central Florida	Oceanic Loggerhead Project	Kate Mansfield	kate.mansfield@ucf.edu	a: 1100	Atl
115	University of New Hampshire	UNH Large Pelagics Research Center - 2009 Cape Code Leatherbacks	Kara Dodge	kara.dodge@post.harvard.edu	b: 423	Atl
116	US Geological Survey	Buck Island Turtles	Kristen Hart	kristen_hart@usgs.gov	a: 782	Atl/GoM
117	US Geological Survey	St. Andrew Bay Sea Turtles	US Geological Survey	none provided	b: 1035	GoM
118	US Geological Survey Greater Everglades Sea Turtles	Dry Tortugas Sea Turtles	Kristen Hart	kristen_hart@usgs.gov	b: 402	Atl/GoM
119	US Geological Survey Greater Everglades Sea Turtles	Everglades Loggerheads	US Geological Survey Greater Everglades Sea Turtles	none provided	b: 1018	Atl/GoM
120	US Geological Survey, Alabama Natural Resources	Alabama Sea Turtles	Kristen Hart	kristen_hart@usgs.gov	b: 627	GoM
121	US Geological Survey; University of Florida	Cape San Blas Loggerheads	Kristen Hart; Margaret Lamont	kristen_hart@usgs.gov; mlamont@usgs.gov	b: 530	GoM
122	Virginia Aquarium and Marine Science Center	Virginia Aquarium Tracking	Kate Mansfield	kate.mansfield@ucf.edu	a: 1205	Atl
123	Virginia Aquarium Stranding Response Program	Virginia Aquarium and US NAVY Sea Turtle Research Project	Gwen Lockhart	glockhar@virginiaaquarium.com	a: 1018	Atl
124	Virginia Aquarium Stranding Response Program	Virginia Aquarium Sea Turtle Research	Gwen Lockhart	glockhar@virginiaaquarium.com	a: 978	Atl

ID	Organization	Dataset name	Primary contact	Primary contact's email	Source	Region
125	Virginia Aquarium Stranding Response Program	Virginia Aquarium Stranding Response Program	Gwen Lockhart	glockhar@virginiaaquarium.com	a: 410	Atl
126	Virginia Institute of Marine Science Sea Turtle Stranding and Research Program	VIMS Sea Turtle Research Program	Kate Mansfield	ktlm@vims.edu	b: 8	Atl

Appendix C: Sea Turtle Research Expert Workshop Summary and Participants

C.1 Background

BOEM convened an online workshop via webinar to engage representative experts from the US sea turtle research community on October 12, 2016. Melissa Ladd, of The Baldwin Group at NOAA, facilitated the meeting and project support staff from Quantum Spatial, Inc. and Duke University were present. The purpose of the workshop was to inform the sea turtle research community representatives of BOEM study and to gather knowledge applicable to the development of the ASTER DST to assess sea turtle entrainment risk in TSHDs. Specific objectives were to:

- Inform the sea turtle research community representatives of the ASTER DST study, their contributing role, and the desired end state
- Engage sea turtle research community representatives as collaborative partners and gather knowledge applicable to the ASTER DST early in the development process
- Identify and leverage existing sea turtle telemetry data and other spatial/temporal data layers to support the tool
- Discuss opportunities to work together to continue gathering data to fill gaps that would help to decrease sea turtle entrainment risk

An introduction to the BOEM project on developing the ASTER DST to reduce sea turtle dredging entrainment risk was presented by Doug Piatkowski, of BOEM, to inform the workshop participants of the need for participation and collaboration from others outside of BOEM, including the USACE, the dredging industry, and sea turtle research communities. Following Doug's introduction, Kristen Hart from the USGS gave a short presentation on the Gulf of Mexico sea turtle satellite telemetry study she was currently leading, in collaboration with BOEM, Meg Lamont from the USGS, and Donna Shaver from the NPS. Finally, Heather Haas, of NMFS Northeast Fisheries Science Center (NEFSC), presented slides on the cooperative satellite tagging and data sharing efforts from the Atlantic Marine Assessment Program for Protected Species (AMAPPS), some initial results, and upcoming plans for estimating sea turtle density using multiple data types.

C.2 Data Priorities and Availability

For the second session, Alexa Ramirez, of Quantum Spatial, Inc., started with a presentation of key example DSTs used for other projects that were of a similar concept. Connie Kot, of Duke University, introduced potential data layers identified as useful in the ASTER DST for assessing sea turtle entrainment risk, based on other related studies predicting marine animal distribution, density, and behavior (Table C.1). The following questions were asked as prompts to reinforce the importance of their responses in relation to development of the ASTER DST:

- What are the priority variables to include?
- What is the relationship to turtles/planning?
- Are there additional variables not mentioned that should be included?
- What are possible sources for additional data needed?

Table C.1. Potentially useful data layers identified by Duke University and Quantum Spatial, Inc. for assessing sea turtle entrainment risk

Dataset Layer	
Sea Turtle Data	Behavior/Distribution Within Water Column (telemetry)
	Dedicated Survey (abundance/density)
	Historic Dredge Entrainment Events
	Location/Movements (telemetry)
	Opportunistic Surveys/Other Observations (presence/behavior)
	Predicted Density (density/habitat models)
	Relocation Trawling Data (captures)
Environmental Data	Bottom Type (hard bottom)
	Chlorophyll *a* Concentration
	Climate
	Critical Habitat Designations
	Depth (from bathymetry)
	Distance to Shoreline
	Fronts
	Geomorphology
	Habitat Areas of Particular Concern
	Human Impacts to Marine Ecosystems (e.g., fishing, shipping routes, pollution, etc.)
	Mesoscale Eddies
	Ocean Circulation
	Ocean Currents
	Photosynthetic Rates
	Photosynthetically Available Radiation (PAR)
	Rugosity (from bathymetry)
	Salinity
	Sea Surface Height
	Sea Surface Roughness
	SST
	Seagrass (presence/absence)
	Sediment Type (sand)
	Slope (from bathymetry)
	Tides
	Water Masses
	Water Velocity
	Wind

Note: These data layers were selected based on other related studies predicting marine animal distribution, density, and behavior.

Participants were first asked to review the list (Table C.1), determine which data layers, if any, may not be applicable in assessing sea turtle risk, and to bring up any additional variables not already listed that should be considered. The meeting attendees discussed the ASTER DST project extent and scope, primary use of data within the ASTER DST, possible ways the data layers should be corrected by effort, and specific types of data that may be useful under the broad data layer category listed as opportunistic surveys/observations (e.g., strandings, nesting, bycatch). Participants were then asked to vote for the critical datasets they thought should be included in the ASTER DST. The top three priority risk factors were identified as sea turtle behavior, temperature, and bottom type (Table C.2).

Table C.2. Risk factors identified and ranked by the sea turtle research experts that are potentially associated with sea turtle entrainment risk in TSHDs

<table>
<tr><th colspan="2">Sea Turtle Entrainment Risk Factors</th></tr>
<tr><td>1</td><td>Sea turtle behavior and relative abundance: More data/information about in-water sea turtles are needed to fine-tune management decisions and mitigation measures. Datasets on sea turtle behavior, prioritized in order of importance, are listed below.

The distribution of sea turtles within the water column collected by various telemetry tags was identified as the most critical data layer. To date, there is no knowledge on a large or broad scale dataset/centralized database containing data from multiple studies compiled on sea turtle behavior. Therefore, principal investigators for individual studies would be the best source.
Relocation trawling data (captures/area trawled) give more information on the presence/abundance of sea turtles occurring at the same place and time as dredging, which is information that is extremely useful in assessing entrainment risk. These data have been archived at USACE up to 2013.
Tracking the location/movements of sea turtles using satellite telemetry can show distribution on a horizontal scale at a relatively high temporal resolution. Duke University's OBIS-SEAMAP and seaturtle.org's STAT databases have catalogued many sea turtle telemetry datasets and can be the first stop for identifying applicable data and data contacts.
Information on dredge entrainment events/take per cubic yards dredged can be calculated to assess relative risk. Past case studies have shown that high abundances/presence of sea turtles in an area do not necessarily result in high entrainment risks and linking specific factors to determine likelihood of entrainment still needs to be investigated. Data are collected and archived by the USACE ODESS.
Relative densities/abundances calculated from dedicated surveys within a particular area would be more appropriate within the ASTER DST than using discrete numbers without correcting for survey effort. The OBIS-SEAMAP has catalogued numerous datasets containing sea turtle observations collected by dedicated surveys.
Predicted sea turtle density (habitat models) has been published in the past for the Atlantic by the US Navy. Updates and new models based on more current data will be available in the future (e.g., by the NEFSC and partners for the Atlantic, by the University of Central Florida for areas in the Gulf of Mexico, and by the US Navy for the Atlantic and Gulf of Mexico).
Opportunistic surveys/other observations (e.g., strandings, nesting, bycatch data) can be useful if sufficient information is available to link data to entrainment risk. It was recognized that these data can potentially fill in data gaps.
</td></tr>
</table>

Sea Turtle Entrainment Risk Factors	
2	**Temperature:** Water temperature has been shown to greatly affect sea turtle distribution and behavior, especially on a seasonal scale. • SST is a key factor commonly found to be related to sea turtle distribution, and can be obtained remotely from MODIS (moderate resolution imaging spectroradiometer) and AVHRR (advanced very high-resolution radiometer) satellite sensors. • The temperature below the surface (in the water column) may also affect how deep and how long turtles dive and spend time near the bottom, behavior that is most relevant to dredging operations and entrainment risk. • Bottom water temperature has been hypothesized as “incredibly important in determining loggerhead distribution within the water column for offshore animals.” More research is needed to determine behavior that may be correlated with measured bottom temperatures from various data sources (e.g., HYbrid Coordinate Ocean Model [HYCOM], in situ measurements, etc.).
3	**Bottom type:** Sea turtles can utilize different types of bottom, depending on their life history stage, sex, species, and season. • The presence of sand and hard bottom surfaces can be used as a baseline for where dredging can/cannot occur, which would influence the level of entrainment risk. • Research is still needed to determine habitat/bottom type preferences for sea turtles. • The US Navy has compiled the best publicly available data on bottom types and hard bottom in the US Atlantic coast and Gulf of Mexico. This is an internal database that is used for US Navy projects, such as environmental impact statements (EISs), and could be shared with BOEM for the ASTER DST if useful.
4	**Depth:** Habitat utilization at different depths can depend on sea turtle species, sex, life history stage, and season. • Currently, not enough information can be used to determine specific depth limitations, and research is ongoing to investigate sea turtle habitats. • Any available behavioral data collected by telemetry (e.g., time/depth recorders) or observations (e.g., time spent at surface vs. time spent submerged) would be useful to fill gaps.
5	**Sea floor / bottom profile**: Geomorphology, slope, and rugosity are important factors that can influence sea turtle habitat utilization on different scales. • Anecdotally, there have been evidence that sea turtles can inhabit/prefer areas after disturbance (e.g., dredging, trawling) which can imply that turtles prefer high rugosity areas for resting/feeding in troughs and valleys, thus increasing the risk of entrainment. • Generally, the morphology of the sea floor is more important than slope in increasing the likelihood of entrainment because TSHD dragheads can skip over “holes” where sea turtles cannot escape. • It may also be important to note that optimal sea turtle foraging areas could be near areas with a high slope (near ledges), because the sea turtles can more easily access deeper, warmer waters for thermoregulation, as compared to foraging in an area where the shelf break is further away.

Sea Turtle Entrainment Risk Factors	
6	**Chlorophyll *a* concentration:** The concentration of chlorophyll *a* is generally used as an indicator of productivity and prey resources. • Some sea turtle species forage in areas with a presence of seagrass/high chlorophyll *a* concentration, however, it is not yet known if this is linked to how much time they spend on the bottom or entrainment risk. • Sea surface chlorophyll *a* concentrations can be linked with the presence of pelagic foraging, but may not be highly related to benthic foraging behavior or when sea turtles are at greater risk of entrainment.
7	**Ocean currents:** Ocean currents were recognized as a possible factor affecting sea turtle entrainment risk, because they have been found to influence sea turtle prey, movements, and distribution, but more details were not specifically discussed during this meeting. In general, more research is necessary to determine the role of ocean currents and sea turtle entrainment risk in TSHDs.
8	**Critical Habitat Designations:** NOAA has delineated areas in the Atlantic and Gulf of Mexico that "contain physical or biological features essential to conservation" for loggerheads. • General areas for nearshore reproductive, breeding, migratory, and winter critical habitats have been identified within the range of the Northwest Atlantic Ocean loggerhead distinct population segment (DPS), highlighting habitats frequently utilized. These designated critical habitats can help determine entrainment risk relative to other undesignated areas. • Past and current loggerhead sea turtle studies using satellite tagging and bycatch data confirm that intense summer foraging occurs in the Mid-Atlantic shelf area and many loggerheads spend winter in the narrow corridor off of North Carolina. These seasonal movements/distributions among designated critical habitats are essential knowledge needed in the ASTER DST to assess sea turtle entrainment risk.
9	**Photosynthetically active radiation (PAR):** PAR, or the amount of solar radiation available for photosynthesis (from 400 to 700 nanometers), influences measured amounts of ocean productivity, chlorophyll *a* concentration, seagrass abundance, and other factors dependent on the sun. • PAR is correlated to many of the environmental variables (e.g., seagrass presence/absence, chlorophyll *a* concentration) commonly related to the abundance and distribution of foraging marine organisms, including sea turtles. • The vertical behavior of marine organisms within the water column, including sea turtles, may vary with PAR, and it would be useful to research this more in terms of behavior affecting entrainment risk.

C.3 Current State of Science

In the third session, workshop participants were asked to review the final list of prioritized sea turtle entrainment risk factors (Table C.2) and discuss:

- Potential sources for the sea turtle behavior and environmental data
- Frequently used databases to collate/archive data
- Ways to build on previous efforts and studies and research still needed to fill data gaps

Several sources, databases, and current studies with applicable results forthcoming were suggested. When participants were asked to re-prioritize the listed variables (Table C.2) based on what is currently available (not a knowledge/data gap), the order of the risk factors did not change. Generally, the response was that any species-specific information on the prioritized data layers, however limited, warrant inclusion, because any and all information would be useful to assess entrainment risk. Workshop participants also talked about common assumptions for how these data layers can influence levels of risk (e.g., sea turtles are less active when temperatures drop and cannot escape easily, highly rugose areas increase entrainment risk, foraging areas near the shelf break with high a slope may be more beneficial, etc.). In addition, it was stressed that there was still the need for gathering and analyzing more information on sea turtle distribution and behavior and the factors that are closely related to entrainment risk, especially when cases have shown that high abundances of sea turtles do not always lead to high entrainment numbers. The necessity to account for any mitigation measures and relative sea turtle densities when analyzing entrainment takes was mentioned. Finally, limiting the scope of the project to include only loggerhead sea turtles in the initial phase was suggested based on the amount of available information and project resources.

C.4 Developing the ASTER DST

In the fourth session, workshop participants were encouraged to provide suggestions and/or concerns for the development of the ASTER DST in response to the following prompts:

- What is the worst way the tool can be built/designed?
- How would the tool be least effective?
- What critical considerations should be made for the development of the tool?
- What is your vision of what the tool could look like and its impacts?

Discussions focused on how the process for producing any outputs of the tool should be well documented and transparent, detailing the input factors, how outcomes were derived, and the decisions that were made as a result. Incorporation of any new high-quality sea turtle behavior data at specific sites and the ability to feedback resulting information to improve future predictions were critical. Concerns for analyzing data at the appropriate scale (e.g., less than 25 square km) and developing the ASTER DST with a capacity for multiple users were also expressed. Finally, distilling relatively complex information for non-expert users and decision-makers was noted as an important need.

C.5 Closing and Next Steps

Melissa Ladd and Doug Piatkowski wrapped up the meeting by thanking everyone for participating and honestly sharing during discussions. All participants were given the opportunity to voice any additional concerns or questions. Finally, Doug Piatkowski closed by outlining the next steps for the project in the near-term, including processing and capturing the information gathered during the workshop, presenting the notes that were documented back to the participants for any additional feedback, and other possible touchpoints with participants in the future. Finalizing the initial requirements, development of the tool, and testing were also mentioned for the next project phase. In the meantime, participants were openly invited to continue discussions and offer information/suggestions for the way forward.

Feedback gathered from participants during the meeting and from post-meeting online surveys was generally very positive and most participants wanted to stay engaged by learning more about and contributing to the ASTER DST project. The schedule for interim products had not been determined at the time of the workshop, but was announced to all stakeholders interested in reviewing when ready. All participants were informed that the final ASTER DST project report was planned for 2017 that would include more details on the information gathered from this workshop.

C.6 Sea Turtle Research Expert Workshop Participants and Affiliations

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Appendix D: Dredging Industry Expert Workshop Summary and Participants

D.1 Background

BOEM convened a workshop to engage representative experts from the US dredging industry on September 13, 2016. Melissa Ladd, of The Baldwin Group at NOAA, facilitated the meeting and project support staff from Quantum Spatial, Inc. and Duke University were present. The purpose of the workshop was to inform the dredging industry representatives of BOEM study and to gather knowledge applicable to the development of the ASTER DST to assess sea turtle entrainment risk in TSHDs. Specific objectives were to:

- Inform the dredging industry representatives of the ASTER DST study, their contributing role, and the desired end state
- Engage dredging industry representatives as collaborative partners early in the development of the ASTER DST
- Solicit dredging industry knowledge on project-specific risk factors (physical, biological, geological, etc.) that reduce the efficacy of current mitigation practices and rank the significance
- Solicit recommendations from the dredging industry regarding new mitigations and/or modifications of existing mitigations to reduce entrainment risk

An introduction to the BOEM project on developing the ASTER DST to reduce sea turtle dredging entrainment risk was presented by Doug Piatkowski, of BOEM, to make the workshop participants aware of the need for participation and collaboration from others outside of BOEM, including the USACE, the dredging industry, and sea turtle research communities. Alexa Ramirez, of Quantum Spatial, Inc., presented key example DSTs used in for other projects that were of a similar concept. Workshop participants discussed the need for gathering and analyzing more information on sea turtle distribution and behavior, data quality standards, and sources, interest in partnering with other institutions to address data gaps in sea turtle biology, and the desire to use a standardized tool with continued input from dredging industry experts.

D.2 Dredging-Related Risk Factors

For the second session, participants were asked to identify dredging project-specific risk factors (physical, biological, geological, etc.) that could reduce the efficacy of current mitigation practices and rank their significance (Table D.1). The following questions were asked as prompts to reinforce the importance of their responses in relation to tool development:

- What are the challenges in minimizing entrainment?
- What are the risk factors?
- How are current mitigation practices causing problems and potentially leading to increased risk of entrainment?
- What factors increase take numbers in certain projects?

The top three priority risk factors identified included sea turtle behavior, borrow area footprint and design, and the bottom environment of the dredging area. The need for more consideration in the borrow area design during the project planning phase of a lease was a main topic of concern for many participants. Ways to investigate efficacy in current mitigation measures and sea turtle behavior, factors to consider in borrow area footprints and design for greater dredging efficiency and efficacy of existing risk reduction measures, and improvements to dredging technologies to reduce entrainment were discussed. Issues on assessing the necessary tradeoffs to “buy down” the risk of entrainment, restrictions for modifying techniques and/or dredging equipment, differential measures required across projects (e.g., relocation trawling), and how to determine the acceptable number of sea turtle takes were also brought up.

Table D.1. Risk factors associated with sea turtle entrainment in TSHDs, in order of importance

<table>
<tr><th colspan="2">Sea Turtle Entrainment Risk Factors</th></tr>
<tr><td>1</td><td>Sea turtle behavior: More data/information about in-water sea turtles are needed to fine-tune management decisions and mitigation measures
Any known project area utilization within the water column and time spent on the bottom and other behavior that makes them more vulnerable to entrainment is needed.
Changes in behavior through time (e.g., seasonal, annual) and different environmental conditions (e.g., water temperature, proximity to predominant foraging areas/food resources) would affect entrainment.
Risks of entrainment within dredged channels vs. borrow areas needs to be distinguished because of variable sea turtle ecology for those different environments.
Habitat utilization in regards to the relationship among sea turtle species distribution/movement/relative abundance and environmental features (e.g., temperature, sargassum, gyres, food resources) needs to be studied and applied to entrainment risk.</td></tr>
<tr><td>2</td><td>Borrow area footprint and design: Reduced dredging productivity due to poorly designed borrow areas increases dredging time and entrainment risk
Dredging efficiency within the borrow area footprint would increase if required project sediment volumes were obtained via shallower cumulative cut depths requiring fewer passes over a larger surface area (i.e., large ratio for total borrow surface area acreage available relative to the total volume and associated dredge depths) compared to obtaining the same volume via deeper cumulative cut depths requiring multiple passes within a smaller surface area.
Maximizing the orientation of the dredge perpendicular to sea/wind/wave direction and the length of cut to minimize the number of maneuvers would increase efficiency and reduce entrainment risk.
A borrow area footprint that supports longer dredge cuts (e.g., 6,000 to 9,000 ft lengths with a reasonable width) would result in less turns and increased efficiency compared to shorter dredge cut lengths.
Greater dredging efficiency within the borrow area would occur if the borrow area design included certain considerations, such as having a consistent bathymetric depth throughout the borrow area (minimize steep slopes and troughs) to maximize deflector efficacy and maintain consistent draghead contact with the sea floor (minimizing risk of sea turtle entrainment).
Provide for a reasonable buffer (i.e., overdepth) from unsuitable materials (suggested as at least 3 ft and preferably 5–7 ft) to increase dredging efficiency and accommodate for dredging inaccuracies. In order to effectively maximize draghead contact with the bottom while dredging the required sediment volume (especially during rough sea states) overdepth dredging is often necessary.
Minimizing corners within the borrow area would maximize area and volume that could be dredged, given limitations to maneuvering TSHDs within tight spaces while maintaining draghead contact with the bottom.</td></tr>
<tr><td>3</td><td>Sea floor/channel bottom profile and environment (pre- and post-dredging): Physical and ecological information on the pre- and post-dredging environment is needed to assess sea turtle entrainment risk for areas that could be dredged again in the future.</td></tr>
</table>

	Sea Turtle Entrainment Risk Factors
	• Bathymetry, rugosity, and geomorphology of the dredged area and how this impacts sea turtle deflector efficacy needs to be considered. For example, the weight and leading-edge angle of sea turtle deflectors can influence the path the draghead takes when dredging over highly rugose areas (i.e., “crabbing”), which may lead to inefficient dredging and increased entrainment risk. • The rugosity of the seafloor and draghead-related trenching may increase the risk of “crabbing” (when the draghead is pulled away from or under the dredge) due to the draghead falling into the trench or steep slope and orienting in a different direction from the dredge. Increased “crabbing” risk may affect sea turtle entrainment risk levels because dragheads need to be raised and reset more often during dredging to maintain vessel safety and to avoid equipment damage, thus, decreasing dredging operations efficiency. • Bathymetry may also influence the behavior of sea turtles within the borrow area if they are utilizing draghead-created trenches, bathymetric highs/lows, and other sea floor features. The decreased dredging efficiency associated with highly rugose areas, coupled with benthic oriented behavior of sea turtles may increase entrainment risk. More information is needed on sea turtle habitat use relative to seafloor rugosity and dredging-related trenching before, during, and after dredging operations. • Other factors related to the possible suspension of relocation trawl operations, such as obstructions and snagging risk on the bottom or debris in the water column, may increase down time and decrease efficiency of dredging operations, especially when regulations specify that relocation trawling must occur while dredging (i.e., “no trawl, no dredge”). Extended dredging project timelines can increase the risk of sea turtle entrainment by increasing the time dragheads are in the water, extending the project timeline to include seasons of higher sea turtle abundance, etc.
4	**Median grain size and sediment type:** Different types of sediment within the borrow area can affect efficiency of dredging effort and projects. • Efficiency of dredging for compatible sediment will be affected by the amount of fine sediment (i.e., overfill ratio). More sediment volume is needed to account for the loss of finer sediments during operations, thus, increasing project duration along with sea turtle entrainment risk. • Efficacy of the sea turtle deflecting draghead may be affected if sediment is too dense when a certain range of gradations are present. Sediment that is too dense may result in the inability of the deflector to plow through the sediment effectively, raising the draghead off the bottom, and increasing entrainment risk due to suboptimal draghead configurations (e.g., consistent contact of the draghead with the bottom is more difficult, because it bounces off of the bottom more and presents difficulties maintaining the aft visor of the draghead on the bottom, etc.). • Isopach (material thickness) relative to the total area of the borrow site will affect the efficiency of TSHDs and project time/production; thus, it is important to maintain a balance between the total surface area of the borrow site and material thickness. For example, though a thick isopach is a positive factor, dredging a small surface area with thick isopach of compatible sediment is less efficient than dredging a larger area with a thinner isopach, because a larger area can allow for greater maneuverability. • Geotechnical analysis below the desired cut depth is needed for more informed dredging and to facilitate overdepth dredging decisions.

Sea Turtle Entrainment Risk Factors	
5	**Factors associated with season and weather:** Other factors related to season and weather were identified as increasing entrainment risk due to their influence on overall dredging productivity. • The duration of a dredging project can vary greatly depending on the time of year due to the increase in limiting environmental factors during certain seasons (e.g., adverse weather conditions, significant wave height, etc.), which can affect risk of entrainment based on dredging efficiency and duration. • Higher sea state, stronger surface currents, etc. may increase "crabbing" risk and decrease the ability to keep dragheads hard on the bottom at all times. An increase in significant wave height also decreases the ability to keep dragheads hard on the bottom at all times and increases the likelihood that the dredge will need to dredge perpendicular to the prevailing sea direction, which may or may not be ideal relative to the orientation of the borrow area. • Relocation trawling operations are more constrained by sea state conditions than dredging (e.g., cannot operate under certain weather conditions, significant wave height, etc.), so when operations are delayed because relocation trawling is deemed a necessary mitigation measure, operational run times increase, thus increasing risk based on project duration ("no trawl, no dredge").
6	**Current dredging operation gear and methods:** Other factors related to the way TSHDs are currently configured or methods used to dredge were identified as possibly affecting entrainment risk and the need to investigate sea turtle behavior and when/how entrainment occurs was acknowledged. • Turtle parts as well as uninjured, live sea turtles have been found in inflow baskets where dragheads have intake screens installed, primarily to prevent UXO or MEC from being dredged; the intake screens also prevent sea turtles from entering through the draghead. The possibility of sea turtles entering the dredge via alternative ports of entry, such as the trunnion port when the drag arm is disengaged, has not been thoroughly researched. Therefore, risks associated with other entry point aspects of the vessel other than the draghead for sea turtles that are not on the bottom are possible but are mostly unknown. • The sea turtle deflector on the draghead can also cause extra trenching during operations, which can increase entrainment risk because of decreased efficiency, "crabbing," and decreased ability for the draghead to remain fixed on the bottom while pumps are on. Removal of the deflector could potentially reduce entrainment risk in certain circumstances. • Heavier equipment (e.g., sea turtle deflector, etc.) can also reduce fuel efficiency and increase emissions, while increasing project time and exposure of sea turtles to dredging. • Sea turtle behavior in relation to dredging operations occurring at different water temperatures should be analyzed to fine-tune dredging windows historically established by a set minimum temperature.

D.3 New and Improved Mitigation Measures

After the risks had been identified and prioritized, participants were asked in the third session to suggest any new mitigation measures or improvements to the current mitigations that could potentially be used to minimize the risk of sea turtle entrainment (Table D.2). Participants were given the following prompts to consider before discussion commenced:

- What are your thoughts for modifying, deleting, adding mitigation measures?
- What new "innovative" technologies are on the table since the deflecting draghead was developed?

- What else could help that may not even be a new mitigation technology?

Suggestions included several methods that have the potential of moving sea turtles from the dredging area or immediate path of the draghead, improving the borrow area design to increase efficiency and time the draghead makes contact with the bottom, emphasizing the importance of collaboration, coordination, and education among stakeholders, and strategically collecting more information to fill data gaps to fine-tune management decisions on a project-level scale. Many participants agreed on the need for more flexibility (either in current regulations, or details written within the NMFS Biological Opinions) to research innovative ways to minimize sea turtle entrainment and that this should be a priority. Placing more responsibility on the dredging community to explore more options would be beneficial. Efforts to share insights and expertise from dredging industry representatives with NMFS should be considered when refining current and developing new mitigation measures.

Table D.2. Suggested dredging mitigation measures and innovations to reduce sea turtle entrainment, listed in no particular order.

	Dredging Mitigation Measures and Innovations to Reduce Sea Turtle Entrainment
1	**Using "tickler chains" on drag arms to move sea turtles** • Using a 25' chain curtain ("tickler chain") connected to drag arm ahead of the sea turtle deflector may stimulate sea turtles to swim away from the dredging path. • A "tickler chain" could increase dredging productivity and reduce overall draghead bottom time. • Efficacy of using the chain curtain as an alternative to the current sea turtle deflector may depend on the project and needs to be tested.
2	**Applying borrow area design BMPs** • For increased efficiency, there should be a high ratio for available surface area acreage relative to the total volume of materials and associated dredge depths. • The orientation of the dredge perpendicular to sea/wind/wave direction and the length of cut should be maximized to minimize the number of maneuvers, increase efficiency, and reduce entrainment risk. • An area with consistent depth/relatively flat would be more efficiently dredged. • Reducing sharp corners in the borrow area footprint would help improve estimates in design volume because of limitations in TSHD maneuverability. • Educating engineers on BMPs for efficient borrow area design to minimize risk was suggested.
3	**Increasing flexibility for innovation based on dredging project-specific factors** • Dredging environmental windows should be based on science and operational logic. • Removing the sea turtle deflector when conditions do not promote efficacy should be an option when warranted. • There needs to be support and incentives for dredging industry-led innovation to minimize sea turtle entrainment.
4	**Using water injections to move sea turtles** • Water jets installed ahead of dragheads may help move sea turtles away from the dredging path. • More research needs to be conducted on efficacy.

	Dredging Mitigation Measures and Innovations to Reduce Sea Turtle Entrainment
5	**Using bed-leveling techniques to increase efficiency and decrease risk** • Allowing for the use of efficient bed-leveler designs and techniques where applicable may improve dredging efficiency and reduce the likelihood sea turtles inhabiting trenches when peaks and valley of the dredge area are leveled. • Efficacy of using a bed-leveler depends on the sediment type/grain size, and sea state at the borrow area. • The currently suggested “sea turtle friendly” bed-leveler design has not been found to be effective in leveling sediment within the dredge area and more research needs to be conducted on the efficacy of this bed-leveling design before being required. The results of a recent study titled “Bed Leveler Evaluation Report (June 2013)” conducted by the USACE Savannah District should be evaluated to support potential use of “traditional” bed-leveling devices for other projects.
6	**Accounting for varying ground pressure** • Improved ways to monitor and adjust ground pressure could increase ways to maintain draghead contact with the bottom in varying sediment types and rugose areas, decrease sea turtle entrainment risk, and increase dredging efficiency with changing bathymetry. • More research needs to be conducted on best practices/methods.
7	**Using non-capture trawl sweeping** • Non-capture trawl sweeping should be considered as measure to move sea turtles off the bottom and out of harm’s way. • More research needs to be conducted on efficacy.
8	**Improving relocation trawling methods** • “Tickler chains” on relocation trawlers could be a modification to help stimulate sea turtles to move away, rather than using trawling alone. • More research needs to be conducted on the efficacy of current relocation trawling methods so that applicable improvements can be made.
9	**Improving current draghead types and configurations** • The current configuration of the draghead sea turtle deflector may not be the best solution for all projects, and there needs to be more flexibility in the NMFS Biological Opinion for alterations in order to research further. • “Slotted” or “open” deflectors has been suggested by the dredging industry representatives as possible options to research efficiently limiting the draghead time in the water and reducing entrainment. • The level of entrainment risk that is dependent on the different types of dragheads used (e.g., IHC Wild Dragon©, ripper, etc.) also needs more research.
10	**Increasing collaboration across agencies and communities** • Communicating with practitioners and managers regarding the use and evaluation of a standardized tool/method (such as the proposed ASTER DST) is needed for any improved decision-making. • Regional collaboration among stakeholders in different communities (e.g., sea turtle research, research engineers, dredging industry, etc.) should be promoted to support more informed decisions.

Dredging Mitigation Measures and Innovations to Reduce Sea Turtle Entrainment	
11	**Making strategic investments to fill data gaps that can "fine-tune" management decisions** • Purchasing scientific research tag/equipment and coordinating with regional partners to take advantage of opportunistic tag/research opportunities was suggested. • Investigating in the feasibility of side scan sonar technology to detect sea turtle presence and assess abundance within a borrow area could be a priority. • Investigating in the feasibility of monitoring sea turtle presence with the use of acoustic cameras and high definition videos is needed. • Researching other ways to deter sea turtles, possibly from lessons learned in the fisheries community (e.g., black lights on sharks/predator shapes to scare sea turtles, lightsticks, acoustics, etc.) or researching physical properties (e.g., suction fields) within the pipe and surrounding a draghead was mentioned. • Building flexibility for gathering sea turtle information opportunistically in future NMFS Biological Opinions as an alternative to requiring ESA Section 10 permits allowing direct and incidental take for scientific purposes or to enhance survival of sea turtles, was determined as highly important.

D.4 Developing the ASTER DST

In the fourth session, workshop participants were encouraged to provide suggestions and/or concerns for the development of the ASTER DST in response to the following prompts:

- What is the worst way the tool can be built/designed?
- How would the tool be least effective?
- What critical considerations should be made for the development of the tool?
- What is your vision of what the tool could look like and its impacts?

Discussions focused on how the process for producing any outputs of the tool should be well documented, detailing the input factors and any associated weights, along with how each variable affected the results (e.g., risk of entrainment is lowered because project time decreased, dragheads were in contact with the bottom more regularly, etc.). Incorporation of high-quality sea turtle behavior data at depth, shape and size of the lease area along with length of cuts, and bathymetry parameters (e.g., slope, rugosity, slope, geomorphology) and its relation to the amount of contact the draghead had with the bottom were critical. Concerns were expressed for further limiting or restricting current allowances for dredging, such as shortening the currently established dredge environmental window, was expressed. Therefore, enabling the ASTER DST to help analyze additional opportunities to dredge under specific parameters outside of the established dredge environmental window was suggested. Furthermore, any formal summary report or accompanying document must be able to educate others, especially dredge area design engineers and resource managers. Any new data/information should be able to feed back into the tool to enable adaptive management. Finally, continued guidance from the dredging industry expert representatives and other stakeholders was emphasized as integral.

D.5 Closing and Next Steps

Melissa Ladd and Doug Piatkowski wrapped up the meeting by thanking everyone for participating and honestly sharing during discussions. All participants were given the opportunity to voice any additional concerns or questions. For the next steps in developing the ASTER DST, Alexa Ramirez summarized recommendations gathered from the workshop:

- An accompanying user manual including the explanation of variables and weights is needed.
- Results are documented in a report with details on variables used and how it affects dredging operations and entrainment risk.
- Variables that are important to include in the ASTER DST include sea turtle behavior data, shape and size of lease area, and bathymetry, and related aspects such as slope, rugosity, and effects on draghead connectivity with the bottom.

Finally, Doug Piatkowski closed by outlining the next steps for the project in the near-term, including processing and capturing the information gathered during the workshop, presenting the notes that were documented back to the participants for any additional feedback, and using the information within any accompanying document supporting the tool. Finalizing the initial requirements, development of the tool, and testing were also mentioned for the next project phase. In the meantime, participants were openly invited to continue discussions and offer information/suggestions for the way forward. Suggestions for additional members to engage that were not already present at the workshop were: other dredging industry experts, other USACE staff from the South Atlantic, North Atlantic, and Gulf of Mexico Divisions, and consultants, geotechnical experts, and coastal engineers involved in borrow area layout and design.

Feedback gathered from participants during the meeting and from post-meeting hand-written surveys was generally very positive and all participants wanted to stay engaged by learning more about and contributing to the ASTER DST project. The schedule for interim products had not been determined at the time of the workshop, but was announced to all stakeholders interested in reviewing when ready. All participants were informed that the final ASTER DST project report was planned for 2017 that would include more details on the information gathered from this workshop.

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Appendix E: ASTER DST Technical Architecture

ASTER
Analyzing Sea Turtle Entrainment Risk

Authors:
Kevin Criss, Jeff Skahill, Alexa Ramirez

Version:
2.0, 11/6/2017

BOEM
Bureau of Ocean Energy Management

Office for Coastal Management
National Oceanic and Atmospheric Administration

quantum SPATIAL

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Preface

In the fall of 2013, Photo Science merged with Watershed Sciences and AeroMetric to form Quantum Spatial, Inc. Although fully integrated into Quantum Spatial, Inc., Photo Science will remain the legal name/entity under the NOAA Coastal Geospatial Services Contract (CGSC), for the duration of the contract. In this and other project documents Photo Science is referred to as Quantum Spatial, Inc. (QSI).

Contents

E.1 Introduction

The BOEM MMP has documented an increasing trend in the need for offshore OCS sediment resources to support shore protection and coastal restoration projects along the Atlantic and Gulf coasts. These projects are designed to protect infrastructure and the environment from beach erosion and may require use of TSHDs to extract sediment from the offshore environment and place it on the beach. To reduce risk to sea turtles associated with the increased use of TSHDs, BOEM developed a standardized DST to assist in making informed decisions to guide mitigation planning decisions, minimize impacts to sea turtles, and decrease dredging costs.

QSI was contracted by BOEM and NOAA, to design and build this DST with input from technical expert representatives from both the sea turtle scientific community and dredging industry.

E.2 Purpose

This document describes the Technical Architecture of the ASTER DST, which was developed to deliver a software application for spatially analyzing entrainment risks to sea turtles using a standardized process. The document details the technologies used to implement the designed functionality while meeting the technical, operational, and transitional requirements described in the Software Requirements Specification and Application Wireframes.

The goal of this technical architecture is to define the technologies, products, and techniques necessary to develop and support the system, and to communicate the system components.

E.3 Application Architecture

The solution is a web-based mapping application operational on a standard internet browser. The technologies chosen for the application were selected because they meet the functional requirements and are consistent with other applications being developed for BOEM. This section describes the technology platform or stack used to develop and deploy the solution.

E.3.1 Software Architecture

Figure E.1 below illustrates the technology stack that was utilized for development of the application.
Data Tier – Data storage utilized a SQL Server 2012 database instance in Amazon's Relational Database Services tier.

> Instance: publicrds.cyksjx6kygfm.us-east-1.rds.amazonaws.com
> Database: SeaTurtleDST

GIS Service Tier – ESRI's ArcGIS Server was used to create the geoprocessing (client and server side processing) logic and for provisioning feature map services. The ESRI ArcGIS python library called ArcPy and a third-party python library called python-pdfkit were utilized to create PDF documents of the output reports.

ArcGIS REST Services Directory: http://dev-public.quantumspatial.com/arcgis/rest/services

Presentation Tier – Leaflet and HTML5 were utilized to render the front-end application and provide user functionality. The sites are enabled with secure login to restrict unauthorized access. Contact doug.piatkowski@boem.gov for permissions. The development site was created to test new functionality within the framework of the system. Once testing was complete and functionality was approved, it was published to the demonstration site for client review.

Development Site: http://dev-public.quantumspatial.com/dev
Demonstration Site: http://dev-public.quantumspatial.com/demo

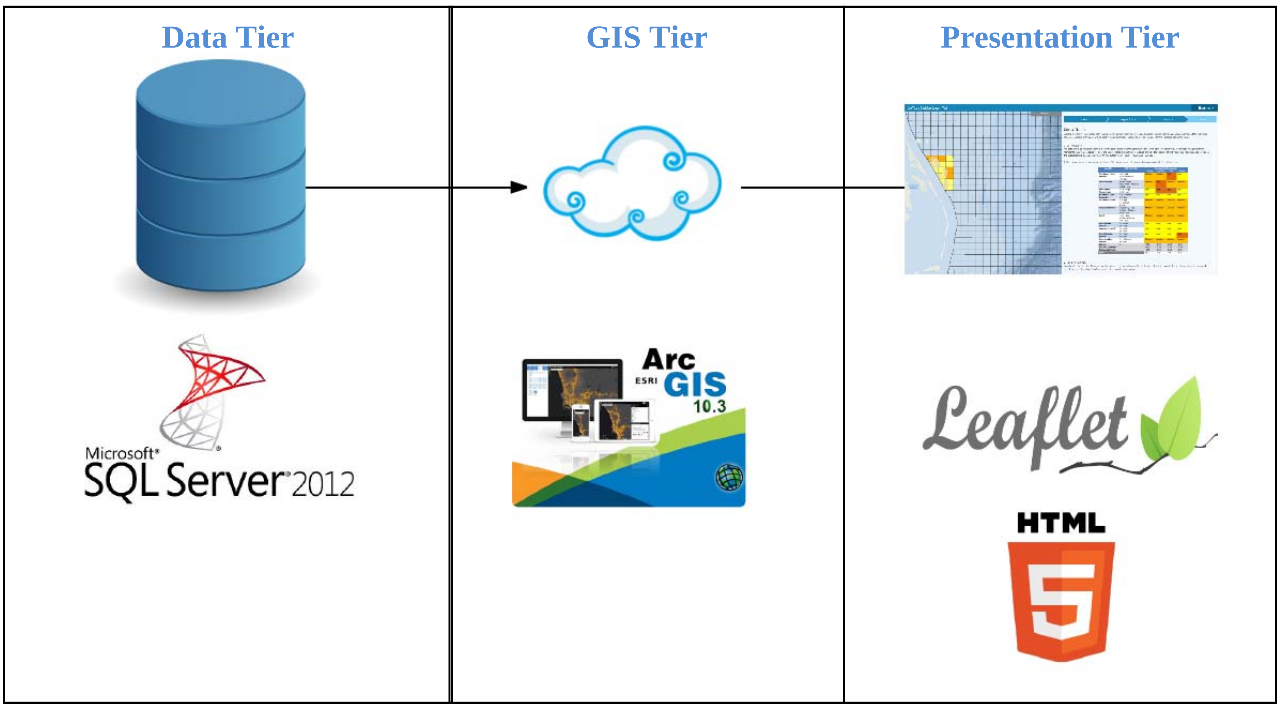

Figure E-1. High-level architecture.

E.3.2 Code Standards and Version Control

The products built for this contract utilized JavaScript, HTML5, and CSS. BOEM did not have established coding guidelines or code reviews, so QSI used industry best practices, such as the Open Web Application Security Project (OWASP) Code Review Guide, to ensure that code is usable, secure, scalable, and maintainable. Code included comments to make it easier to maintain by BOEM.

Code for the application was stored in a code repository. During development, daily commits of the code were made to a QSI owned GitHub repository. QSI made this repository available to BOEM staff for code review at any time during development. The final source code was delivered to BOEM in .zip format for archiving and maintenance.

BOEM was in the process of setting up HP WebInspect to use for vulnerability scanning of custom applications. QSI supported vulnerability scanning of our solution and addressed any issues identified in the results.

E.3.3 Section 508 Amendment to the Rehabilitation Act (508 Compliance)

The Section 508 Amendment to the Rehabilitation Act of 1973 was enacted to ensure information technology is accessible to people with disabilities. BOEM does not have set targets for 508 compliance, so QSI leveraged capabilities implemented on other Federal software projects to ensure the products were accessible to visually impaired individuals. This includes capabilities like being able to tab through elements on the screen in order and including machine readable text on every element in the page.

E.3.4 Browser Support

QSI tested the products using Chrome and Internet Explorer to ensure it was accessible through BOEM supported browsers.

E.3.5 Mobile Support

No specific requirements were designated for mobile support, but QSI used standard design principles to develop a mobile friendly website. These mobile friendly principles include small size images for faster loading, larger fonts for easier reading, and buttons far enough apart to accommodate use of fingers to select.

E.4 Physical Architecture

E.4.1 Development Infrastructure

The application infrastructure was developed in a cloud based environment provided by the hosting service, Amazon EC2. The production environment has yet to be identified but is targeted for the Marine Mineral Program enterprise GIS shared infrastructure. Figure E.2 below is a diagram describing the development environment including the server layout, the hardware specifications and core software installations that support this solution.

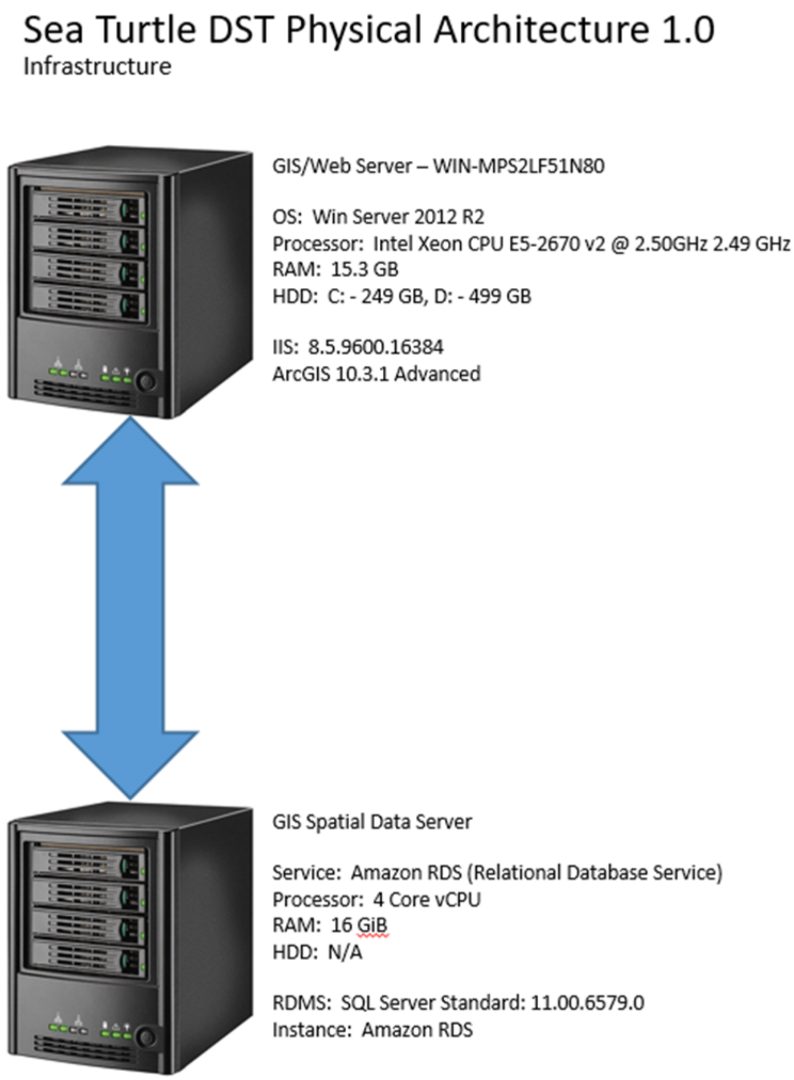

Figure E-2. QSI development server architecture.

E.4.2 Production Infrastructure

QSI worked with BOEM to identify and support deployment to a production location for the system to operate. The targeted production location is on the Department of Interior's Denver Data Center (DDC). Currently, the BOEM MMIS project has a test and production platform that supports the same technology stack the ASTER DST utilizes and is described in Section 3 of this document. QSI leveraged their role on the MMIS project to ensure both systems continue to use the same technologies so that the ASTER DST can eventually live on the same DOI testing and production infrastructure as the MMIS. Sharing IT infrastructure will reduce costs for operation and maintenance of both systems.

E.5 Functional Architecture

This section describes the high-level functions or use cases for the ASTER DST solution (Table E.1). The functional blocks of interaction between the user and system are illustrated visually in the workflow diagram. Each system action in the diagram is then technically explained.

Table E.1. System functional components

Action ID	Description	Parent Req
SA01	**System loads layers** – The application loads a map and a set of layers using ESRI for Leaflet and Leaflet.	**FR01,9,17**
SA02	**Tool opens** – An HTML form is built using HTML, CSS and Leaflet	**FR02**
SA03	**Pick time of year** – Using HTML a drop-down is available to the user.	**FR06**
SA04	**Select AOI** – Using ESRI for Leaflet a polygon is drawn on the map. This polygon is passed to a python based geoprocessing service. This service returns a collection of OCS blocks with analysis information available in the selected area.	**FR03, 10, 17,18**
SA05	**Select variables for analysis** – Using the returned collection of OCS blocks from the selection geoprocessing service the CSS enable\disable of each analysis checkbox and slider will be set.	**FR04,12**
SA06	**Set variable ranges (H/M/L)** – After selecting each variable checkbox the corresponding slider will be enabled using JavaScript. For each Low\Medium\High slider the range value will be assigned based on the OCS blocks collection.	**FR04,12**
SA07	**Analyze risk** – The selected time of year, all variable checkbox values, slider values and selected OCS blocks are organized into a geoprocessing property collection and passed to a python High/Medium/Low geoprocessing service. The geoprocessing service returns OCS blocks with data organized based on the time of year value and a quantified 1, 2, or 3 value for each selected variable and slider value.	**FR07,10,12, 13,14**
SA08	**Set the absolute risk** – Using Leaflet a chart will display the selected information based on risk and count. A two thumb HTML slider is used to set the absolute risk value.	**FR07**
SA09	**Review results** – Using ESRI for Leaflet, a symbology is created from the absolute risk value and applied to the output OCS blocks. The OCS blocks are then placed on the map for display.	**FR05,8,20**
SA10	**Show mitigations** – A web form is displayed using Leaflet for mitigations. This form has a list of available mitigation options and values.	**FR13,15**
SA11	**Select mitigations** – Mitigation values are passed to geoprocessing service and values are added. OCS Blocks with mitigated values are passed back to application. Risk scores are adjusted on the fly and displayed to viewer as mitigations are selected.	**FR05,11, 12,13,14**
SA12	**Review results** – Using HTML and Leaflet the review results page displays report information. Using ESRI for Leaflet the output OCS blocks symbology is displayed using the selected mitigation values and placed on the results map.	**FR05,11, 12,13,14, 15,20**
SA13	**Create report** – Using ESRI for Leaflet the OCS Blocks with mitigated attribution and the html markup are passed to a python geoprocessing service. This service creates a OCS blocks map layer, applies the symbology to the OCS blocks map layer, saves the OCS blocks and creates a representation for the OCS blocks within a file geodatabase. The geoprocessing service then generates a PDF report from the HTML markup. The service finally packages the file geodatabase and PDF report in a zip and returns a URL for download.	**FR11,5,15, 20,21,22, 23,24,25, 26,27**

E.6 Data Architecture

E.6.1 Data Model

The data model contains two types of relationships between supporting data and the block grid used to define analysis areas. The block grid is a combination of BOEM Outer Continental Shelf Leasing Blocks and blocks of the same size created to cover the nearshore state waters.

The first relationship was created between vector datasets and the block grid using spatial intersects and definition queries. For instance, each block was recorded as either having or not having an overlapping sand resource polygon. The second relationship was created between raster datasets and the block grid utilizing spatial statistics tools like Zonal Statistics and Surface Information to derive mean or sum values of raster cells that fall within a block (Figure E.4).

Several of the raster and vector datasets also contain a temporal component that is aggregated in the block grid attributes. There are two forms of aggregation within the data model. The first incorporates a set of seasonal attributes for all temporally affected datasets. The second is a monthly aggregation.

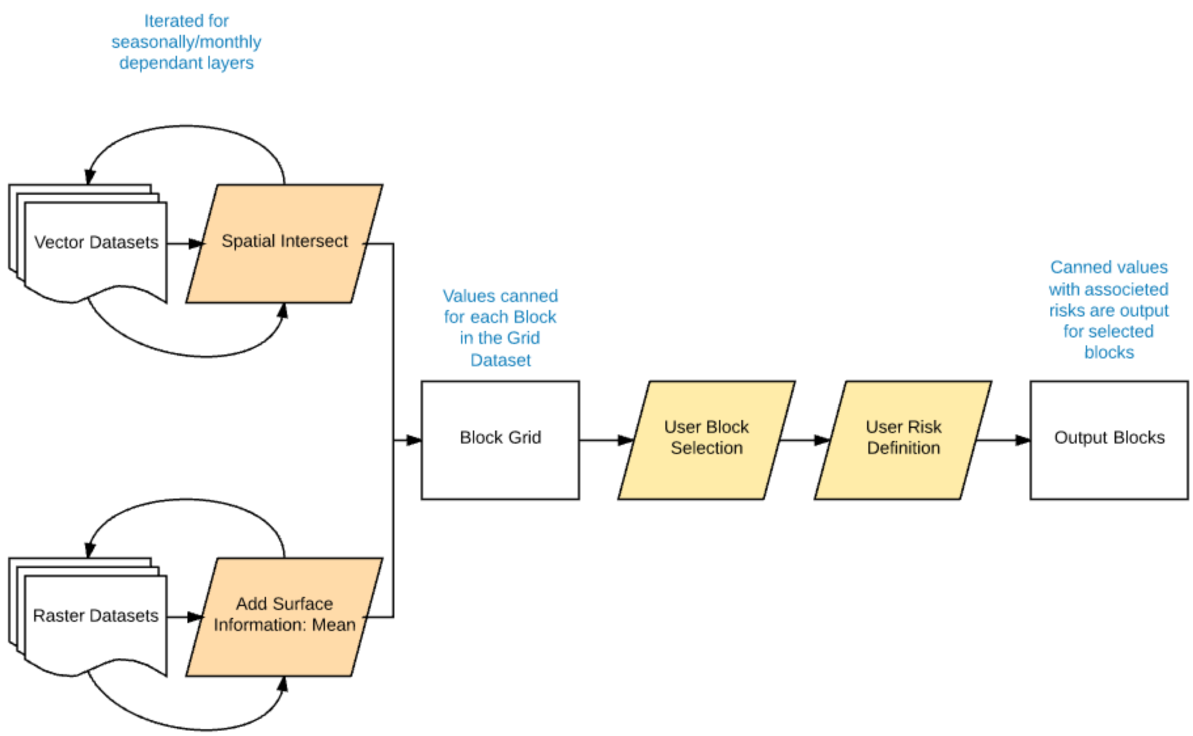

Figure E-4: Geoprocessing workflow

Data sets developed for the ASTER tool were chosen based on results of the literature review, feedback from turtle scientists and dredge industry representatives, and the ability to find publicly available data. Table E.2 identifies the high priority requirements established by these interactions and proposed source locations. The parent business requirement associated with the data requirement is also listed to cross reference with the Software Requirement Specification document submitted as a deliverable for this project.

Table E.2. High priority data requirements

Req.ID	Requirement	Parent Req
DR01	Telemetry Data with Z values (depth behavior) - OBIS-SEAMAP	BR01
DR02	Telemetry Data with XY values (distribution) - OBIS-SEAMAP	BR01
DR03	Dedicated Survey Data (abundance/density) - OBIS-SEAMAP	BR01
DR04	Relocation Trawling Data (normalized for effort) – USACE ODESS	BR01
DR05	Dredge Entrainment Events (normalized for effort) - USACE ODESS	BR01
DR06	Predicted Density Models - US Navy/Marine Cadastre.gov	BR01
DR07	Opportunistic Surveys (presence) - OBIS-SEAMAP	BR01
DR08	Temperature - GHRSST L4 CMC/MGET Tool	BR01
DR09	Bottom Type - US Navy DB, SEAMAP, NOAA Benthic Cover, TNC NAMERA, Seagrass layers	BR01
DR10	Depth - GEBCO, NOAA Coastal Relief Model, or input raster	BR01
DR11	Slope (derived from depth) - GEBCO, NOAA Coastal Relief Model, or input raster	BR01
DR12	Rugosity (derived from slope) - GEBCO, NOAA Coastal Relief Model, or input raster	BR01
DR13	Sediment Type - USGS usSEABED/Marine Cadastre.gov	BR01
DR14	Chlorophyll *a* - MODIS-Aqua/MGET Tool	BR01
DR15	Critical Habitat Designations - NOAA/Marine Cadastre.gov	BR01
DR16	Ocean Currents - OSCAR/MGET Tool	BR01
DR17	Significant Wave Height - AVISO/MGET Tool	BR01
DR18	Wind - AVISO/MGET Tool	BR01

E.6.2 Data Storage

Data will be stored within a single Microsoft SQL Server database. The ESRI ArcSDE Schema was used to host and manage spatial data for this application.

E.7 Security

Security requirements for the production instance of this application have yet to be defined. For this phase of the project, a low level of security was implemented within the development environment utilizing the localized internet information server windows authentication method. A single local user was created and allowed access to the application.

E.8 Risks & Assumptions

Table E.3 includes a list of risks and assumptions that QSI considered while developing this project.

Table E.3. Risks & assumptions

Req. ID	Assumptions
AS01	This solution depends on a common set of server technologies including a web server, spatial server, and database server. It is understood by the project team that BOEM has limited IT resources to host and maintain the required infrastructure. Beyond the agreement end date, it is uncertain how the solution will be hosted and maintained. Should BOEM identify a hosting infrastructure, the technical project team will deploy the solution to the production environment. If a production environment cannot be identified before the project end date, the solution will be delivered in source code format. The team will work with Lora Turner and the MMIS team to leverage the MMIS platform that is currently in development.
AS02	The team has yet to identify BOEM technical resources who can provide information on BOEM supported technologies or coding reviews and best practices. The team will work with Lora Turner and the MMIS team to follow the same practices used for the MMIS application.

E.9 Acronym Definitions

Below is a list of acronyms used throughout the document and the definition.

- SA – system action
- DR – data requirement
- BR – business requirement
- AS – assumption

Appendix F: ASTER DST User Manual

ASTER

Analyzing Sea Turtle Entrainment Risk

Author:
Alexa Ramirez

Version: 2.0
11/06/2017

BOEM
Bureau of Ocean Energy Management

Office for Coastal Management
National Oceanic and Atmospheric Administration

quantum SPATIAL

Acknowledgments

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Preface

In the fall of 2013, Photo Science merged with Watershed Sciences and AeroMetric to form QSI. Although fully integrated into QSI, Photo Science will remain the legal name/entity under the NOAA CGSC, for the duration of the contract. In this and other project documents, Photo Science is referred to as QSI.

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F.1 Summary

This document contains information on how to use the ASTER DST. Also included is information on how to interpret the results and the logic that went into getting them.

The BOEM MMP is tasked with managing the use of marine minerals on the OCS in an environmentally responsible way. QSI has been contracted by BOEM, through an interagency agreement with NOAA, to develop a DST that integrates multiple data sources within a simple and standardized user interface to support risk- based planning decisions.

Through execution of this project, BOEM will develop a tool to help reduce sea turtle entrainment risk associated with dredging OCS sediment resources to support shore protection and coastal restoration projects along the Atlantic and Gulf coasts. These projects are designed to protect infrastructure and the environment from beach erosion and may require the use of TSHD operations to excavate OCS sand resources. The tool will function to assist in making informed decisions to guide mitigation planning decisions, minimize impacts to sea turtles, and potentially decrease dredging costs. Information for this tool was gathered from technical expert representatives from both the sea turtle community and the dredging industry.

F.2 Getting Started

To access the ASTER DST, please contact Doug Piatkowski (doug.piatkowski@boem.gov) for a link to the application and credentials.

F.2.1 Splash Page

The link opens the introductory page of the tool, henceforth known as the "splash page" (Figure F.1). This page includes our mission statement and high-level instructions on how to use the tool and links to related sites of interest and the buttons needed to get the analysis started.

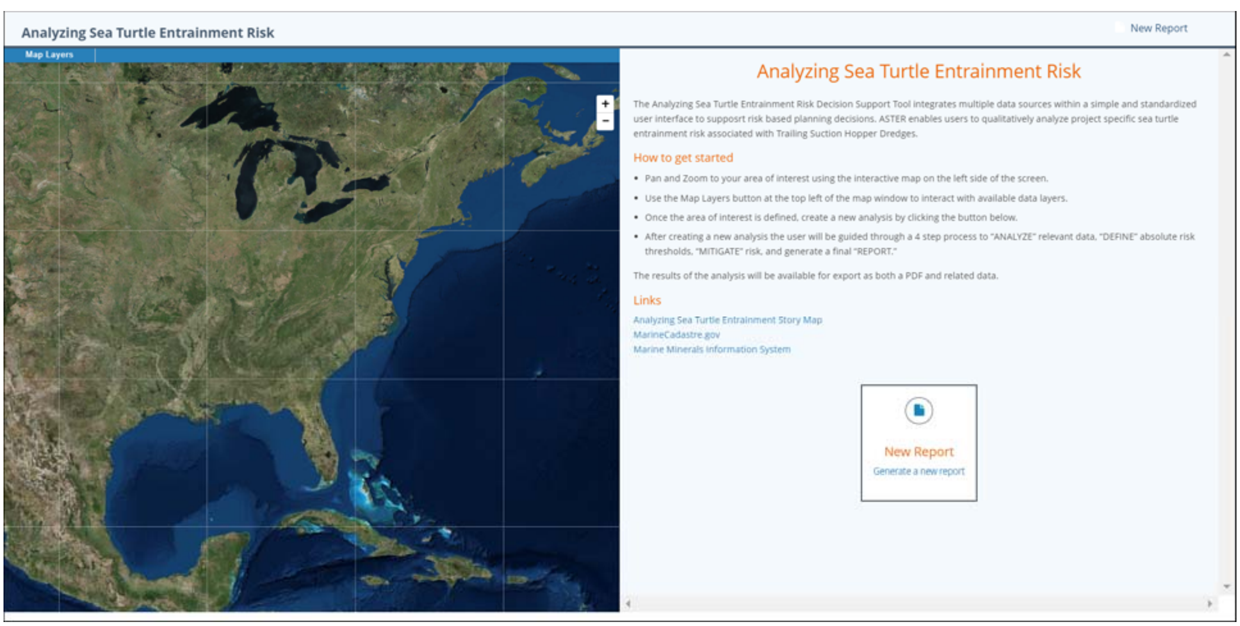


Figure F-1. The opening 'splash page' of the ASTER tool.

F.2.1.1 Map

The left panel on the splash page is a map containing the available analysis area, the US Gulf of Mexico and Atlantic coastal waters. Use the mouse wheel to zoom and left-click button pan to an AOI. The paired plus and minus symbols (upper righthand corner of the map) will also zoom in and out, respectively and double-clicking will also zoom in.

F.2.1.2 Map Layers

In the top left corner of the map panel is a Map Layers label, which is a drop-down menu containing all data layers identified by technical experts which could be considered relevant to analyzing sea turtle entrainment risk. Left-click on the map layers button to expand the menu down and show available data layers, as a group and individually. The layers are scale dependent and become active as a user zooms farther in. Then select the adjacent check box to display the relevant data in the AOI.

Many of the layers are global in scale, and load times are prohibitive therefore data layers are displayed at various scales. If a layer in the list is grayed out and italicized, zoom in closer until it becomes available to view.

Some data layers have nested layers (Figure F-2). For instance the Hard Bottom group contains four layers representing different sources of hard bottom data. Both the group level checkbox and an individual nested layer will need to be enabled with a check to be displayed.

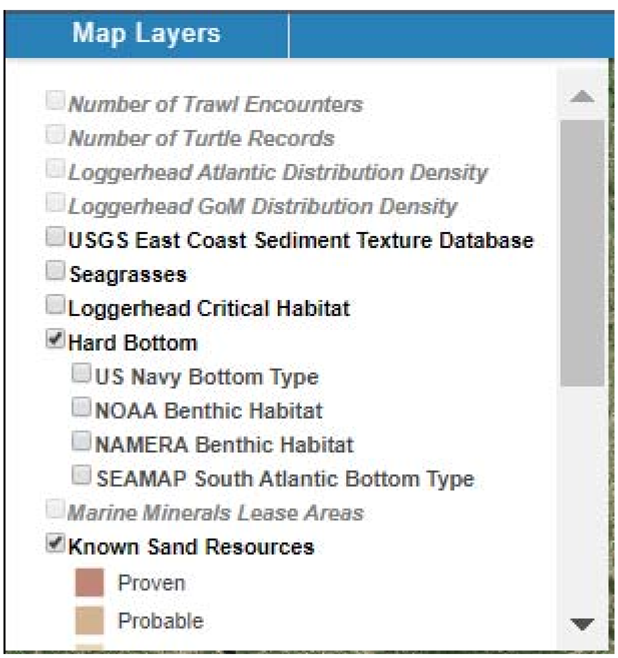


Figure F-2. Map layers
Gray italics = inactive map layers. Bold black = available layers. Nested layers are open under hard bottom.

F.2.1.3 Links
Links to related sites of interest are included at the bottom of the splash page. Summaries of each link are provided below:

- **ASTER Story Map -** A more detailed review of the mission of the ASTER tool can be found in the ASTER Story Map. This Story Map provides background information on dredging/sand resources and sea turtle surveying, as well as an explanation of the path of the tool development.
- **MarineCadastre.gov –** Many of the variables used in the tool's approach originated from this Federal online resource. This portal is a valuable resource for additional information to support the results determined by a user's chosen variables, mitigation techniques, and subsequent analysis.
- **Marine Minerals Information System Web Viewer –** Several of the variables in the ASTER analyses originate from the datasets housed on the MMIS Web Viewer. This is the home for data related to identifying sediment resources within the OCS. The MMIS database contains current and historical data related to the operation of the BOEM MMP, including geologic data sets and leasing information.
- **OBIS-SEAMAP –** OBIS-SEAMAP is an online repository for turtle researchers to house and share their data. Turtle records and turtle densities used in the ASTER application were retrieved from here. Additional analyses can be done by searching this website for more specific datasets.

F.2.1.4 New Report Button
In the center of the right panel of the ASTER tool is a "New Report" button. Once a user has zoomed and explored the map layers for an AOI, a user clicks the button to begin Step 1 on the next portion of the tool. Another "New Report" button is in the top-right of this panel. This button persists throughout the application and will reset the analysis to the first step at any point in the tool should there be a need to start over.

F.3 Analyze
Step 1 of the application consists of variable selection, definition and documenting any pertinent information before moving on. Instructions are listed on the page.

F.3.1 Selecting an Area

F.3.1.1 Organize Data By
This drop-down menu is the first step in the analysis, allowing a user to divide the analysis temporally, either by seasons or months. Each month or season will have its own determined risk score to assist in identifying an ideal time of year to conduct dredging operations. Data by month is averaged to determine a seasonal value when appropriate. Some data is already defined seasonally, these data sets will not be available as part of the monthly analysis to minimize any assumptions about the data. Seasons are defined as follows:

- Winter – December, January, February
- Spring – March, April, May
- Summer – June, July, August
- Fall – September, October, November

F.3.1.2 Select Area

Selecting a temporal organization from the drop-down menu enables the selection of an AOI. Users utilize the mouse to draw a polygon to select blocks for analysis. Blocks are based on BOEM lease blocks but have been extended into state-regulated waters. For the purpose of this tool, data is summarized by block as either a count, an average, or presence/absence. Various browsers may have similar but different methods for completing a polygon within the map. Drawing at least two points and completing by clicking on the first point will close the polygon on most browsers (Figure F.3). Closing a polygon will activate the “Apply Selection” button to the right of the drop-down.

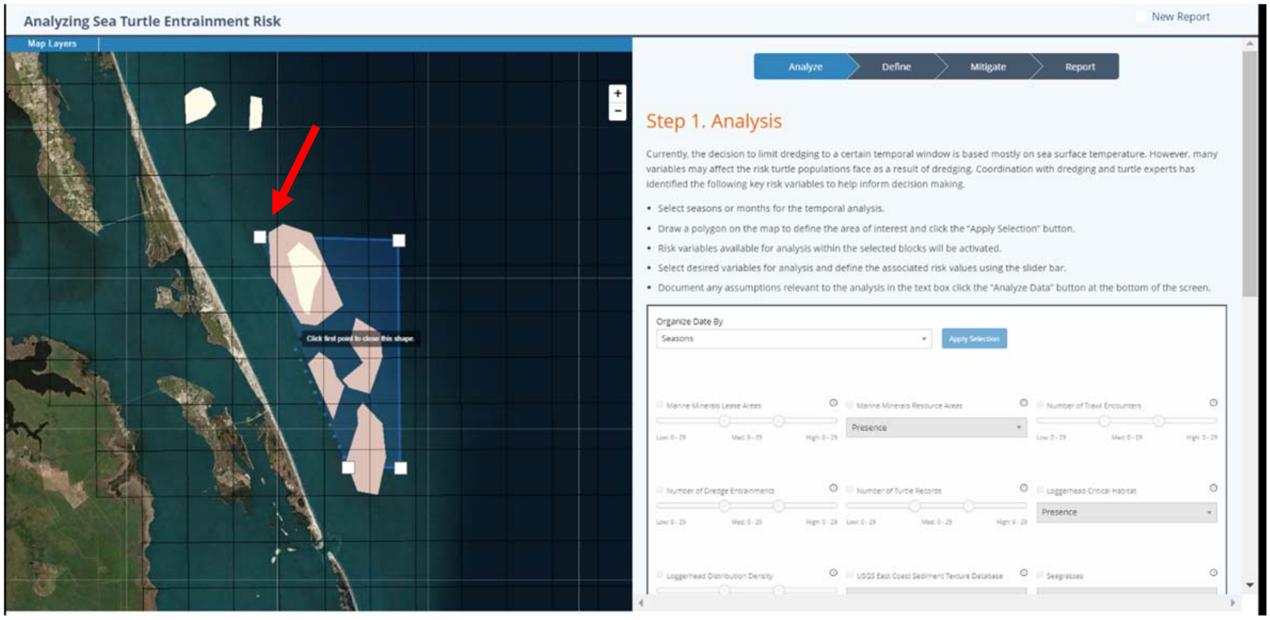


Figure F-3. Completing a polygon

After completing the selection, the blocks of the AOI will be highlighted (Figure F.4). The “Apply Selection” button changes to a “Redraw AOI” button, in the event a user’s AOI is unsatisfactory.

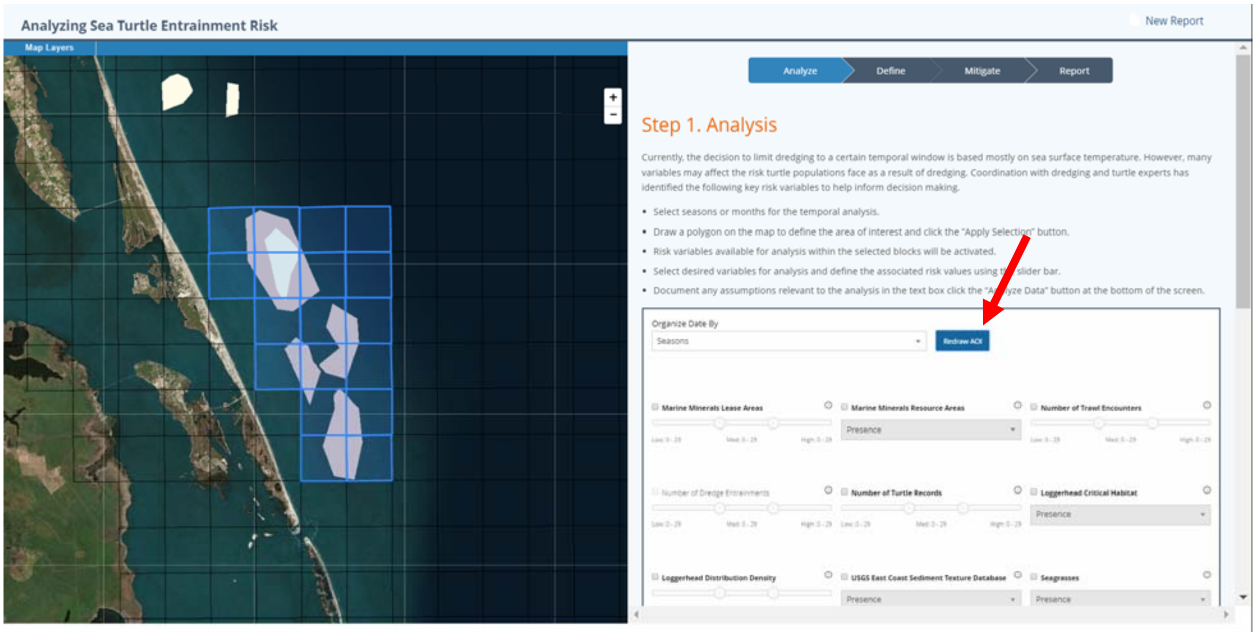


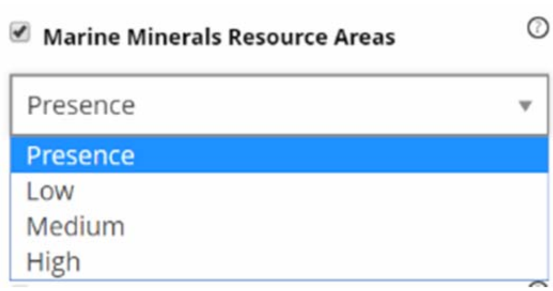
Figure F-4. Resulting selection and "Redraw AOI" button.

F.3.2 Selecting Data

F.3.2.1 Variable Selection

With the selection highlighted, variables with data that overlap in the AOI will activate, changing from gray to bold black (Table F.1). Variables were chosen after collaboration with experts from the dredging industry and the scientific sea turtle community. This tool uses readily consumable data associated with variables which are most likely to influence dredging efficacy and sea turtle entrainment risk. Additional variables with limited or no digitally available data are documented in the summary highlights from each meeting provided as appendices in the ESPIS final report for this project. Supplemental information for a variable is prompted on-screen when the check box is selected, or the ⓘ modal is clicked. This includes a description of why this variable may be relevant, as well as a link to the source data (when available) where the original dataset can be found and explored. There are two (2) types of variables, presence/absence, and count/range.

Presence/Absence: These variables are polygon data representing a seabed feature or political boundary (MMP lease areas, critical habitat designated areas, etc.). The presence of a particular feature may impact the likelihood of either turtles being present or the ability to dredge. It is up to the user to decide if the presence of the feature would indicate a Low, Medium, or High risk of sea turtle entrainment.



Count/Range: These variables are raster (continuous) or point data that reflect a range of values. The magnitude of the particular variable varies across the dataset, as does the risk. It is up to the user to decide what intervals reflect Low, Medium, or High risk. The scale bar reflects the range of values within the selected blocks; however, the information modal contains the range for the whole dataset. In combination, this information is intended to provide guidance to set the intervals while allowing professional knowledge to make the final determination. The user has the option to assign one, two, or three ranges depending on the placement of the slider thumbs. For instance, if the range of the whole turtle data set is 1–143, then the range of 1–23 in an AOI may warrant a completely low risk interval. Professional knowledge may influence a decision to have the low interval <10 turtle records, the medium interval as 10-20 turtle records, and the high interval >20 records because 143 is most likely an outlier and considered abnormal.

NOTE: A minimum of one variable needs to be selected to move forward in the processing, however, it is suggested that user picks more than one variable OR a count/range variable to have a range of risk scores calculated. Selecting a single risk score for an AOI and across all time periods does not allow for setting meaningful absolute risk intervals in Step 2. An error message will prompt a user to return and adjust the variable selection.

Table F.1. A list of variables and their associated analyses.

Variable Name	Variable Type	Analysis
Marine Minerals Lease Areas	Count	Count of sediment resource leases in the selected area
Marine Minerals Resource Areas	Presence	Presence/Absence of any level of confidence sediment resource area
Number of Relocation Trawling Encounters	Count	Count of any direct impacts of dredging activity with a turtle (relocation trawling or other)
Number of Dredge Encounters	Count	Count of any dredge-related takes, lethal or non-lethal (not a complete dataset)
Number of Turtle Records*	Count	Count of available visual (ship and aerial surveys) and telemetry turtle records in an area for a particular month or season
Loggerhead Critical Habitat	Presence	Presence/Absence of any Designated Critical Habitat
Loggerhead Distribution Density*	Range	Modeled mean loggerhead density over a block for a given season, not available as a monthly dataset
USGS East Coast Sediment Texture Database	Presence	Presence/Absence of any sample classified as Sand within a block
Seagrasses	Presence	Presence/Absence of seagrass within a block
NAMERA Benthic Habitat	Presence	Presence/Absence of gravel classed areas within a block
NOAA Benthic Habitat	Presence	Presence/Absence of features classified as anything other than Sand, Mud, or Unknown (e.g., Hard Bottom) within a block
US Navy Bottom Type	Presence	Presence/Absence of features classified as anything other than Soft (i.e., Hard Bottom) within a block
SEAMAP South Atlantic Bottom Type	Presence	Presence/Absence of features classified as Hard Bottom or Partial Hard Bottom within a block
Bathymetry	Range	Mean elevation value in meters within a block
Slope	Range	Mean slope value in degrees within a block calculated using ArcGIS Slope Spatial Analyst tool
Roughness	Range	Mean roughness value within a block calculated as the standard deviation of slope
SST*	Range	Mean SST in degrees Celsius within a block calculated as the mean monthly value over the last 10 years

Variable Name	Variable Type	Analysis
Current Velocity*	Range	Mean current velocity in meters per second within a block calculated as the mean monthly value over the last 10 years
Wind Velocity*	Range	Mean wind velocity in meters per second within a block calculated as the mean monthly value over the last 10 years
Significant Wave Height*	Range	Mean significant wave height in meters within a block calculated as the mean monthly value over the last 10 years
Chlorophyll *a**	Range	Mean chlorophyll *a* concentration in mg/m^3 within a block calculated as the mean monthly value over the last 10 years

*indicates values vary by month or season and will affect the temporal and spatial variation in risk, all others are constants throughout the year and will affect only the spatial distribution of risk.

F.3.2.2 Analysis Summary Text Box

To complete the initial setup, the user documents the logic associated with the choice of variables and risk ranges. Sources or reasoning that led to specific interval decisions will validate the resulting conclusions and provide a written account that can be distributed along with the analysis results. Text entered here will accompany the resulting final report. Standard formatting tools are provided, along with spellcheck, and text can be copied and pasted from other sources if desired. Providing a conclusion is required to activate the "Analyze Data" button to progress a user to the next step.

F.3.3 Processing

The low, medium and high ranges set in **Step 1** are used to assign qualitative risk scores of 1, 2, or 3, respectively, to each variable for each time interval. For example, using the Number of Turtle Records example listed in Section 3.2.1, a block in the spring may have 7 turtles, so that block/season combination would get a risk score of 1 (<10 records) for that variable. The same block in the summer may have 23 turtle records, therefore that block/season combination would have a risk score of 3 (>20 records) for that variable. That process is iterative for all the selected variables and for all block/season (or block/month) combinations. The variable scores for each block/time combination are then added for the total risk score, where the block/spring combination total might be 15 and the block/summer total might be 18.

F.4 Define

Step 2 allows the user to view preliminary results and asks the user to define ranges for indicating Low, Medium, and High risk at the block/time level, as opposed to the variable level. This allows users to visually and spatially compare risk throughout the year and provides a static definition of risk intervals when scores are adjusted during the optional mitigation selection (Step 3).

F.4.1 Histogram

The histogram is a graphical representation of the frequency distribution of continuous numerical data. It aggregates similar values to show the distribution. For ASTER, the continuous data is the total risk score calculated in Section 3.3 above (e.g., SST Risk + SWH Risk + Number of Turtle Records Risk + etc.). The range of risk scores for all block/time combinations are displayed on the X-axis (Figure F.5). The Y-axis represents the total number of blocks (the number of selected blocks multiplied by 4 (for a seasonal analysis) or 12 (for a monthly analysis)). The result is that each block has a risk score for each temporal division and a count of equal risk scores are displayed by the height of the bar.

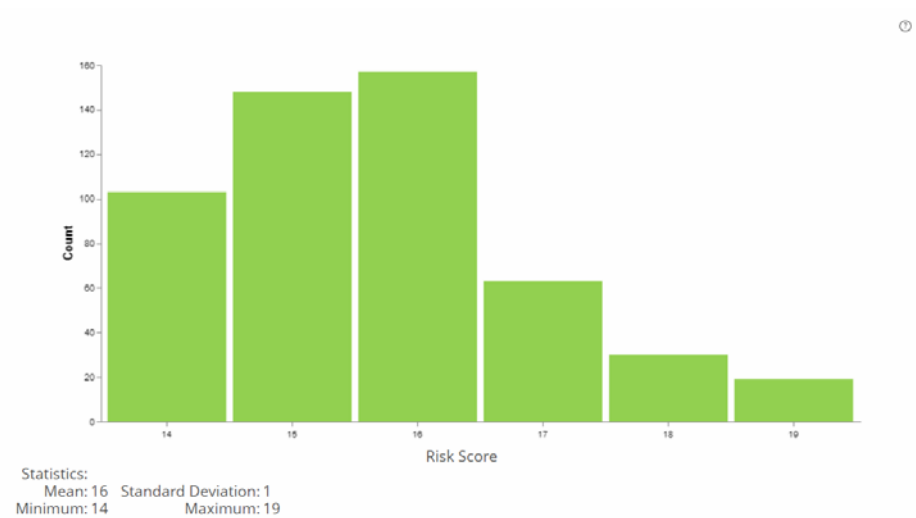


Figure F-5. A histogram output from ASTER

F.4.1.1 Statistics

Along with the histogram, some basic statistics are provided to assist in the interpretation of the data. Minimum, maximum, mean, and standard deviation.

F.4.2 Selecting Absolute Risk Intervals

The user is now asked to review the spread of risk scores and supplemental statistics. This should provide insight of normal "medium risk" in the AOI and for the selected variables. Once the data has been inspected, intervals should be defined using the slider bar below the histogram. As a guide, the mean plus one standard deviation ($\mu+\sigma$) could be used as the medium risk. In Figure F.5, that would set all block/time combinations with a value of 14 as low risk, those with values between 15-17 would be medium risk, and those with a score of above 18 would be high risk. Again, with varying experience, a user may choose to deviate from that norm. At least two (2) intervals must be used. If both slider handles are set to the minimum or maximum scale values, an error message will advise a user to edit the selection. This disables the "Apply Thresholds" button until the sliders are reset.

When the intervals are defined and pass the checks, the "Apply Thresholds" button will enable and a click will proceed to the Mitigation page (Step 3).

F.5 Mitigate

The resulting classification from Step 2 can now be visually inspected on the map. Based on these results, there are two options for moving forward. First, the results may be satisfactory, showing an acceptable level of risk in the targeted AOI. In this scenario, moving forward to generate the report would be appropriate. The other option, if the results are deemed too risky to proceed unchecked, is to apply mitigations which will "buy down" the inherent risk before generating a final report.

F.5.1 Review the Results

To review the results of the analysis, select a season/month from the drop-down menu. Results will be visible on the map panel. Continue to select different time periods to assess how risk changes throughout the year. (Figure F.6)

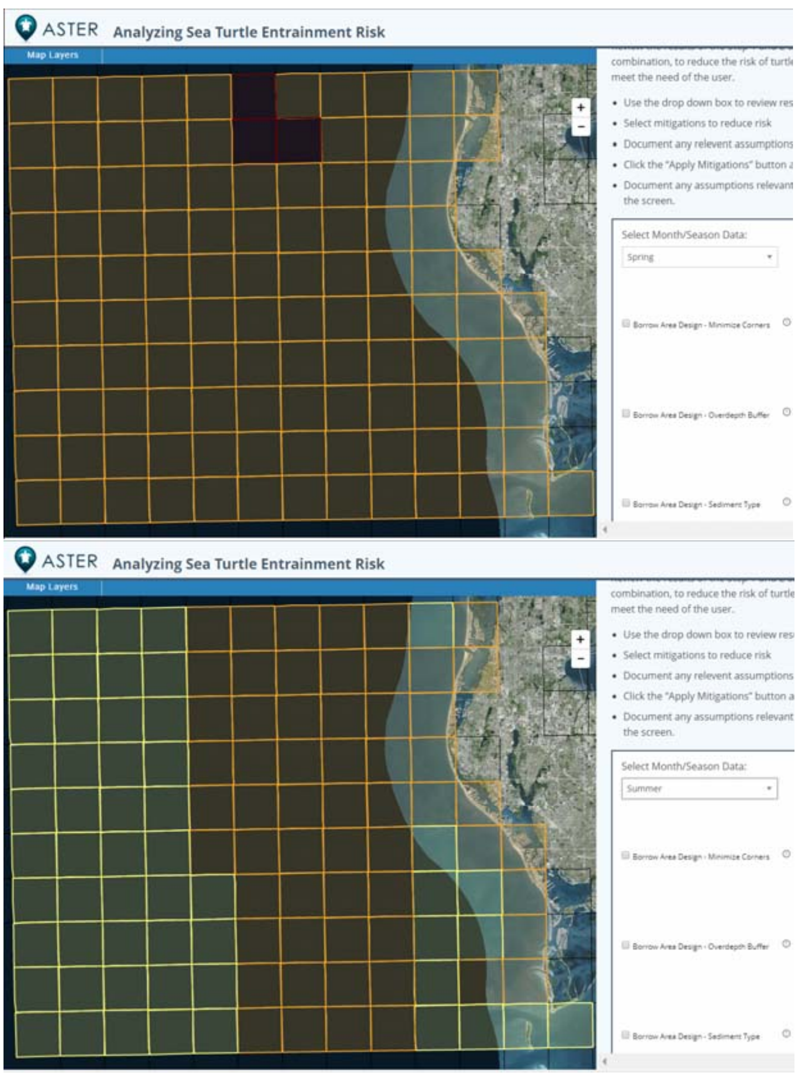


Figure F-6. Spring (top) versus Summer (bottom) results
Yellow indicates lower risk, orange indicates medium risk, and red indicates higher risk.

If there is already a planned time or location intended for dredging, pay particular attention to those corresponding analysis results. This is also an opportunity to overlay selected variable datasets from the Map Layers drop-down with the results in the map to see which, if any, layer influenced the results most (Figure F.7).

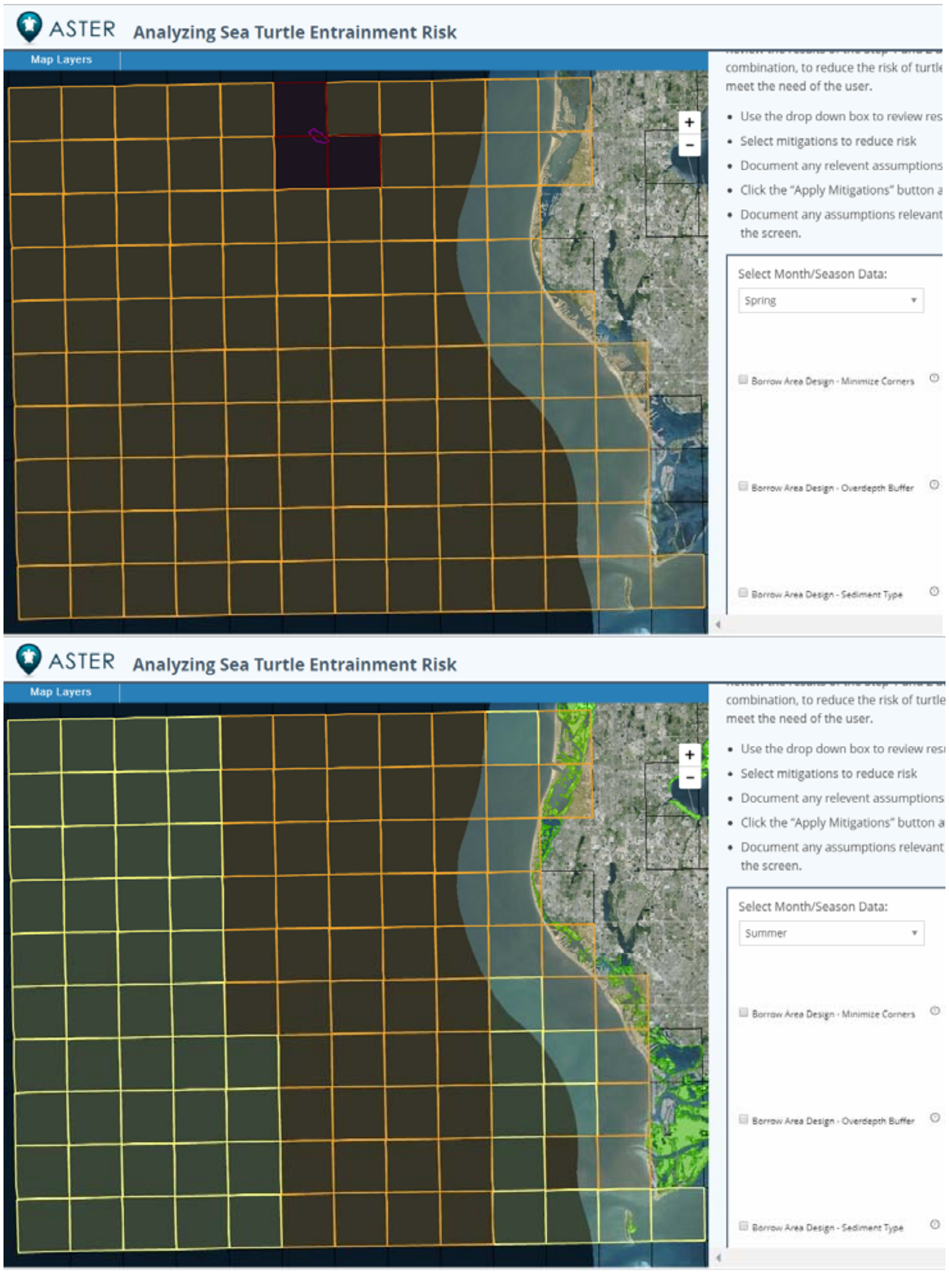


Figure F-7. Inference of layer influence on results
The spring distribution (top) seems to be partially influenced by the presence of a marine minerals lease in the northern portion of the AOI. The presence of seagrass is an example of a variable that may be influencing the results in the eastern portion of the AOI in the summer.

F.5.2 Mitigations

If the analysis meets the appropriate needs unaltered (without mitigation), skip to Section 5.4. Otherwise, there may be a need to further reduce the risk. This can be done by selecting one or more mitigation options provided. The credit associated with each mitigation is subtracted from the total risk score. The use of mitigations may drop a total risk score into the next lower risk interval so that a higher risk block may become a medium risk or a medium risk block may become a lower risk. This list of mitigation options was gathered from meetings with dredge industry and turtle experts as potential ways to reduce the risk of turtle entrainment (Table F.2). Note that currently all mitigations have an equal credit value due to limited research on the effectiveness of each measure. However, future versions of ASTER may weight the mititgations as more communicaiton with experts and information is available.

Table F.2. List of available mitigations, why they might be helpful, and the credit earned for use.

Mitigation	Purpose	Credit
Borrow Area Design - Minimize Corners	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. Minimizing the number of corners in the borrow area will maximize the surface area and volume that could be dredged and minimize the total number of turns and associated percentage of time that the draghead is raised off the bottom while maneuvering.	0.5
Borrow Area Design - Perpendicular Orientation	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. Maximizing the ability of the TSHD to orient perpendicular to the sea/wind/wave direction at any given time during operations would increase dredging efficiency and thereby reduce entrainment risk.	0.5
Borrow Area Design - Cut Length	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. A borrow area footprint that supports longer dredge cut lengths during each load cycle (e.g., 6,000 to 9,000 ft) would result in fewer turns and increased efficiency and thereby minimizing the time that the draghead is raised off the bottom reducing entrainment risk.	0.5
Borrow Area Design - Overdepth Buffer	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. Providing a reasonable overdepth buffer from unsuitable materials (at least 3 feet and preferably 5 - 7 feet) would accommodate for dredging inaccuracies and promote dredging efficiencies. To effectively maximize draghead contact with the bottom, overdepth dredging is often necessary (especially during rough sea states) to promote efficient operation of turtle deflecting dragheads. Extending geotechnical analyses below the desired cut depth should be considered for more informed dredging and to facilitate overdepth dredging decisions.	0.5
Borrow Area Design - Shallow Cut Depth	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. Dredging efficiencies may be achieved if project sediment volumes were obtained via shallower cumulative cut depths requiring fewer passes over a larger surface area (i.e., large ratio for total borrow surface area acreage available relative to the total volume and associated dredge depths) compared to obtaining the same volume via deeper cumulative cut depths requiring multiple passes within a smaller surface area. This would also minimize changes to seafloor relief which could potentially influence alterations in sea turtle habitat usage and efficacy of the turtle deflecting draghead.	0.5

Mitigation	Purpose	Credit
Borrow Area Design - Seafloor Bottom Profile	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. Bathymetry, rugosity, and geomorphology of the dredged area may impact the efficacy of the turtle deflecting draghead. The weight and leading-edge angle of sea turtle deflectors can influence the path the draghead takes when dredging over highly rugose areas (i.e., "crabbing"), which may lead to inefficient dredging and increased entrainment risk. The rugosity of the seafloor and draghead-related trenching may increase the risk of "crabbing" (when the draghead is pulled away from or under the dredge) due to the draghead falling into the trench or steep slope and orienting in a different direction from the dredge. Increased "crabbing" risk may affect sea turtle entrainment risk levels because dragheads need to be raised and reset more often during dredging to maintain vessel safety and to avoid equipment damage and, thus, decreasing dredging operations efficiency.	0.5
Borrow Area Design - Sediment Type	Borrow area design parameters are directly correlated with TSHD efficiency and productivity. TSHD efficiency may be affected by the amount of fine sediment (i.e., overfill ratio) in the borrow area. More sediment volume is needed to account for the loss of finer sediments during operations, thus, increasing project duration and potential risk of sea turtle entrainment. Additionally, the efficacy of the sea turtle deflecting draghead may be affected if sediment is too dense when a certain range of gradations are present. Sediment that is too dense may result in the inability of the deflector to plow through the sediment effectively, raising the draghead off the bottom, and increasing entrainment risk due to suboptimal draghead configurations (e.g., consistent contact of the draghead with the bottom is more difficult because it bounces off of the bottom more and presents difficulties maintaining the aft visor of the draghead on the bottom, etc.).	0.5
Trawling	Capture relocation trawling in advance of and during a TSHD project may reduce the number of turtles entrained by physically capturing and relocating turtles from the area of operation. Non-capture trawl sweeping in advance of and during a project may reduce the number of turtles entrained by disturbing them from the bottom and into the water column away from the TSHD area of operation. These mitigations are ideal for projects at less than 60ft depth, which is the average depth limit of a trawler. It should be noted that the presence of a trawler may also increase time on a project due to downtime associated with refueling, sea state constraints, relocating turtles, etc.	0.5
Turtle Deflecting Draghead	The installation of a rigid deflector on the draghead and associated operating conditions to promote burial of the leading-edge of the deflector would create a sand wave ahead of the draghead and "push" turtles away from the area of draghead entrainment risk. It is important to note that certain borrow area conditions may reduce the efficacy of the deflector, increase the risk of "crabbing," and reduce the intended mitigation value. TSHD operating conditions should be evaluated both before and during construction to consider whether reduction of sea turtle entrainment risk is obtained through the use of or removal of a turtle deflecting draghead.	0.5

F.5.3 Review Mitigation Results

Checking a mitigation box will dynamically change the results in the map display. Multiple mitigations can be selected. Only check boxes for mitigations that are intended to be used during a dredge project.

F.5.4 Mitigation Summary Text Box

The last step of the mitigation adjustment is to document the logic behind the choice(s) of mitigation or the lack thereof. Because all mitigations are credited equally, any disagreements or assumed weightings may be documented here. Sources or reasonings which led to these decisions will validate the resulting conclusions by providing a written account which will be distributed with the analysis. Text entered in this box will be available in its own section on the resulting final report. Standard formatting tools are provided, along with spell check, and text can be copied from other sources and pasted into the box for ease. This step is required to activate the "Generate Report" button that progresses the tool to the last step. Once the conclusion text is entered, click the "Generate Report" button to proceed.

F.6 Report

The results of the analysis are combined into a final report that can be exported and shared to support a larger decision analysis. The report can also be maintained as a record to consider if another lease is planned within the same area. The report contains several key sections outlined below.

F.6.1 Report Sections

Section 1: Data Input Table

This table is a record of all available and user selected variables with user defined risks. The table displays an average over the whole area (as opposed to "by block") for each time period in order to identify on a larger scale the time periods likely to have the lowest risk for dredging overall in the area of interest.

Section 2: Results Summary

An explicit statement of the highest and lowest risk time periods as determined by this support tool is provided.

Section 3: Conclusions

This section is a concatenation of the Analysis and Mitigation summary text boxes from Step 1 and Step 3 in the tool. Additional concluding thoughts or formatting can be added here for inclusion in the PDF version of the report.

Section 4: Additional Information

Because not all relevant dredging and turtle data was available for inclusion in this tool, or may not be quantifiable presently, technical experts from both the dredging industry and turtle workgroups proposed it may be necessary to mention other potential factors that could reduce future entrainment risks. It is important to consider these variables and mitigations in the larger decision of when and where to dredge for mineral resources to reduce turtle entrainment.

Section 5: Relevant Turtle Studies
This dataset reflects studies that contributed to the Number of Turtle Records variable gathered from OBIS-SEAMAP. The studies listed may provide additional useful information regarding sea turtle behavior in a user's AOI. Likewise, there may be a benefit to reaching out to the dataset provider to incorporate their expert knowledge of turtles in the area to the larger decision-making process.

Section 6: Data Sources
This section contains a listing of each variable, the source of the data, and a link to the data location. Deeper research into ASTER's datasets may be necessary to fully explore the risk of turtle entrainment in an AOI.

Section 7: Citation
A citation for the final report associated with the development of this tool as well as a citation for noting the use of this tool in any publication or presentation.

F.6.2 PDF Report

The final PDF version of the report will contain the user added text and a map appendix. The map appendix is a collection of maps, either 4 (seasonal) or 12 (monthly) displaying side-by-side the original analysis results and mitigated results so that the data can be viewed spatially without the need for proprietary software (Figure F.8).

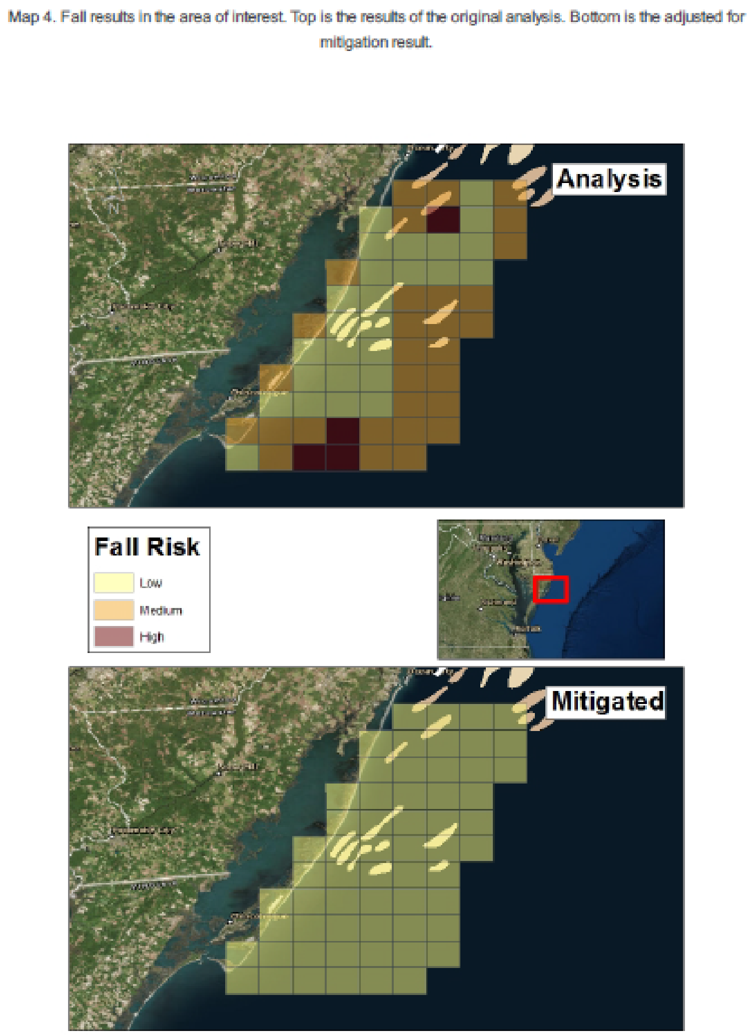


Figure F-8. Example from the map appendix

F.6.3 Export

Once the report has been reviewed, it can be exported and saved to a local location. A .ZIP file is generated containing the PDF version of the report and a feature class containing the analysis results for each block and time. The file contains the average/total variable value for range and count data sets, a yes/no flag for presence/absence data sets for each block and time, the assigned risk value for each variable/time combination, total risk score for each time period, and mitigated risk score for each time period (Table F.3). Data will be output as a file geodatabase (fGDB) for mapping application display and as a .CSV for viewing only the tabular data.

Table F.3. List of attributes for each block in the output feature class.

Attribute	Alias	Definition
Label	Label	Unique block ID, derived from BOEM leasing blocks; blocks in state waters were given the two-letter state code combined with a sequentially generated number.
Leases	Lease Count	Count of leases in the selected area
Resources	Resource Present	Presence/Absence of any level of confidence sediment resource area
TrawlEnc	Number of Relocation Trawl Encounters	Count of any direct impacts of dredging activity with a turtle (relocation trawling or other)
NumEntrained	Number of Dredge Encounters	Count of any dredge-related takes, lethal or non-lethal (not a complete dataset)
NumRecords	Number of Turtle Records	Count of available visual (ship and aerial surveys) and telemetry turtle records in an area for a particular month or season
TurtleCHD	Critical Habitat Present	Presence/Absence of any designated Critical Habitat areas
CcDensity	Loggerhead Density/km2	Mean loggerhead density over a block for a given season, not available as a monthly dataset
Sand	Sand Present	Presence/Absence of any sample classified as Sand within a block
Seagrass	Seagrass Present	Presence/Absence of seagrass within a block
BenHab_NAMERA	NAMERA Benthic Habitat	Presence/Absence of gravel classed areas within a block
BenHab_NOAA	NOAA Benthic Habitat	Presence/Absence of features classed as anything other than Sand, Mud, or Unknown (ie. Hard Bottom) within a block
BotTyp_USNavy	US Navy Bottom Type	Presence/Absence of features classified as anything other than Soft (ie. Hard Bottom) within a block
BotTyp_SEAMAP	SEAMAP South Atlantic Bottom Type	Presence/Absence of features classified as Hard Bottom or Partial Hard Bottom within a block
Depth	Depth (m)	Mean elevation value in meters within a block
Slope	Slope (Degrees)	Mean slope value in degrees within a block calculated using ArcGIS Slope Spatial Analyst tool
Roughness	Roughness	Mean roughness value within a block calculated as the standard deviation of slope
SST	Sea Surface Temperature	Mean SST in degrees Celsius within a block calculated as the mean monthly value over the last 10 years
CurrentVel	Current Velocity (m/s)	Mean current velocity in meters per second within a block calculated as the mean monthly value over the last 10 years

Attribute	Alias	Definition
WindVel	Wind Velocity (m/s)	Mean wind velocity in meters per second within a block calculated as the mean monthly value over the last 10 years
SWH	Significant Wave Height (m)	Mean significant wave height in meters within a block calculated as the mean monthly value over the last 10 years
ChlA	Chlorophyll *a* (mg/m3)	Mean chlorophyll *a* concentration in mg/m^3 within a block calculated as the mean monthly value over the last 10 years
LeaseRisk	Lease Risk	Risk value associated with the analysis area based on user risk definition for lease presence
DepthRisk	Depth Risk	Risk value associated with the analysis area based on user risk definition for Bathymetry
TrawlRisk	Trawl Encounter Risk	Risk value associated with the analysis area based on user risk definition for Number of Trawl Encounters
CHDRisk	Critical Habitat Risk	Risk value associated with the analysis area based on user risk definition for Critical Habitat presence
ResourceRisk	Resource Risk	Risk value associated with the analysis area based on user risk definition for Sediment Resource presence
USNavyRisk	US Navy HB Risk	Risk value associated with the analysis area based on user risk definition for Hard Bottom presence
SST_01Risk	SST Jan Risk	Risk value associated with the analysis area based on user risk definition for SST
CcDensity_01Risk	Cc Density Jan Risk	Risk value associated with the analysis area based on user risk definition for Loggerhead Density
TotalSeason#Risk	TotalSeason#Risk	Sum of risk values for a season
TotalMonth#Risk	TotalMonth#Risk	Sum of risk values for a month
MitCredits	Mitigation Credits	Total credits based on mitigation selections in Step 3
TotalSeason#Risk_Mit	Total Season# Risk	Final mitigated score for a season. TotalRisk - MitCredits
TotalMonth#Risk_Mit	Total Month# Risk	Final mitigated score for a month. TotalRisk - MitCredits

Note 1: For temporal variables, seasons and months indicated by _01, _02, _03, _04, etc., where 01 is either Winter or January.

Note 2: For Presence/Absence data, 0-no, 1-yes

Note 3: For risk values, 1-Low, 2-Medium, 3-High. Attributes may vary based on the variable selection from Step 1.

Appendix G: Review of DSTs Applicable to Analyzing Sea Turtle Entrainment Risks in TSHDs or Marine Spatial Planning

Many tools were evaluated, and the ones included in this list were leveraged in the development of the ASTER DST based on the degree to which a tool could incorporate multiple objectives, be spatially and temporally explicit, analyze alternative scenarios, be publicly accessible, and be currently available and supported.

ARIES (ARtificial Intelligence for Ecosystem Services)

URL:	http://aries.integratedmodelling.org
Organization:	Gund Institute for Ecological Economics; University of Vermont
Scope:	"to quantify the benefits that nature provides to society in a manner that accounts for dynamic complexity and its consequences"
Platform:	Web; k.LAB
Input:	Spatial datasets and values
Region:	Global
Products:	Maps, tables, reports
Reference:	Villa et al. (2014)

BASS (Bayesian Analysis for Spatial Siting)

URL:	http://hornet.coas.oregonstate.edu/bass
Organization:	Oregon State University
Scope:	"multi-criteria decision analysis system to evaluate ocean renewable energy project proposals in the context of [coastal and marine spatial planning]"
Platform:	Web; Windows, Accord Enterprise client/server application, Java
Input:	Spatial datasets, models, scientific measures, geographic information system linked Bayesian belief networks (GIS-BBNs)
Region:	Pacific US
Products:	Maps, tables, reports, models
References:	Parametrix (2013a; 2013b)

Co$ting Nature

URL:	http://www.policysupport.org/costingnature
Organization:	King's College London (models), AmbioTEK (software), UNEP-WCMC (applications)
Scope:	"a web based tool for natural capital accounting and analysing the ecosystem services provided by natural environments (i.e. nature's benefits), identifying the beneficiaries of these services and assessing the impacts of human interventions"
Platform:	Web; Any OS with Firefox with JavaScript
Input:	Spatial datasets and costs
Region:	Global
Products:	Maps, tables, reports
References:	Mulligan et al. (2010); Mulligan (2016)

EMDS (Ecosystem Management Decision Support) Priority Analyst

URL:	http://1726-4482.el-alt.com/
Organization:	Mountain View Business Group
Scope:	"an application framework for knowledge-based decision support of ecological analysis and planning at any geographic scale [and includes a] planning component that assists with setting priorities for management activities in landscape elements of the assessment area given results of a landscape evaluation performed by the NetWeaver logic engine"
Platform:	Desktop; Windows, Linux, Mac OS X
Input:	Spatial datasets and landscape features
Region:	Global
Products:	Maps, tables, reports
Reference:	Reynolds et al. (2014)

Habitat Priority Planner

URL:	https://coast.noaa.gov/digitalcoast/tools/hpp
Organization:	National Oceanic and Atmospheric Administration
Scope:	"aids in making decisions about conservation, restoration, and planning [that] allows users to easily test various ideas and 'what if' scenarios on the fly"
Platform:	Desktop; Windows, Microsoft.NET, ESRI Desktop
Input:	Spatial datasets
Region:	Global
Products:	Maps, tables, reports
References:	Bamford et al. (2009); OCM (2016)

InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs)

URL:	http://www.naturalcapitalproject.org/invest
Organization:	Natural Capital Project
Scope:	"suite of free, open-source software models used to map and value the goods and services from nature that sustain and fulfill human life"
Platform:	Desktop; ArcGIS compatible OS, open-source software and ArcGIS, Python
Input:	Spatial datasets and prices
Region:	Global
Products:	Maps, tables, reports
References:	Nelson et al. (2009); Sharp et al. (2015)

Marxan/Marxan with Zones

URL:	http://www.uq.edu.au/marxan/index.html?page=77654&p=1.1.4.1
Organization:	University of Queensland
Scope:	Marxan: "designed for solving complex conservation planning problems in landscapes and seascapes"; Marxan with Zones: "provides land-use zoning options in geographical regions for biodiversity conservation"
Platform:	Desktop; Windows, C++
Input:	Spatial datasets and costs
Region:	Global
Products:	Maps, tables, reports
References:	Ball et al. (2009); Watts et al. (2009)

MIMES-MIDAS (Multi-scale Integrated Model of Ecosystem Services - Marine Integrated Decision Analysis System)

URL:	http://www.afordablefutures.com
Organization:	AFORDable Futures
Scope:	"provides economic arguments for land use managers to approach conservation of ecosystems as a form of economic development. The model facilitates quantitative measures of ecosystem service effects on human well-being"
Platform:	Web; open-source software
Input:	Spatial datasets, models, prices
Region:	Global
Products:	Map, tables, reports
Reference:	Boumans et al. (2015)

SLAMM-View (Sea Level Affecting Marshes Model Visualization)

URL:	http://www.slammview.org
Organization:	Image Matters, LLC, US Fish and Wildlife Service, Warren Pinnacle Consulting, Inc., The Nature Conservancy, National Wildlife Federation
Scope:	"web browser-based application that provides tools for improved understanding of results from research projects that employ the Sea Level Affecting Marshes Model (SLAMM)"
Platform:	Web; Image Matters' user Smarts technology, Java and Javascript
Input:	Spatial datasets and resource values
Region:	US
Products:	Maps, tables, reports
Reference:	FWS et al. (2012)

Vista

URL:	http://www.natureserve.org/conservation-tools/natureserve-vista
Organization:	NatureServe
Scope:	"integrate conservation with many types of planning, ecosystem-based management, ecosystem-based adaptation, and scenario planning"
Platform:	Desktop; Windows, ArcGIS
Input:	Spatial datasets and resource values
Region:	Global
Products:	Maps, tables, reports
Reference:	NatureServe Vista (2011)

Zonation

URL:	http://cbig.it.helsinki.fi/software/zonation
Organization:	University of Helsinki, Department of Biosciences, Conservation Biology Informatics Group
Scope:	"produces a hierarchical prioritization of the landscape based on the occurrence levels of biodiversity features in sites (cells) by iteratively removing the least valuable remaining cell while accounting for connectivity and generalized complementarity"
Platform:	Desktop; Windows and GNU/Linux, C++ using the Qt toolkit, GDAL, open-source software
Input:	Spatial datasets (rasters), connectivity requirements, land cost, conservation areas, etc.
Region:	Global
Products:	Maps, table, reports, spatial datasets
References:	Moilanen et al. (2005); Moilanen (2007)

Department of the Interior (DOI)
The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)
The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program
The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).